

DRAFT STORM DRAINAGE REPORT

for

CROWN RIDGE ESTATES

SR-9 ROADWAY IMPROVEMENTS

STAR DEVELOPMENT, INC.

Prepared by:

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File No. 3-0226-0908

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CITY OF ARLINGTON

MJ 97-0005 LP

50% Submittal

Project Overview

The proposed project is the widening of State Route 9 in the vicinity of station 852+00 to station 864+00 south of the City of Arlington. See the location map, Figure 1. The road improvement project will provide a northbound right turn lane and a southbound left turn lane for the proposed Crown Ridge development entrance. Existing street lighting will be relocated and supplemented to accommodate this widening. The road improvement project will create more than 5,000 square feet of impervious area.

Stormwater detention and water quality are required for this project. Stormwater detention can be accommodated by an existing detention pond, located north of the entrance to the Gleneagle development by modifying the control structure. A filter strip is proposed adjacent to the proposed new pavement. This report describes the existing drainage system and the design of the proposed drainage system.

Downstream Analysis

A downstream analysis was performed for the proposed road improvement area. See the Downstream Analysis Map, Figure 2. Discharge from the existing detention pond located on the west side of SR-9 enters an existing 18-inch-diameter concrete culvert located at approximately 860+65, and discharges to the east side of SR-9. Stormwater then drains southeasterly approximately 30 feet and disperses into a wooded area. The east side of SR-9 sheet flows easterly into this wooded area. Stormwater from both of these sources sheet flows through the forested area easterly approximately 150 feet and enters a wetland.

The wooded wetland consists of a series of shallow pools and small random streams that generally drain northwesterly. This drainage becomes more defined when it reaches the roadside ditch located on the east side of SR-9 at approximately 867+00. This ditch has a two-foot bottom and is two to three feet deep. Stormwater drains northerly in the roadside ditch approximately 600 feet before being conveyed westerly across SR-9 by a 60-inch-diameter concrete culvert. Stormwater then is discharged to an open channel that is approximately three feet wide and four feet deep, and drains northerly along the west side of SR-9. There were no apparent signs of scouring, flooding, sedimentation or erosion throughout this drainageway.

Hydrologic Analysis

Stormwater Detention - The proposed stormwater system is designed in accordance with the WSDOT Highway Runoff manual and the Department of Ecology (DOE) manual. The detention requirements are to control stormwater discharge from the developed site to one-half of the existing 2-year storm and match the existing 10-year and 100-year storm events.

The detention volume required for this proposed development can be accommodated by an existing detention pond located on the west side of SR-9 north of Eaglefield Drive. Triad Associates designed this detention system as part of SR-9 road improvements associated with the Gleneagle development. This detention system was designed to accommodate full development of this intersection. Excerpts from Triad's drainage report dated November of 1995 are included in Appendix C.

The advantage of this design is that it consolidates stormwater detention systems required for the area. This reduces the impact to trees and wetlands on the east side of SR-9, and it reduces the number of systems to be maintained.

A recent topographic survey, as-built plan information, and an on-site field inspection were used to evaluate and confirm the condition and size of this existing detention pond and control structure. A hydrologic model (using Water Works software) was developed to assess the function of this system.

Two models were run to evaluate this detention system. Model 1 was run to verify Triad's model and confirm the surplus storage capacity of the existing detention system. Model 2 was run to assess how much of the surplus storage will be used when additional impervious area is added to the tributary basin.

In Model 1 the existing and proposed basin conditions are described as follows:

Existing Conditions

Tributary Area = 3.73 Ac

Impervious Area = 0.43 Ac @ CN = 98

Pervious Area = 3.30 Ac @ CN = 70

Developed Conditions

Tributary Area = 1.88 Ac

Impervious Area = 0.85Ac @ CN = 98

Pervious Area = 1.03.Ac @ CN = 74

The Existing Conditions Basin Map, and Developed Conditions Basing Map are shown in Figures 3 and 4. The Model 1 results show peak discharge rates similar to Triad's model results; i.e., Model 1 peak discharge rates are within three percent of Triad's model results. See Appendix A for Model 1 hydrologic calculations.

Model 2 is similar to Model 1, except that the impervious area is increased and the pervious area is decreased by 0.26 acres, an amount equivalent to the new pavement area proposed for the Crown Ridge SR-9 road improvements. (See bolded items as listed below.) See the Developed Conditions Map for Crown Ridge, Figure 5.

Existing Conditions

Tributary Area = 3.73 Ac
Impervious Area = 0.43 Ac @ CN = 98
Pervious Area = 3.30 Ac @ CN = 70

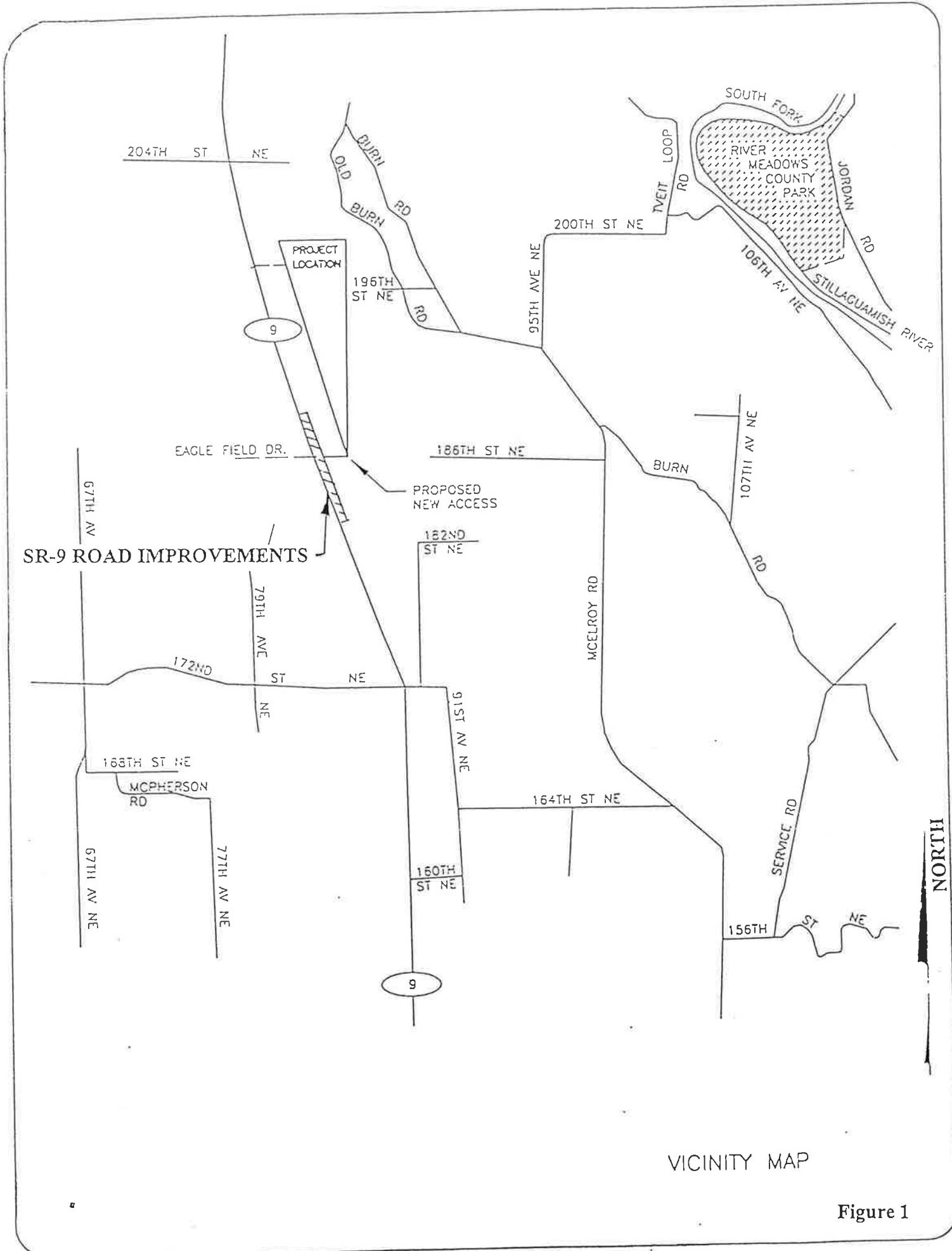
Developed Conditions

Tributary Area = 1.88 Ac
Impervious Area = 1.11 Ac @ CN = 98
Pervious Area = 0.77 Ac @ CN = 74

The affect of this change in the model is that the size of the control structure orifice must be reduced to maintain the same peak discharge rate.

The end result is that the smaller orifice reduces the discharge, forcing more water to be backed up and stored in the existing detention pond. The total amount of detention required for full development of this intersection is 6,024 cubic feet. This includes the application of a 35 percent safety factor based on a 59 percent impervious surface area for the basin. The existing detention pond has the capacity to store 6,120 cubic feet of stormwater.

Water Quality - A filter strip is proposed as part of the SR-9 road improvements. The proposed filter strip is 10 feet wide and has a six percent cross slope. The filter strip is adjacent to the new pavement. Stormwater will sheet flow from the pavement across the filter strip before draining into adjacent wooded areas.



VICINITY MAP

Figure 1

DOWNSTREAM DRAINAGE MAP

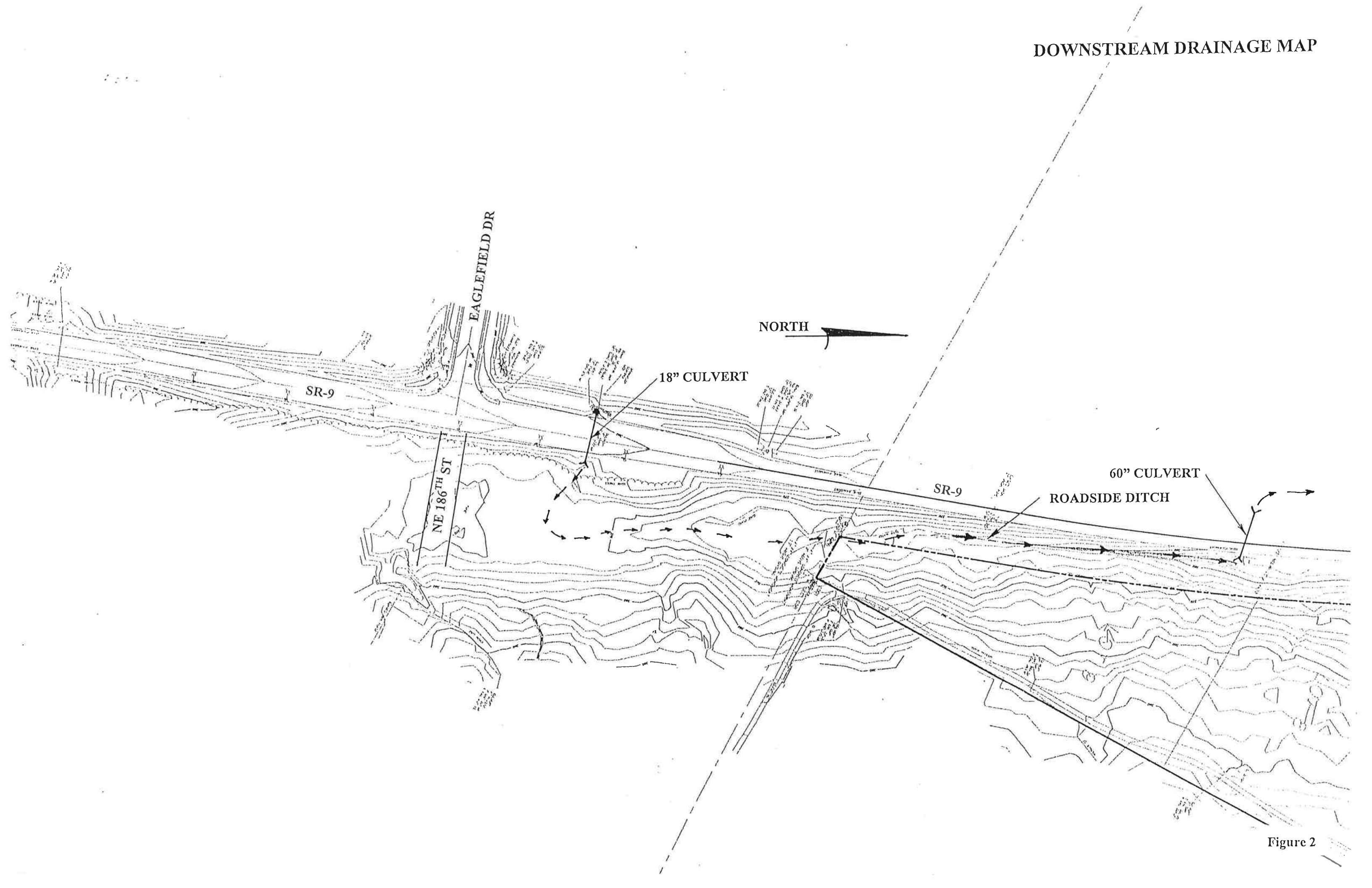
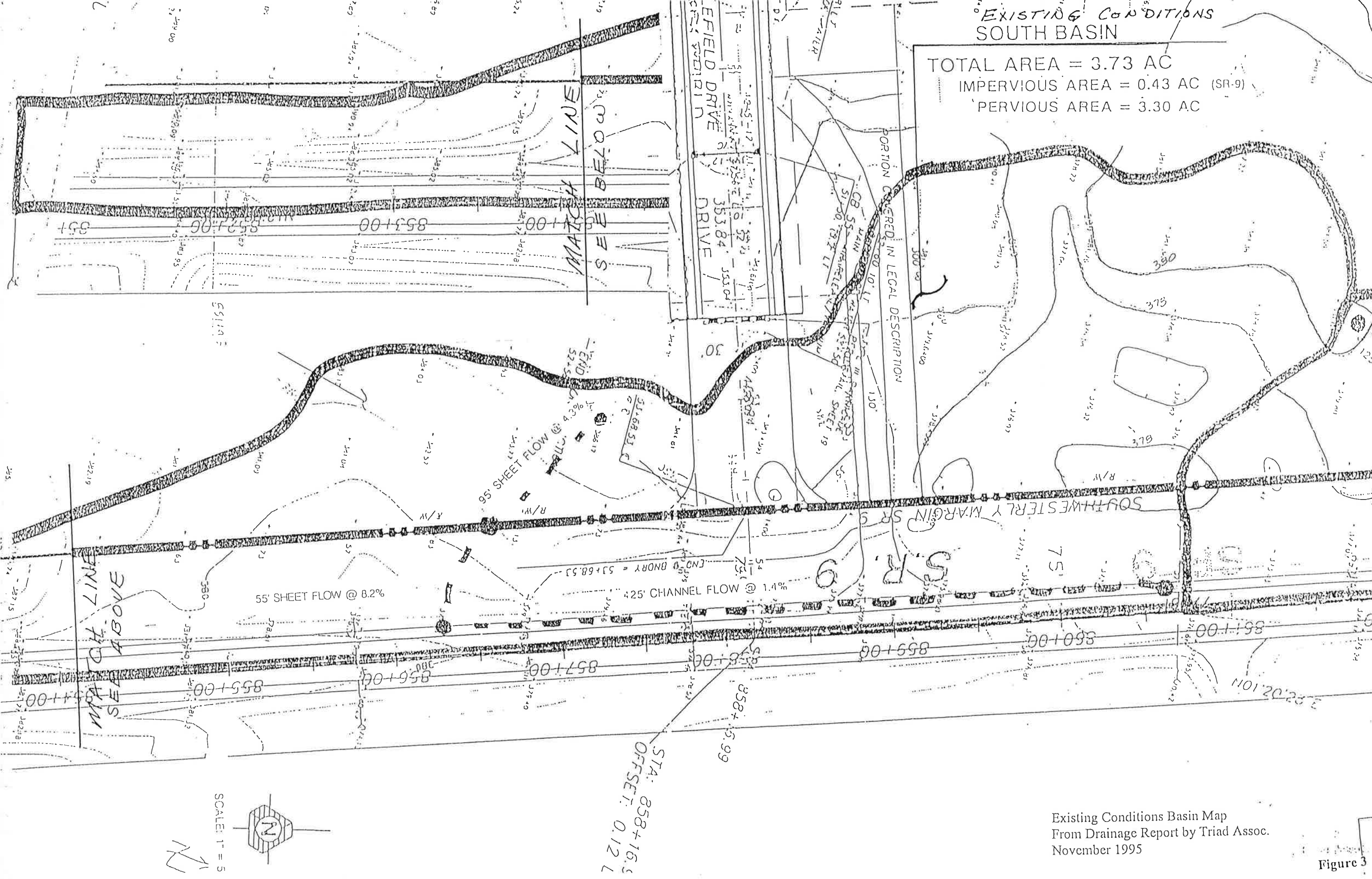


Figure 2

EXISTING CONDITIONS
SOUTH BASIN

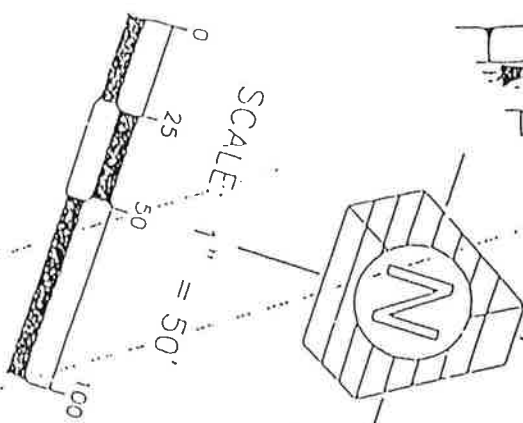
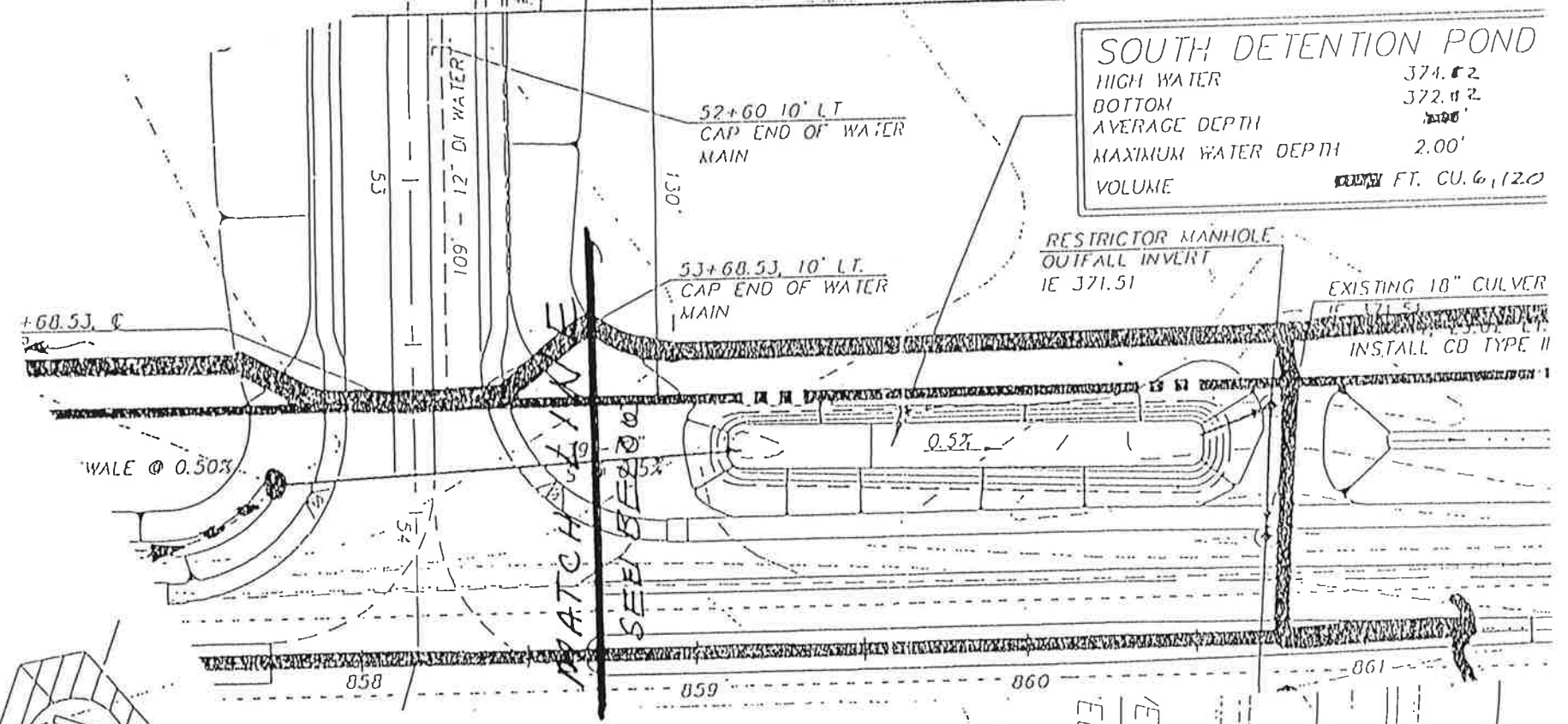
TOTAL AREA = 3.73 AC
 IMPERVIOUS AREA = 0.43 AC (SR-9)
 PERVIOUS AREA = 3.30 AC



Existing Conditions Basin Map
 From Drainage Report by Triad Assoc.
 November 1995

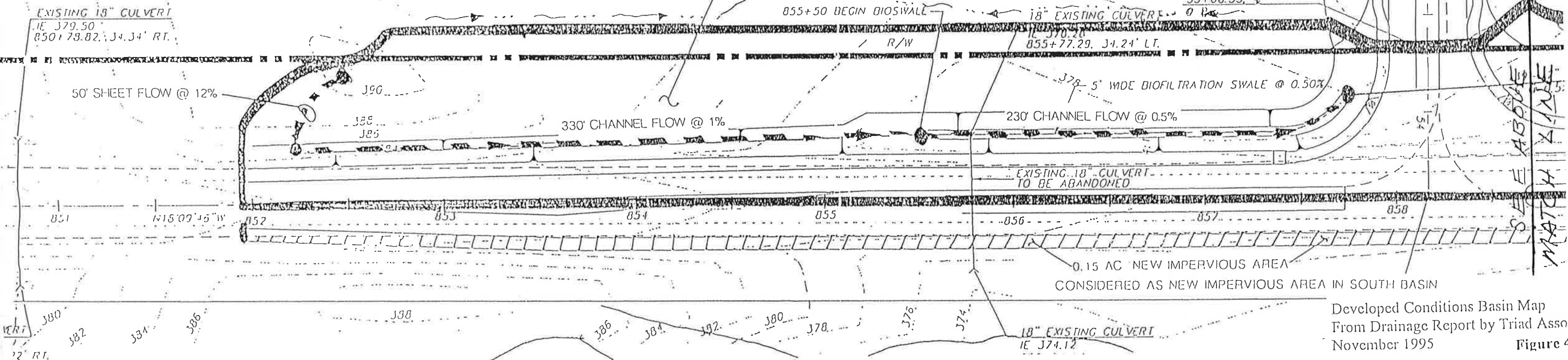
Figure 3

SOUTH DETENTION POND	
HIGH WATER	374.82
BOTTOM	372.82
AVERAGE DEPTH	2.00'
MAXIMUM WATER DEPTH	2.00'
VOLUME	100,000 FT. CU. 6,120

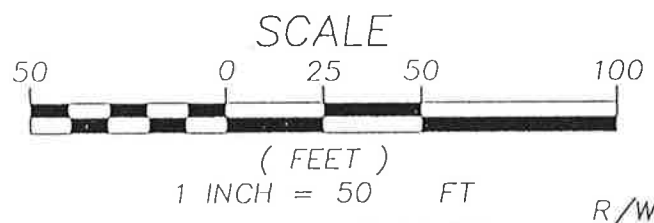
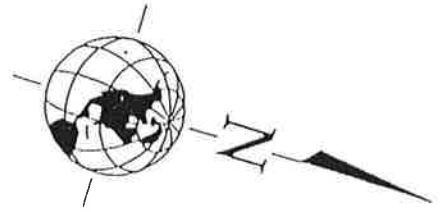


PROPOSED SOUTH BASIN
 DEVELOPED CONDITION
 TOTAL AREA = 1.88 AC
 IMPERVIOUS AREA = 0.85 AC
 NEW IMPERV. AREA = 0.42 AC
 PERVIOUS AREA = 1.03 AC

MATCH LINE SEE
 SECTOR 3A PLANS



Developed Conditions Basin Map
 From Drainage Report by Triad Asso
 November 1995
 Figure 4



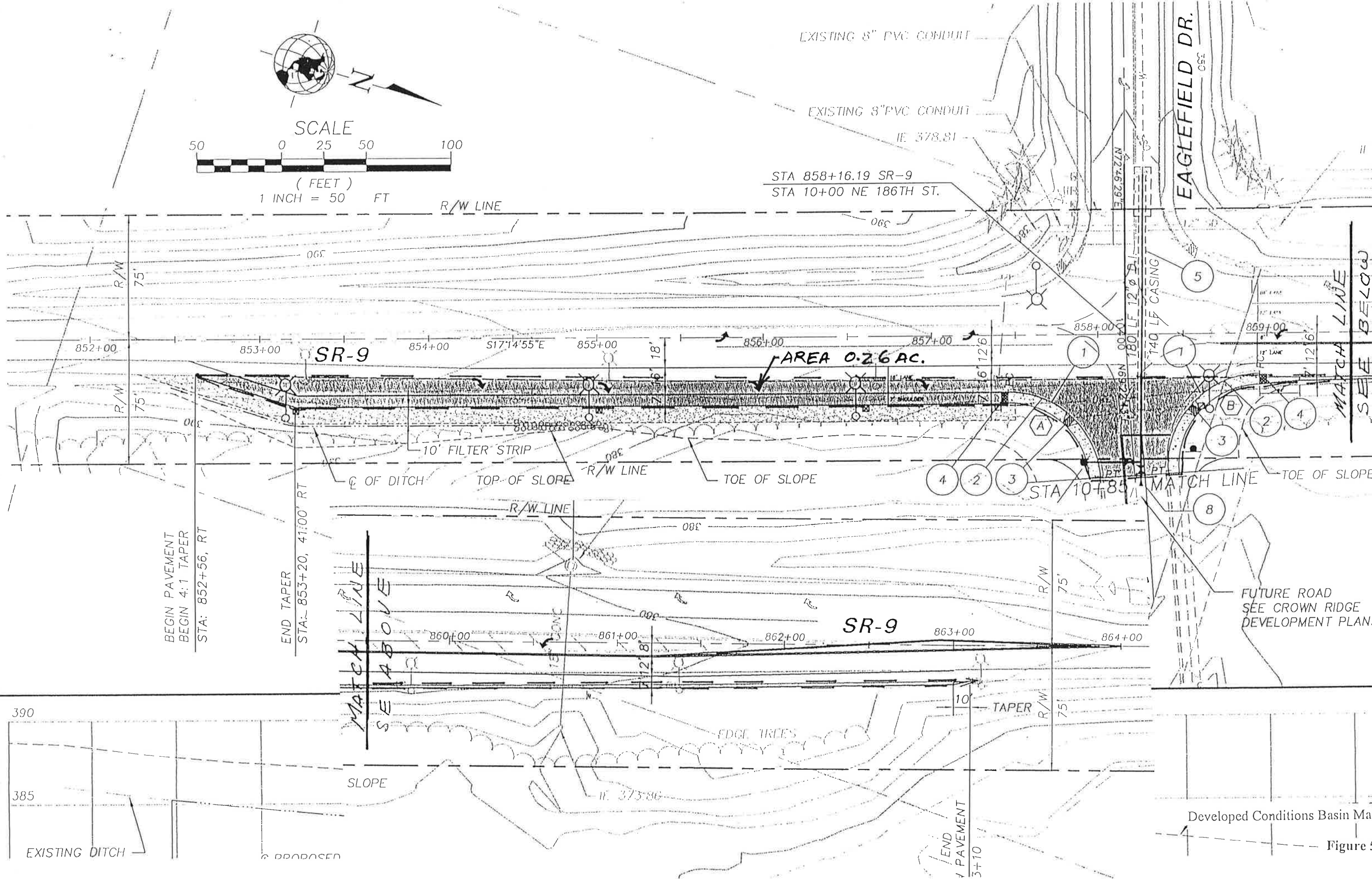
EXISTING 8" PVC CONDUIT

EXISTING 8" PVC CONDUIT

IE 378.81

STA 858+16.19 SR-9
STA 10+00 NE 186TH ST.

EAGLEFIELD DR.
055



SR-9

AREA 0.26 AC.

10' FILTER STRIP

Q OF DITCH

TOP OF SLOPE

R/W LINE

TOE OF SLOPE

TOE OF SLOPE

R/W LINE

SR-9

FUTURE ROAD
SEE CROWN RIDGE
DEVELOPMENT PLANS

BEGIN PAVEMENT
BEGIN 4:1 TAPER
STA: 852+56, RT

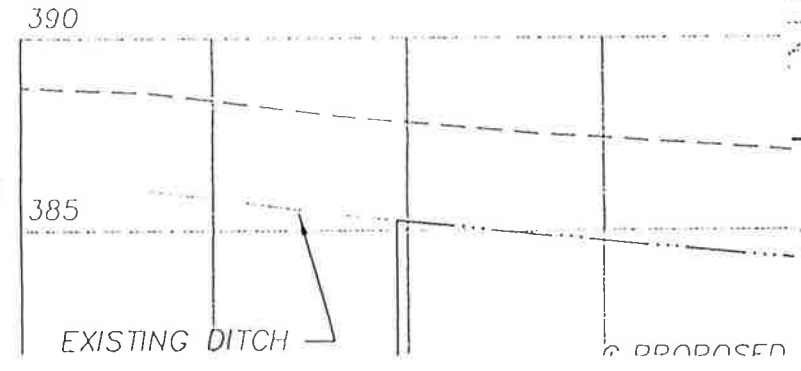
END TAPER
STA: 853+20, 41:00 RT

MATCH LINE
SEE ABOVE

STA 10+85

MATCH LINE

MATCH LINE
SEE BELOW



Developed Conditions Basin Map

Figure 5

APPENDIX A

3/10/98 4:55:46 pm

W&H Pacific, Inc.
CROWN RIDGE SR-9 WSDOT

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BASIN SUMMARY

BASIN ID: EX02 NAME: EXIST 2 YR 24 HR STORM
 SBUH METHODOLOGY
 TOTAL AREA.....: 3.73 Acres BASEFLOWS: 0.00 cfs
 RAINFALL TYPE....: TYPE1A PERV IMP
 PRECIPITATION....: 1.80 inches AREA...: 3.30 Acres 0.43 Acres
 TIME INTERVAL....: 10.00 min CN.....: 70.00 98.00
 TC.....: 29.93 min 6.00 min

ABSTRACTION COEFF: 0.20
 TcReach - Sheet L: 95.00 ns:0.4000 p2yr: 1.80 s:0.0430
 TcReach - Sheet L: 55.00 ns:0.2400 p2yr: 1.80 s:0.0820
 TcReach - Channel L: 425.00 kc:20.00 s:0.0140
 impTcReach - Sheet L: 50.00 ns:0.0110 p2yr: 1.80 s:0.0300
 impTcReach - Channel L: 425.00 kc:20.00 s:0.0140
 PEAK RATE: 0.15 cfs VOL: 0.10 Ac-ft TIME: 480 min

BASIN ID: EX10 NAME: EXIST 10 YR 24 HR STORM
 SBUH METHODOLOGY
 TOTAL AREA.....: 3.73 Acres BASEFLOWS: 0.00 cfs
 RAINFALL TYPE....: TYPE1A PERV IMP
 PRECIPITATION....: 2.75 inches AREA...: 3.30 Acres 0.43 Acres
 TIME INTERVAL....: 10.00 min CN.....: 70.00 98.00
 TC.....: 29.93 min 6.00 min

ABSTRACTION COEFF: 0.20
 TcReach - Sheet L: 95.00 ns:0.4000 p2yr: 1.80 s:0.0430
 TcReach - Sheet L: 55.00 ns:0.2400 p2yr: 1.80 s:0.0820
 TcReach - Channel L: 425.00 kc:20.00 s:0.0140
 impTcReach - Sheet L: 50.00 ns:0.0110 p2yr: 1.80 s:0.0300
 impTcReach - Channel L: 425.00 kc:20.00 s:0.0140
 PEAK RATE: 0.34 cfs VOL: 0.25 Ac-ft TIME: 480 min

BASIN ID: EX100 NAME: EXIST 100 YR 24 HR STORM
 SBUH METHODOLOGY
 TOTAL AREA.....: 3.73 Acres BASEFLOWS: 0.00 cfs
 RAINFALL TYPE....: TYPE1A PERV IMP
 PRECIPITATION....: 3.75 inches AREA...: 3.30 Acres 0.43 Acres
 TIME INTERVAL....: 10.00 min CN.....: 70.00 98.00
 TC.....: 29.93 min 6.00 min

ABSTRACTION COEFF: 0.20
 TcReach - Sheet L: 95.00 ns:0.4000 p2yr: 1.80 s:0.0430
 TcReach - Sheet L: 55.00 ns:0.2400 p2yr: 1.80 s:0.0820
 TcReach - Channel L: 425.00 kc:20.00 s:0.0140
 impTcReach - Sheet L: 50.00 ns:0.0110 p2yr: 1.80 s:0.0300
 impTcReach - Channel L: 425.00 kc:20.00 s:0.0140
 PEAK RATE: 0.73 cfs VOL: 0.45 Ac-ft TIME: 480 min

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BASIN SUMMARY

BASIN ID: PR02TR NAME: PROP 02 YR 24 HR STORM TRIAD
 SBUH METHODOLOGY
 TOTAL AREA.....: 1.88 Acres BASEFLOWS: 0.00 cfs
 RAINFALL TYPE....: TYPE1A PERV IMP
 PRECIPITATION....: 1.80 inches AREA...: 1.03 Acres 0.85 Acres
 TIME INTERVAL....: 10.00 min CN....: 74.00 98.00
 TC....: 9.60 min 6.46 min

ABSTRACTION COEFF: 0.20
 TcReach - Sheet L: 50.00 ns:0.1500 p2yr: 1.80 s:0.1200
 TcReach - Channel L: 330.00 kc:20.00 s:0.0100
 TcReach - Channel L: 230.00 kc:17.00 s:0.0050
 impTcReach - Sheet L: 30.00 ns:0.0110 p2yr: 1.80 s:0.0300
 impTcReach - Channel L: 330.00 kc:20.00 s:0.0100
 impTcReach - Channel L: 230.00 kc:17.00 s:0.0050
 PEAK RATE: 0.31 cfs VOL: 0.13 Ac-ft TIME: 480 min

BASIN ID: PR100TR NAME: PROP 100 YR 24 HR STORM TRIAD
 SBUH METHODOLOGY
 TOTAL AREA.....: 1.88 Acres BASEFLOWS: 0.00 cfs
 RAINFALL TYPE....: TYPE1A PERV IMP
 PRECIPITATION....: 3.75 inches AREA...: 1.03 Acres 0.85 Acres
 TIME INTERVAL....: 10.00 min CN....: 74.00 98.00
 TC....: 9.60 min 6.46 min

ABSTRACTION COEFF: 0.20
 TcReach - Sheet L: 50.00 ns:0.1500 p2yr: 1.80 s:0.1200
 TcReach - Channel L: 330.00 kc:20.00 s:0.0100
 TcReach - Channel L: 230.00 kc:17.00 s:0.0050
 impTcReach - Sheet L: 30.00 ns:0.0110 p2yr: 1.80 s:0.0300
 impTcReach - Channel L: 330.00 kc:20.00 s:0.0100
 impTcReach - Channel L: 230.00 kc:17.00 s:0.0050
 PEAK RATE: 0.92 cfs VOL: 0.37 Ac-ft TIME: 480 min

BASIN ID: PR10TR NAME: PROP 10 YR 24 HR STORM TRIAD
 SBUH METHODOLOGY
 TOTAL AREA.....: 1.88 Acres BASEFLOWS: 0.00 cfs
 RAINFALL TYPE....: TYPE1A PERV IMP
 PRECIPITATION....: 2.75 inches AREA...: 1.03 Acres 0.85 Acres
 TIME INTERVAL....: 10.00 min CN....: 74.00 98.00
 TC....: 9.60 min 6.46 min

ABSTRACTION COEFF: 0.20
 TcReach - Sheet L: 50.00 ns:0.1500 p2yr: 1.80 s:0.1200
 TcReach - Channel L: 330.00 kc:20.00 s:0.0100
 TcReach - Channel L: 230.00 kc:17.00 s:0.0050
 impTcReach - Sheet L: 30.00 ns:0.0110 p2yr: 1.80 s:0.0300
 impTcReach - Channel L: 330.00 kc:20.00 s:0.0100
 impTcReach - Channel L: 230.00 kc:17.00 s:0.0050
 PEAK RATE: 0.59 cfs VOL: 0.24 Ac-ft TIME: 480 min

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HYDROGRAPH SUMMARY

HYD NUM	PEAK RUNOFF RATE cfs	TIME OF PEAK min.	VOLUME OF HYDRO cf\AcFt	Contrib Area Acres
1	0.155	480	4497 cf	3.73
2	0.341	480	10879 cf	3.73
3	0.726	480	19453 cf	3.73
4	0.402	480	7081 cf	1.88
5	0.706	480	12258 cf	1.88
6	1.058	480	18122 cf	1.88
7	0.240	480	3964 cf	2.14
8	0.310	480	5840 cf	1.88
9	0.586	480	10592 cf	1.88
10	0.920	480	16140 cf	1.88
11	0.060	980	5844 cf	1.88
12	0.300	510	10592 cf	1.88
13	0.680	500	16144 cf	1.88

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STAGE STORAGE TABLE

TRAPEZOIDAL BASIN ID No. POND
Description: ROADSIDE POND
Length: 90.00 ft. Width: 11.00 ft.
Side Slope 1: 3 Side Slope 3: 3
Side Slope 2: 3 Side Slope 4: 4
Infiltration Rate: 0.00 min/inch

STAGE <----STORAGE---->			STAGE <----STORAGE---->			STAGE <----STORAGE---->			STAGE <----STORAGE---->		
(ft)	---cf---	--Ac-Ft-	(ft)	---cf---	--Ac-Ft-	(ft)	---cf---	--Ac-Ft-	(ft)	---cf---	--Ac-Ft-
373.30	0.0000	0.0000	374.30	1313	0.0301	375.30	3326	0.0764	376.30	6125	0.1406
373.40	102.10	0.0023	374.40	1481	0.0340	375.40	3569	0.0819	376.40	6451	0.1481
373.50	210.45	0.0048	374.50	1656	0.0380	375.50	3820	0.0877	376.50	6786	0.1558
373.60	325.14	0.0075	374.60	1839	0.0422	375.60	4079	0.0936	376.60	7130	0.1637
373.70	446.26	0.0102	374.70	2029	0.0466	375.70	4346	0.0998	376.70	7483	0.1718
373.80	573.88	0.0132	374.80	2226	0.0511	375.80	4622	0.1061	376.80	7844	0.1801
373.90	708.08	0.0163	374.90	2431	0.0558	375.90	4906	0.1126	376.90	8215	0.1886
374.00	848.97	0.0195	375.00	2643	0.0607	376.00	5198	0.1193	377.00	8596	0.1973
374.10	996.61	0.0229	375.10	2863	0.0657	376.10	5498	0.1262			
374.20	1151	0.0264	375.20	3091	0.0710	376.20	5807	0.1333			

373.20

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STAGE DISCHARGE TABLE

MULTIPLE ORIFICE ID No. CS
Description: CONTROL STRUCTURE
Outlet Elev: 373.20
Elev: 371.20 ft Orifice Diameter: 1.3418 in.
Elev: 374.80 ft Orifice 2 Diameter: 5.7422 in.
Elev: 375.00 ft Orifice 3 Diameter: 3.0000 in.

STAGE (ft)	<--DISCHARGE--> ---cfs--	STAGE (ft)	<--DISCHARGE--> ---cfs--	STAGE (ft)	<--DISCHARGE--> ---cfs--	STAGE (ft)	<--DISCHARGE--> ---cfs--
373.20	0.0000	374.50	0.0557	375.80	1.1920	377.10	1.8074
373.30	0.0155	374.60	0.0578	375.90	1.2504	377.20	1.8462
373.40	0.0218	374.70	0.0598	376.00	1.3062	377.30	1.8841
373.50	0.0268	374.80	0.0618	376.10	1.3596	377.40	1.9213
373.60	0.0309	374.90	0.3467	376.20	1.4109	377.50	1.9578
373.70	0.0345	375.00	0.4657	376.30	1.4604	377.60	1.9936
373.80	0.0378	375.10	0.6347	376.40	1.5082	377.70	2.0287
373.90	0.0409	375.20	0.7442	376.50	1.5545	377.80	2.0633
374.00	0.0437	375.30	0.8373	376.60	1.5995	377.90	2.0973
374.10	0.0464	375.40	0.9200	376.70	1.6432	378.00	2.1307
374.20	0.0489	375.50	0.9954	376.80	1.6858		
374.30	0.0512	375.60	1.0652	376.90	1.7273		
374.40	0.0535	375.70	1.1305	377.00	1.7678		

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LEVEL POOL TABLE SUMMARY

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<-----DESCRIPTION----->	MATCH (cfs)	INFLOW (cfs)	-STO- --id-	-DIS- --id-	<-PEAK-> <-STAGE>	id	OUTFLOW (cfs)	STORAGE VOL (cf)
2 YEAR	0.06	0.31	POND	CS	374.71	11	0.06	2043.98 cf
10 YEAR	0.30	0.59	POND	CS	374.88	12	0.30	2397.72 cf
100 YEAR	0.68	0.92	POND	CS	375.14	13	0.68	2957.76 cf

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APPENDIX B

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BASIN SUMMARY

BASIN ID: EX02 NAME: EXIST 2 YR 24 HR STORM
 SBUH METHODOLOGY
 TOTAL AREA.....: 3.73 Acres BASEFLOWS: 0.00 cfs
 RAINFALL TYPE....: TYPE1A PERV IMP
 PRECIPITATION....: 1.80 inches AREA...: 3.30 Acres 0.43 Acres
 TIME INTERVAL....: 10.00 min CN....: 70.00 98.00
 TC....: 29.93 min 6.00 min

ABSTRACTION COEFF: 0.20
 TcReach - Sheet L: 95.00 ns:0.4000 p2yr: 1.80 s:0.0430
 TcReach - Sheet L: 55.00 ns:0.2400 p2yr: 1.80 s:0.0820
 TcReach - Channel L: 425.00 kc:20.00 s:0.0140
 impTcReach - Sheet L: 50.00 ns:0.0110 p2yr: 1.80 s:0.0300
 impTcReach - Channel L: 425.00 kc:20.00 s:0.0140
 PEAK RATE: 0.15 cfs VOL: 0.10 Ac-ft TIME: 480 min

BASIN ID: EX10 NAME: EXIST 10 YR 24 HR STORM
 SBUH METHODOLOGY
 TOTAL AREA.....: 3.73 Acres BASEFLOWS: 0.00 cfs
 RAINFALL TYPE....: TYPE1A PERV IMP
 PRECIPITATION....: 2.75 inches AREA...: 3.30 Acres 0.43 Acres
 TIME INTERVAL....: 10.00 min CN....: 70.00 98.00
 TC....: 29.93 min 6.00 min

ABSTRACTION COEFF: 0.20
 TcReach - Sheet L: 95.00 ns:0.4000 p2yr: 1.80 s:0.0430
 TcReach - Sheet L: 55.00 ns:0.2400 p2yr: 1.80 s:0.0820
 TcReach - Channel L: 425.00 kc:20.00 s:0.0140
 impTcReach - Sheet L: 50.00 ns:0.0110 p2yr: 1.80 s:0.0300
 impTcReach - Channel L: 425.00 kc:20.00 s:0.0140
 PEAK RATE: 0.34 cfs VOL: 0.25 Ac-ft TIME: 480 min

BASIN ID: EX100 NAME: EXIST 100 YR 24 HR STORM
 SBUH METHODOLOGY
 TOTAL AREA.....: 3.73 Acres BASEFLOWS: 0.00 cfs
 RAINFALL TYPE....: TYPE1A PERV IMP
 PRECIPITATION....: 3.75 inches AREA...: 3.30 Acres 0.43 Acres
 TIME INTERVAL....: 10.00 min CN....: 70.00 98.00
 TC....: 29.93 min 6.00 min

ABSTRACTION COEFF: 0.20
 TcReach - Sheet L: 95.00 ns:0.4000 p2yr: 1.80 s:0.0430
 TcReach - Sheet L: 55.00 ns:0.2400 p2yr: 1.80 s:0.0820
 TcReach - Channel L: 425.00 kc:20.00 s:0.0140
 impTcReach - Sheet L: 50.00 ns:0.0110 p2yr: 1.80 s:0.0300
 impTcReach - Channel L: 425.00 kc:20.00 s:0.0140
 PEAK RATE: 0.73 cfs VOL: 0.45 Ac-ft TIME: 480 min

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BASIN SUMMARY

BASIN ID: PR02		NAME: PROP 02 YR 24 HR STORM		
SBUH METHODOLOGY				
TOTAL AREA.....:	1.88 Acres	BASEFLOWS:	0.00 cfs	
RAINFALL TYPE....:	TYPE1A	PERV		IMP
PRECIPITATION....:	1.80 inches	AREA...:	0.77 Acres	1.11 Acres
TIME INTERVAL....:	10.00 min	CN....:	74.00	98.00
		TC....:	9.60 min	6.46 min
ABSTRACTION COEFF:	0.20			
TcReach - Sheet L:	50.00 ns:0.1500	p2yr:	1.80	s:0.1200
TcReach - Channel L:	330.00 kc:20.00	s:0.0100		
TcReach - Channel L:	230.00 kc:17.00	s:0.0050		
impTcReach - Sheet L:	30.00 ns:0.0110	p2yr:	1.80	s:0.0300
impTcReach - Channel L:	330.00 kc:20.00	s:0.0100		
impTcReach - Channel L:	230.00 kc:17.00	s:0.0050		
PEAK RATE:	0.40 cfs	VOL:	0.16 Ac-ft	TIME: 480 min

BASIN ID: PR10		NAME: PROP 10 YR 24 HR STORM		
SBUH METHODOLOGY				
TOTAL AREA.....:	1.88 Acres	BASEFLOWS:	0.00 cfs	
RAINFALL TYPE....:	TYPE1A	PERV		IMP
PRECIPITATION....:	2.75 inches	AREA...:	0.77 Acres	1.11 Acres
TIME INTERVAL....:	10.00 min	CN....:	74.00	98.00
		TC....:	9.60 min	6.46 min
ABSTRACTION COEFF:	0.20			
TcReach - Sheet L:	50.00 ns:0.1500	p2yr:	1.80	s:0.1200
TcReach - Channel L:	330.00 kc:20.00	s:0.0100		
TcReach - Channel L:	230.00 kc:17.00	s:0.0050		
impTcReach - Sheet L:	30.00 ns:0.0110	p2yr:	1.80	s:0.0300
impTcReach - Channel L:	330.00 kc:20.00	s:0.0100		
impTcReach - Channel L:	230.00 kc:17.00	s:0.0050		
PEAK RATE:	0.71 cfs	VOL:	0.28 Ac-ft	TIME: 480 min

BASIN ID: PR100		NAME: PROP 100 YR 24 HR STORM		
SBUH METHODOLOGY				
TOTAL AREA.....:	1.88 Acres	BASEFLOWS:	0.00 cfs	
RAINFALL TYPE....:	TYPE1A	PERV		IMP
PRECIPITATION....:	3.75 inches	AREA...:	0.77 Acres	1.11 Acres
TIME INTERVAL....:	10.00 min	CN....:	74.00	98.00
		TC....:	9.60 min	6.46 min
ABSTRACTION COEFF:	0.20			
TcReach - Sheet L:	50.00 ns:0.1500	p2yr:	1.80	s:0.1200
TcReach - Channel L:	330.00 kc:20.00	s:0.0100		
TcReach - Channel L:	230.00 kc:17.00	s:0.0050		
impTcReach - Sheet L:	30.00 ns:0.0110	p2yr:	1.80	s:0.0300
impTcReach - Channel L:	330.00 kc:20.00	s:0.0100		
impTcReach - Channel L:	230.00 kc:17.00	s:0.0050		
PEAK RATE:	1.06 cfs	VOL:	0.42 Ac-ft	TIME: 480 min

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HYDROGRAPH SUMMARY

HYD NUM	PEAK RUNOFF RATE cfs	TIME OF PEAK min.	VOLUME OF HYDRO cf\AcFt	Contrib Area Acres
1	0.155	480	4497 cf	3.73
2	0.341	480	10879 cf	3.73
3	0.726	480	19453 cf	3.73
4	0.402	480	7081 cf	1.88
5	0.706	480	12258 cf	1.88
6	1.058	480	18122 cf	1.88
11	0.055	1350	7084 cf	1.88
12	0.223	570	12265 cf	1.88
13	0.693	500	18123 cf	1.88

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STAGE STORAGE TABLE

TRAPEZOIDAL BASIN ID No. POND
Description: ROADSIDE POND
Length: 90.00 ft. Width: 11.00 ft.
Side Slope 1: 3 Side Slope 3: 3
Side Slope 2: 3 Side Slope 4: 4
Infiltration Rate: 0.00 min/inch

STAGE <----STORAGE---->			STAGE <----STORAGE---->			STAGE <----STORAGE---->			STAGE <----STORAGE---->		
(ft)	---cf---	--Ac-Ft-	(ft)	---cf---	--Ac-Ft-	(ft)	---cf---	--Ac-Ft-	(ft)	---cf---	--Ac-Ft-
373.30	0.0000	0.0000	374.30	1313	0.0301	375.30	3326	0.0764	376.30	6125	0.1406
373.40	102.10	0.0023	374.40	1481	0.0340	375.40	3569	0.0819	376.40	6451	0.1481
373.50	210.45	0.0048	374.50	1656	0.0380	375.50	3820	0.0877	376.50	6786	0.1558
373.60	325.14	0.0075	374.60	1839	0.0422	375.60	4079	0.0936	376.60	7130	0.1637
373.70	446.26	0.0102	374.70	2029	0.0466	375.70	4346	0.0998	376.70	7483	0.1718
373.80	573.88	0.0132	374.80	2226	0.0511	375.80	4622	0.1061	376.80	7844	0.1801
373.90	708.08	0.0163	374.90	2431	0.0558	375.90	4906	0.1126	376.90	8215	0.1886
374.00	848.97	0.0195	375.00	2643	0.0607	376.00	5198	0.1193	377.00	8596	0.1973
374.10	996.61	0.0229	375.10	2863	0.0657	376.10	5498	0.1262			
374.20	1151	0.0264	375.20	3091	0.0710	376.20	5807	0.1333			

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STAGE DISCHARGE TABLE

COMBINATION DISCHARGE ID No. COMB
Description: COMBINATION ORIFICE/NOTCH WEIR
Structure: CS1 Structure:
Structure: WEIR Structure:
Structure:

STAGE	<--DISCHARGE-->	STAGE	<--DISCHARGE-->	STAGE	<--DISCHARGE-->	STAGE	<--DISCHARGE-->
(ft)	---cfs--	(ft)	---cfs--	(ft)	---cfs--	(ft)	---cfs--
372.42	0.0000	373.90	0.0399	375.40	0.0651	376.90	4.6461
372.50	0.0093	374.00	0.0413	375.50	0.1803	377.00	5.0001
372.60	0.0139	374.10	0.0426	375.60	0.3606	377.10	5.3441
372.70	0.0174	374.20	0.0438	375.70	0.5847	377.20	5.6755
372.80	0.0202	374.30	0.0450	375.80	0.8428	377.30	5.9919
372.90	0.0227	374.40	0.0462	375.90	1.1281	377.40	6.2909
373.00	0.0250	374.50	0.0474	376.00	1.4358	377.50	6.5697
373.10	0.0271	374.60	0.0485	376.10	1.7618	377.60	6.8261
373.20	0.0290	374.70	0.0496	376.20	2.1023	377.70	7.0573
373.30	0.0308	374.80	0.0507	376.30	2.4543	377.80	7.2609
373.40	0.0325	374.90	0.0517	376.40	2.8146	377.90	7.4343
373.50	0.0341	375.00	0.0527	376.50	3.1805	378.00	7.5749
373.60	0.0357	375.10	0.0538	376.60	3.5493		
373.70	0.0371	375.20	0.0547	376.70	3.9182		
373.80	0.0386	375.30	0.0557	376.80	4.2846		

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STAGE DISCHARGE TABLE

MULTIPLE ORIFICE ID No. CS1
Description: CONTROL STRUCTURE
Outlet Elev: 372.42
Elev: 371.57 ft Orifice Diameter: 1.1000 in.

STAGE (ft)	<--DISCHARGE--> ---cfs--	STAGE (ft)	<--DISCHARGE--> ---cfs--	STAGE (ft)	<--DISCHARGE--> ---cfs--	STAGE (ft)	<--DISCHARGE--> ---cfs--
372.42	0.0000	373.90	0.0399	375.40	0.0567	376.90	0.0695
372.50	0.0093	374.00	0.0413	375.50	0.0576	377.00	0.0703
372.60	0.0139	374.10	0.0426	375.60	0.0586	377.10	0.0710
372.70	0.0174	374.20	0.0438	375.70	0.0595	377.20	0.0718
372.80	0.0202	374.30	0.0450	375.80	0.0604	377.30	0.0725
372.90	0.0227	374.40	0.0462	375.90	0.0613	377.40	0.0733
373.00	0.0250	374.50	0.0474	376.00	0.0621	377.50	0.0740
373.10	0.0271	374.60	0.0485	376.10	0.0630	377.60	0.0747
373.20	0.0290	374.70	0.0496	376.20	0.0638	377.70	0.0755
373.30	0.0308	374.80	0.0507	376.30	0.0647	377.80	0.0762
373.40	0.0325	374.90	0.0517	376.40	0.0655	377.90	0.0769
373.50	0.0341	375.00	0.0527	376.50	0.0663	378.00	0.0776
373.60	0.0357	375.10	0.0538	376.60	0.0671		
373.70	0.0371	375.20	0.0547	376.70	0.0679		
373.80	0.0386	375.30	0.0557	376.80	0.0687		

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STAGE DISCHARGE TABLE

NOTCH WEIR ID No. WEIR
Description:
Weir Length: 0.9100 ft. Weir height (p): 0.8000 ft.
Elevation : 375.38 ft. Weir Increm: 0.10

STAGE	<--DISCHARGE-->	STAGE	<--DISCHARGE-->	STAGE	<--DISCHARGE-->	STAGE	<--DISCHARGE-->
(ft)	---cfs--	(ft)	---cfs--	(ft)	---cfs--	(ft)	---cfs--
375.38	0.0000	375.70	0.5253	376.10	1.6988	376.50	3.1142
375.40	0.0084	375.80	0.7824	376.20	2.0385	376.60	3.4821
375.50	0.1226	375.90	1.0669	376.30	2.3896		
375.60	0.3020	376.00	1.3737	376.40	2.7491		

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LEVEL POOL TABLE SUMMARY

-----DESCRIPTION----->	MATCH (cfs)	INFLOW (cfs)	-STO- --id-	-DIS- --id-	<-PEAK-> <-STAGE>	id	OUTFLOW (cfs)	STORAGE VOL (cf)
2 YEAR	0.06	0.40	POND	COMB	375.26	11	0.06	3222.91 cf
10 YEAR	0.24	0.71	POND	COMB	375.52	12	0.22	3881.84 cf
100 YEAR	0.68	1.06	POND	COMB	375.74	13	0.69	4462.46 cf

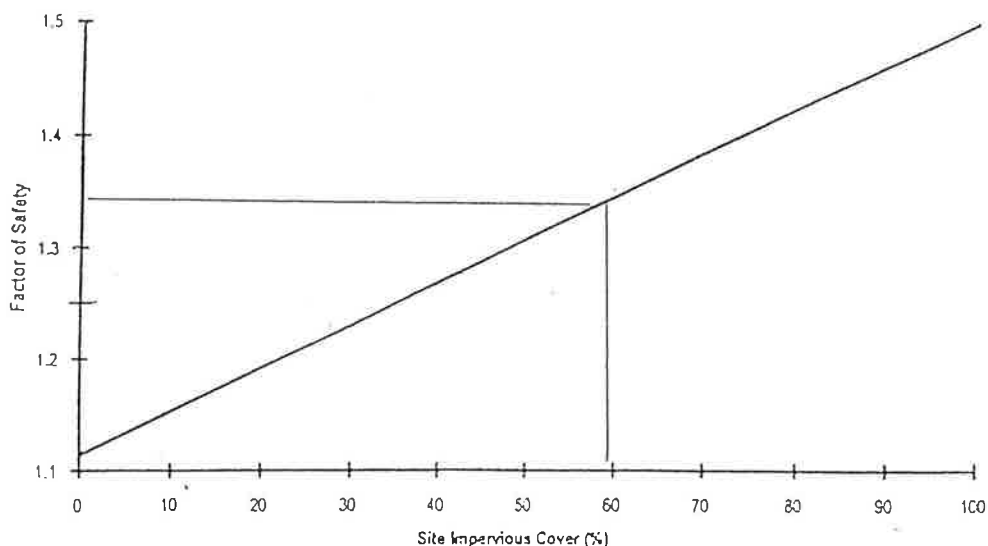
$$\% \text{ IMPERVIOUS} = \frac{1.11}{1.88} = \underline{\underline{59\%}}$$

FROM FIGURE Z-6.2 (HIGHWAY RUNOFF MANU.)
SAFETY FACTOR = 35%

REQUIRED DETENTION (FULL BUILD OUT)

$$4462 \times 1.35 = \underline{\underline{6024 \text{ CF}}}$$

DETENTION PROVIDED = 6120 CF
(EXISTING DETENTION POND)



Factor of Safety for Detention Ponds and Vaults

Figure 2-6.2

2-7 Minimum Requirement 6 — Wetlands

Stormwater runoff discharging to a wetland must be treated for water quality and quantity in a manner consistent with that described in Minimum Requirement 4 and 5. Stormwater treatment facilities should not be placed in the designated buffer for a wetland.

Wetlands are more sensitive to varying site specific and regional conditions. Thus every wetland must be evaluated on a case-by-case basis to determine impacts of stormwater discharges. The diversity in the values and functions of a wetland, as well as the uniqueness of the type of wetland, will need to be understood before determining if the treatment provided by Minimum Requirements 4 and 5 will adequately protect the receiving wetland. In addition, the management strategy for wetlands on a watershed basis will influence available stormwater control options. The best source of information regarding wetlands is the service center Biology Unit. Preliminary guidelines are provided in Section 5-2.10.

If a wetland is created to replace wetlands that were unavoidably destroyed during design and construction of a project, that wetland can not be used for stormwater treatment. Constructed wetlands can be designed to treat stormwater runoff. A constructed wetland must be in an area that was not a wetland and be designed specifically for the purpose of treating stormwater. The designers should see the Hydraulics Section for guidance if they want to use a Constructed Wetland BMP.

2-8 Minimum Requirement 7 — Downstream Analysis

An analysis shall be performed to determine the potential impacts from the project on the downstream system. At a minimum, the downstream analysis will include the area from the project site to a point one quarter of a mile downstream of the

Land Use Description	Curve Numbers by Hydrologic Soil Group			
	A	B	C	D
Mountain brush — oak brush, aspen, maple:				
Good Condition: ground cover > 70%	40	40	41	48
Fair Condition: ground cover 30% to 70%	40	48	57	63
Poor Condition: ground cover < 30%	46	66	74	79
Woods or forest land:				
Good condition: Natural conditions	40	55	70	77
Fair condition: Some forest litter	40	60	73	79
Poor condition: No small trees or brush	45	66	77	83
Woods/Grass combination (orchard or tree farm):				
Good condition: ground cover > 75%	40	58	72	79
Fair condition: ground cover 50% to 75%	43	65	76	82
Poor condition: ground cover < 50%	57	73	82	86
Brush with weeds and grass:				
Good condition: ground cover > 75%	40	48	65	73
Fair condition: ground cover 50% to 75%	40	56	70	77
Poor condition: ground cover < 50%	48	67	77	83
Meadow — continuous grass:	40	58	71	78
Residential districts:				
¼ acre lots:	61	75	83	87
½ acre lots:	57	72	81	86
¾ acre lots:	54	70	80	85
1 acre lots:	51	68	79	84
Pasture or range:				
Good condition: lightly grazed	40	61	74	80
Fair condition: not heavily grazed	49	69	79	84
Poor condition: heavily grazed w/no mulch	68	79	86	89
Newly graded areas (no vegetation established)	77	86	91	94
Open spaces, lawns, parks, golf courses, cemeteries:				
Good condition: grass cover > 75%	40	61	74	80
Fair condition: grass cover 50% to 75%	49	69	79	84
Poor condition: grass cover < 50%	68	79	86	89
Gravel roads and parking lots:	88	92	95	98
Dirt roads and parking lots:	86	90	94	98
Impervious surfaces: pavement and roofs	98	98	98	98
Open water bodies: lakes, wetlands, and ponds	100	100	100	100

For a more detailed description of agricultural land use and arid region curve numbers, refer to Soil Conservation Service Technical Release 55, Chapter 2, June 1986.

Runoff Curve Numbers

Figure 3-3.2

APPENDIX C

DRAINAGE REPORT

for

GLENEAGLE

State Route No. 9 Widening Improvements

Revised December 14, 1995

November 3, 1995

Triad Job No. 94-015

Prepared by:
SHAWN G. MOORE

Reviewed by:
MICHAEL L. MATHESON, P.E.



TRIAD ASSOCIATES

DRAINAGE REPORT

for

GLENEAGLE

State Route No. 9 Widening Improvements

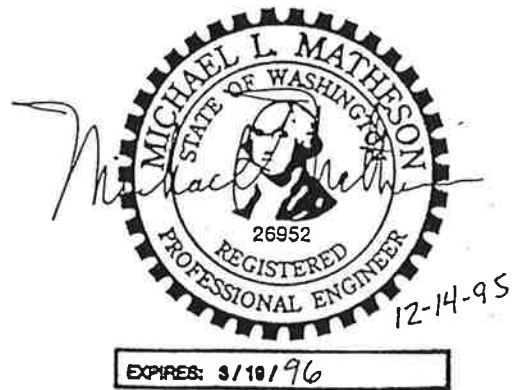
Revised December 14, 1995

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Prepared by:
SHAWN G. MOORE

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TRIAD ASSOCIATES

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APPENDIX

Vicinity Map

Existing and Developed Conditions Maps

Downstream Drainage Map

Curve Numbers Table

Factor of Safety Table

Outlet Control Culvert Sizing Nomograph

INTRODUCTION

The proposed project is the widening of State Route 9 (SR 9), adjacent to the Gleneagle development, from approximately station 851+93 to station 863+90. The widening project will provide a northbound left turn lane and a southbound right turn lane, as well as paved shoulders and a southbound bike lane. The west side of SR 9 will have a roadside ditch to collect drainage, while the east side will have a fill slope. The widening project will create more than five thousand square feet of new impervious area, therefore, storm drainage detention will be required.

DRAINAGE CONCEPT

Storm drainage detention and water quality enhancement is proposed to be provided for the SR-9 improvements in the proposed roadside ditch on the west side of SR-9. Two detention ponds will provide peak rate runoff control in accordance with Department of Ecology standards. Specifically, the post-developed 2-year, 24-hour storm will be detained to one-half the 2-year pre-development peak rate. Also, the post-development peak runoff rates for the 10-year and 100-year, 24-hour storms will be detained to the pre-development peak runoff rates for the 10-year and 100-year storms. Additionally, a volume correction factor will be applied to the required volume of live storage per Department of Transportation standards. The detention calculations were performed using the computer program Water Works with hydrologic input recommended by the Washington State Department of Transportation's Highway Runoff Manual. The roadside ditch will be designed to function as a biofiltration swale upstream of the proposed detention ponds. Maintenance of the detention ponds and biofiltration swales will be provided by the City of Arlington. The proposed drainage improvements are immediately adjacent to SR-9, thus vehicular access for maintenance is provided for the City of Arlington. A summary of the detention calculations is included later in this report. It should be noted that the

developed basins for both of the detention ponds are slightly smaller than the existing drainage basins. A berm will be constructed with Gleneagle Sector IIIA approximately 13.5 feet west of the SR-9 right-of-way. As a result, runoff from the existing tributary areas located west of this berm will be collected into the storm drainage system for Sector IIIA and will not enter these detention facilities. The precipitation for the 2-year, 10-year, and 100-year, 24-hour storm events for the City of Arlington are 1.80, 2.75, and 3.75 inches, respectively. The precipitation for the water quality, 6-month, storm event was determined to be 1.15 inches (0.64 x 1.80"). Please reference the "Existing Condition" and "Developed Condition" maps in the Appendix of this report.

Although the widening improvements for SR-9 will be constructed on both sides of the road, detention will only be provided on the west side. The majority of the east side of SR-9 is constructed in a fill section. Thus, it is impractical to collect the runoff from the additional impervious area on the east side of the road. However, in an effort to provide detention for the runoff from the new impervious area on the east side, the detention ponds, located on the west side of the road, were "over" designed. Specifically, the detention ponds were "over" designed by assuming that the new impervious area on the east side of the road was constructed within the developed basins for the detention ponds. It should be noted that this additional impervious area was accounted for in the developed conditions only and it was accounted for without increasing the total area of the developed basins. Another alternative would be to generate existing and developed hydrographs for the improvements on the east side of SR-9 and to adjust the release rates for the ponds accordingly. We do not feel that this is necessary, however. We feel that the method chosen is conservative and provides equivalent results (i.e. increased detention volumes).

In order to maintain existing drainage patterns, two detention ponds are proposed for the widening improvements instead of one. The two detention ponds, a

southerly pond and a northerly pond, will be constructed within the right-of-way on the west side of SR-9. The southerly pond will discharge detained flows to an existing culvert located beneath SR-9 at approximately station 860+67. The existing culvert is 18-inches in diameter and at a slope of 1.7%. Gravity flow capacity of this culvert is in excess of 14 cfs, which is well in excess of the estimated 100-year developed flow of 0.90 cfs. The northerly pond will discharge detained flows into the existing ditch on the west side of SR-9. This ditch continues to convey flows in a northerly direction along SR-9. The ponds are designed to reach a maximum depth of two feet during the 100-year storm event. The maximum depth of two feet was held as a design constraint such that the ponds would not be designated as "clear zone hazards" (as defined by the Washington State Department of Transportation).

DOWNSTREAM ANALYSIS

SOUTH BASIN

Please reference the Downstream Drainage Map in the appendix. Drainage enters an 18-inch diameter concrete culvert located at approximately Station 860+66 and is discharged on the east side of SR9. Stormwater then travels southerly approximately 50 feet and is dispersed into a wooded area. Drainage then sheet flows through the forest easterly approximately 150 feet and enters a wetland. The wetland consists of a series of pools and stream reaches which drain in a northerly direction parallel with SR9. Drainage from the wetland complex emerges from the forest at approximately Station 867+00 and enters a more defined channel at the toe of the SR9 fill slope. Stormwater continues to flow northerly, to approximately STA 872+90, via a channel which is approximately two feet wide and three feet deep. At this point, drainage enters a 60-inch diameter concrete culvert which conveys stormwater westerly beneath SR9 to an open channel. This open channel is approximately three feet wide and four feet deep and parallels SR9 in a northerly direction. No problems were observed in this quarter mile reach associated with erosion, sedimentation, flooding, overtopping, or scouring. With the detention standard proposed for the widening improvements, future drainage problems are not anticipated.

NORTH BASIN

Please reference the Downstream Drainage Map in the appendix. Stormwater will be discharged from the northerly detention facility at approximately Station 864+10 into the existing roadside ditch on the west side of SR9. This ditch is approximately one foot wide and two feet deep with a channel slope of approximately one percent. Drainage continues in a northerly direction until it reaches the downstream end of the 60-inch diameter concrete culvert referenced in the South Basin downstream analysis. Stormwater flows in a northerly direction in this open channel parallel with SR9. The channel slope begins to increase as SR9 begins its descent towards the valley floor. The channel also shifts westerly away from SR9 to a ravine. In the quarter mile reach downstream of the proposed discharge point, the channel appears to be very stable with no evidence of flooding, undue erosion, downcutting,

or sedimentation. With the detention standard proposed for the widening improvement, future drainage problems are not anticipated.

DETENTION CALCULATIONS

NORTH BASIN

Existing Condition

The total existing condition area tributary to the northern pond is approximately 0.88 acres. This area is comprised of existing impervious area (asphalt paving) and pervious areas (grass, brush, and second growth forest). A summary of the existing condition hydrographs and of the allowable release rates is included below.

Total Area = 0.88 Ac

Impervious Area = 0.14 Ac @ CN-98 (existing paving for SR-9)

Pervious Area = 0.74 Ac @ CN-70

0.34 Ac - Second Growth Forest (CN-70; Gleneagle area)

0.40 Ac - grass/brush (CN-70; within SR-9 right-of-way)

BASIN ID: EX2		NAME: EX 2 YR HYDRO	
SBUH METHODOLOGY			
TOTAL AREA..:	0.88 Acres	BASEFLOWS :	0.00 cfs
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA	
PRECIPITATION..:	1.80 inches	AREA..:	0.74 Acres
TIME INTERVAL..:	10.00 min	CN..:	70.00
TIME OF CONC..:	53.48 min	IMPERVIOUS AREA	
ABSTRACTION COEFF :	0.20	AREA..:	0.14 Acres
		CN..:	98.00

TcReach - Sheet L: 125.00 ns:0.4000 p2yr: 1.80 s:0.0320

TcReach - Sheet L: 145.00 ns:0.2400 p2yr: 1.80 s:0.0210

PEAK RATE: 0.03 cfs VOL: 0.03 Ac-ft TIME: 490 min

BASIN ID: EX10		NAME: EX 10 YR HYDRO	
SBUH METHODOLOGY			
TOTAL AREA..:	0.88 Acres	BASEFLOWS :	0.00 cfs
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA	
PRECIPITATION..:	2.75 inches	AREA..:	0.74 Acres
TIME INTERVAL..:	10.00 min	CN..:	70.00
TIME OF CONC..:	53.48 min	IMPERVIOUS AREA	
ABSTRACTION COEFF :	0.20	AREA..:	0.14 Acres
		CN..:	98.00

PEAK RATE: 0.07 cfs VOL: 0.06 Ac-ft TIME: 490 min

BASIN ID: EX00		NAME: EX 100 YR HYDRO	
SBUH METHODOLOGY			
TOTAL AREA..:	0.88 Acres	BASEFLOWS :	0.00 cfs
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA	
PRECIPITATION..:	3.75 inches	AREA..:	0.74 Acres
TIME INTERVAL..:	10.00 min	CN..:	70.00
TIME OF CONC..:	53.48 min	IMPERVIOUS AREA	
ABSTRACTION COEFF :	0.20	AREA..:	0.14 Acres
		CN..:	98.00

PEAK RATE: 0.14 cfs VOL: 0.11 Ac-ft TIME: 490 min

Allowable Release Rates

2-yr Release Rate = $1/2$ (Existing 2-yr Peak Rate)

2-yr Release Rate = $1/2$ (0.032 cfs)

2-yr Release Rate = 0.016 cfs (use 0.02 cfs)

10-yr Release Rate = Existing 10-yr Peak Rate

10-yr Release Rate = 0.07 cfs

100-yr Release Rate = Existing 100-yr Peak Rate

100-yr Release Rate = 0.14 cfs

Developed Condition

The total developed area tributary to the detention pond is 0.68 acres. The developed basin was assumed to have 0.29 acres of impervious area. Approximately 0.14 acres is existing impervious area, while the remaining 0.15 acres is new impervious area. However, 0.03 acres of the 0.15 acres of new impervious area is actually being constructed on the east side of SR-9, out of the developed basin.

Total Area = 0.68 Ac

Impervious Area = 0.29 Ac @ CN-98

Existing Imperv. Area = 0.14 Ac

New Imperv. Area = 0.15 Ac

Pervious Area = 0.39 Ac @ CN-74 (lawn/landscaping)

Time of Concentration = 6.0 min. (Assumed; conservative)

BASIN ID: DV6		NAME: DEV 6 month (Water Quality)	
SBUH METHODOLOGY			
TOTAL AREA..:	0.68 Acres	BASEFLOWS :	0.00 cfs
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA	
PRECIPITATION..:	1.15 inches	AREA..:	0.39 Acres
TIME INTERVAL..:	10.00 min	CN..:	74.00
TIME OF CONC..:	6.00 min	IMPERVIOUS AREA	
ABSTRACTION COEFF :	0.20	AREA..:	0.29 Acres
		CN..:	98.00

PEAK RATE: 0.06 cfs VOL: 0.02 Ac-ft TIME: 480 min

BASIN ID: DV2		NAME: DEV 2 YR HYDRO	
SBUH METHODOLOGY			
TOTAL AREA..:	0.68 Acres	BASEFLOWS :	0.00 cfs
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA	
PRECIPITATION..:	1.80 inches	AREA..:	0.39 Acres
TIME INTERVAL..:	10.00 min	CN..:	74.00
TIME OF CONC..:	6.00 min	IMPERVIOUS AREA	
ABSTRACTION COEFF :	0.20	AREA..:	0.29 Acres
		CN..:	98.00

PEAK RATE: 0.11 cfs VOL: 0.05 Ac-ft TIME: 480 min

BASIN ID: DV10		NAME: DEV 10 YR HYDRO	
SBUH METHODOLOGY			
TOTAL AREA..:	0.68 Acres	BASEFLOWS :	0.00 cfs
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA	
PRECIPITATION..:	2.75 inches	AREA..:	0.39 Acres
TIME INTERVAL..:	10.00 min	CN..:	74.00
TIME OF CONC..:	6.00 min	IMPERVIOUS AREA	
ABSTRACTION COEFF :	0.20	AREA..:	0.29 Acres
		CN..:	98.00

PEAK RATE: 0.21 cfs VOL: 0.08 Ac-ft TIME: 480 min

BASIN ID: DV00		NAME: DEV 100 YR HYDRO
SBUH METHODOLOGY		
TOTAL AREA..:	0.68 Acres	BASEFLOWS :
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA
PRECIPITATION..:	3.75 inches	AREA..:
TIME INTERVAL..:	10.00 min	CN..:
TIME OF CONC..:	10.00 min	IMPERVIOUS AREA
ABSTRACTION COEFF :	0.20	AREA..:
		CN..:

PEAK RATE: 0.33 cfs VOL: 0.13 Ac-ft TIME: 480 min

Stage - Storage/Discharge

STORAGE ID No.: DET1
 DESCRIPTION: Theoretical Detention Pond
 Bottom: 371.00 ft Maximum Water Surface: 373.00 ft
 Length: approx. 41 ft Width: approx. 10 ft

DISCHARGE ID No.: DIS1
 DESCRIPTION: Orifice & Notch Weir
 Outlet Elev: 371.00
 Elev: 369.00 ft Orifice Diameter: 11/16 in.
 Weir Elev: 372.60 ft Weir Length: 0.25 ft

STAGE [FT]	STORAGE [CF]	DISCHARGE [CFS]
371.00	0	0.0000
371.50	245	0.0093
372.00	575	0.0131
372.50	1000	0.0160
373.00	1528	0.1634

Level Pool Routing

The following table represents the results of routing the developed hydrographs through the above theoretical detention pond. This determines the theoretical volume of detention required per D.O.E. standards. The actual detention volume required is then determined by applying the appropriate factor of safety to the theoretical volume.

Description	Inflow [CFS]	Storage ID	Discharge ID	P. Stage [FT]	Volume [CF]	Outflow [CFS]	P. Time [Min]
2 YR THEOR. STORM	0.11	DET1	DIS1	372.51	1014	0.02	1440
10 YR THEOR. STORM	0.21	DET1	DIS1	372.75	1249	0.06	670
100 YR THEOR. STORM	0.33	DET1	DIS1	372.95	1476	0.14	530

The outflow from the pond is less than or equal to the allowable release rates for each of the storm events. Thus, the theoretical volume of storage required is 1,476 cubic-feet. With the required factor of safety of 28 percent (43% impervious area; see the Factor of Safety Table in the Appendix), the *actual volume of storage required is 1,889 cubic feet* (1.28 x 1,476). The proposed detention pond for the north basin was also designed with an additional construction factor of safety of at least 10 percent. The *actual volume of storage provided is 5,150 cubic feet*; which is in excess of the volume required.

Biofiltration Swale

The biofiltration swale was designed using the undetained developed flow for the water quality, 6-month, storm event. This flow was previously determined to be 0.06 cfs. The swale was also checked to ensure capacity to convey the undetained developed flow for the 100-year storm event, 0.33 cfs. Summaries of these calculations are included below:

Required Basewidth

Channel Input Information:

Design Flow: 0.06 cfs
Depth: 0.33 ft
Slope: 0.005 ft/ft
Side Slopes: 3-1
Manning's 'n': 0.23

Normal Depth Flow Information:

Basewidth: 0.27 ft

Velocity: 0.14 fps

The actual biofiltration swale was designed to be 200 feet long with a five foot basewidth. The actual swale was checked for capacity to convey the developed 100-year flow rate of 0.33 cfs.

Capacity Check

Channel Input Information:

Flow: 0.33 cfs

Basewidth: 5.0 ft

Slope: 0.005 ft/ft

Side Slopes: 3-1

Manning's 'n': 0.03

Normal Depth Flow Information:

Flow Depth: 0.09 ft

Velocity: 0.70 fps

The biofiltration swale, as designed with a minimum depth of 1.5 feet, has adequate capacity to convey the developed flow of 0.33 cfs.

Emergency Overflow Spillway

The detention pond was designed with a five foot wide emergency overflow spillway. The spillway was designed to convey the 100-year developed flow rate, 0.33 cfs, with a maximum of 0.5 feet of head. The capacity of the spillway, with 0.5 feet of head, is approximately 6.24 cfs, well in excess of 0.33 cfs.

SOUTH BASIN

Existing Condition

The total existing condition area tributary to the southern pond is approximately 3.73 acres. This area is comprised of existing impervious area (asphalt paving) and pervious areas (grass, brush, and second growth forest). A summary of the existing condition hydrographs and of the allowable release rates is included below.

Total Area = 3.73 Ac

Impervious Area = 0.43 Ac @ CN-98 (existing paving for SR-9)

Pervious Area = 3.30 Ac @ CN-70

2.05 Ac - Second Growth Forest (CN-70; Gleneagle area)

1.25 Ac - grass/brush (CN-70; within SR-9 right-of-way)

BASIN ID: EX2		NAME: EX 2 YR HYDRO	
SBUH METHODOLOGY			
TOTAL AREA..:	3.73 Acres	BASEFLOWS :	0.00 cfs
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA	
PRECIPITATION..:	1.80 inches	AREA..:	3.30 Acres
TIME INTERVAL..:	10.00 min	CN..:	70.00
TIME OF CONC..:	29.93 min	IMPERVIOUS AREA	
ABSTRACTION COEFF :	0.20	AREA..:	0.43 Acres
		CN..:	98.00

TcReach - Sheet L: 95.00 ns:0.4000 p2yr: 1.80 s:0.0430

TcReach - Sheet L: 55.00 ns:0.2400 p2yr: 1.80 s:0.0820

TcReach - Channel L: 425.00 kc:20.00 s:0.0140

PEAK RATE: 0.12 cfs VOL: 0.10 Ac-ft TIME: 480 min

BASIN ID: EX10		NAME: EX 10 YR HYDRO	
SBUH METHODOLOGY			
TOTAL AREA..:	3.73 Acres	BASEFLOWS :	0.00 cfs
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA	
PRECIPITATION..:	2.75 inches	AREA..:	3.30 Acres
TIME INTERVAL..:	10.00 min	CN..:	70.00
TIME OF CONC..:	29.93 min	IMPERVIOUS AREA	
ABSTRACTION COEFF :	0.20	AREA..:	0.43 Acres
		CN..:	98.00

PEAK RATE: 0.30 cfs VOL: 0.25 Ac-ft TIME: 490 min

BASIN ID: EX00		NAME: EX 100 YR HYDRO	
SBUH METHODOLOGY			
TOTAL AREA..:	3.73 Acres	BASEFLOWS :	0.00 cfs
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA	
PRECIPITATION..:	3.75 inches	AREA..:	3.30 Acres
TIME INTERVAL..:	10.00 min	CN..:	70.00
TIME OF CONC..:	29.93 min	IMPERVIOUS AREA	
ABSTRACTION COEFF :	0.20	AREA..:	0.43 Acres
		CN..:	98.00

PEAK RATE: 0.68 cfs VOL: 0.44 Ac-ft TIME: 490 min

Allowable Release Rates

2-yr Release Rate = 1/2(Existing 2-yr Peak Rate)

2-yr Release Rate = 1/2(0.12 cfs)

2-yr Release Rate = 0.06 cfs

10-yr Release Rate = Existing 10-yr Peak Rate

10-yr Release Rate = 0.30 cfs

100-yr Release Rate = Existing 100-yr Peak Rate

100-yr Release Rate = 0.68 cfs

Developed Condition

The total developed area tributary to the detention pond is 1.88 acres. The developed basin was assumed to have 0.85 acres of impervious area. Approximately 0.43 acres is existing impervious area, while the remaining 0.42 acres is new impervious area. However, 0.15 acres of the 0.42 acres of new impervious area is actually being constructed on the east side of SR-9, out of the developed basin. Developed flows will be conveyed under Eaglefield Drive through a 124-foot long, 12-inch diameter culvert at a slope of 2.26 percent (gravity flow capacity = 5.80 cfs). With an available headwater depth of 2.5 feet,

and assuming outlet control (pond full condition), the inlet capacity of the culvert is approximately 4.5 cfs (See the Outlet Control Culvert Sizing Nomograph in the Appendix of this Report). Considering that the 100-year developed inflow into the pond is only 0.90 cfs, it is apparent that the culvert has adequate capacity

Total Area = 1.88 Ac

Impervious Area = 0.85 Ac @ CN-98

Existing Imperv. Area = 0.43 Ac

New Imperv. Area = 0.42 Ac

Pervious Area = 1.03 Ac @ CN-74 (lawn/landscaping)

Time of Concentration = 9.60 min.

Reach 1: 50' Sheet flow @ 12%; 'n' = 0.15

Reach 2: 330' Channel flow @ 1.0%; 'k' = 20

Reach 3: 230' Channel flow @ 0.5%; 'k' = 17

BASIN ID: DV6		NAME: DEV 6 month (water quality) Hydro
SBUH METHODOLOGY		
TOTAL AREA..:	1.88 Acres	BASEFLOWS :
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA
PRECIPITATION..:	1.15 inches	AREA..:
TIME INTERVAL..:	10.00 min	CN..:
TIME OF CONC..:	9.60 min	IMPERVIOUS AREA
ABSTRACTION COEFF :	0.20	AREA..:
		CN..:

PEAK RATE: 0.18 cfs VOL: 0.07 Ac-ft TIME: 480 min

BASIN ID: DV2		NAME: DEV 2 YR HYDRO
SBUH METHODOLOGY		
TOTAL AREA..:	1.88 Acres	BASEFLOWS :
RAINFALL TYPE..:	TYPE1A	PERVIOUS AREA
PRECIPITATION..:	1.80 inches	AREA..:
TIME INTERVAL..:	10.00 min	CN..:
TIME OF CONC..:	9.60 min	IMPERVIOUS AREA
ABSTRACTION COEFF :	0.20	AREA..:
		CN..:

PEAK RATE: 0.30 cfs VOL: 0.13 Ac-ft TIME: 480 min

BASIN ID: DV10	NAME: DEV 10 YR HYDRO
SBUH METHODOLOGY	
TOTAL AREA.: 1.88 Acres	BASEFLOWS : 0.00 cfs
RAINFALL TYPE.: TYPE1A	PERVIOUS AREA
PRECIPITATION.: 2.75 inches	AREA.: 1.03 Acres
TIME INTERVAL.: 10.00 min	CN.: 74.00
TIME OF CONC.: 9.60 min	IMPERVIOUS AREA
ABSTRACTION COEFF : 0.20	AREA.: 0.85 Acres
	CN.: 98.00

PEAK RATE: 0.57 cfs VOL: 0.24 Ac-ft TIME: 480 min

BASIN ID: DV00	NAME: DEV 100 YR HYDRO
SBUH METHODOLOGY	
TOTAL AREA.: 1.88 Acres	BASEFLOWS : 0.00 cfs
RAINFALL TYPE.: TYPE1A	PERVIOUS AREA
PRECIPITATION.: 3.75 inches	AREA.: 1.03 Acres
TIME INTERVAL.: 10.00 min	CN.: 74.00
TIME OF CONC.: 9.60 min	IMPERVIOUS AREA
ABSTRACTION COEFF : 0.20	AREA.: 0.85 Acres
	CN.: 98.00

PEAK RATE: 0.90 cfs VOL: 0.37 Ac-ft TIME: 480 min

Stage - Storage/Discharge

STORAGE ID No.: DET1

DESCRIPTION: Theoretical Detention Pond

Bottom: 373.20 ft Maximum Water Surface: 375.20 ft

Length: approx. 90 ft Width: approx. 11 ft

DISCHARGE ID No.: DISN

DESCRIPTION: Orifice & Notch Weir

Outlet Elev: 373.20

Orifice Elev: 371.20 ft Orifice Diameter: 1-5/16 in. 1.3125"

Weir Length: 0.85 ft Weir Elevation : 374.80 ft.

STAGE [FT]	STORAGE [CF]	DISCHARGE [CFS]
373.20	0	0.0000
373.70	572	0.0331
374.20	1305	0.0469
374.70	2207	0.0574
375.20	3288	0.7227

Level Pool Routing

The following table represents the results of routing the developed hydrographs through the above theoretical detention pond. This determines the theoretical volume of detention required per D.O.E. standards. The actual detention volume required is then determined by applying the appropriate factor of safety to the theoretical volume.

Description	Inflow [CFS]	Storage ID	Discharge ID	P. Stage [FT]	Volume [CF]	Outflow [CFS]	P. Time [Min]
2 YR THEOR. STORM	0.30	DET1	DIS1	374.71	2224	0.06	980
10 YR THEOR. STORM	0.57	DET1	DIS1	374.96	2753	0.24	550
100 YR THEOR. STORM	0.90	DET1	DIS1	375.18	3245	0.68	500

The outflow from the pond is less than or equal to the allowable release rates for each of the storm events. Thus, the theoretical volume of storage required is 3,245 cubic-feet. With the required factor of safety of 29 percent (45% ³⁵ impervious area; see the Factor of Safety Table in the Appendix), the *actual volume of storage required is 4,186 cubic feet* (1.29 x 3,245). The detention pond for the south basin was designed with an additional construction factor of safety of at least 10 percent. The *actual volume of storage provided is 6,120 cubic feet*, which is well in excess of the volume required.

Biofiltration Swale

The biofiltration swale was designed using the undetained developed flow for the water quality, 6-month, storm event. This flow was previously determined to be 0.18 cfs. The swale was also checked to ensure capacity to convey the undetained developed flow for the 100-year storm event, 0.90 cfs. Summaries of these calculations are included below:

Required Basewidth

Channel Input Information:

Design Flow: 0.18 cfs
Depth: 0.33 ft
Slope: 0.005 ft/ft
Side Slopes: 3-1
Manning's 'n': 0.23

Normal Depth Flow Information:

Basewidth: 2.08 ft
Velocity: 0.18 fps

The actual biofiltration swale was designed to be 200 feet long with a five foot basewidth. The actual swale was checked for capacity to convey the developed 100-year flow rate of 0.90 cfs.

Capacity Check

Channel Input Information:

Flow: 0.90 cfs
Basewidth: 5.0 ft
Slope: 0.005 ft/ft
Side Slopes: 3-1
Manning's 'n': 0.03

Normal Depth Flow Information:

Flow Depth: 0.17 ft
Velocity: 0.99 fps

The biofiltration swale, as designed with a minimum depth of 1.5 feet, has adequate capacity to convey the developed flow of 0.90 cfs.

Emergency Overflow Spillway

The detention pond was designed with a five foot wide emergency overflow spillway. The spillway was designed to convey the 100-year developed flow rate,

0.90 cfs, with a maximum of 0.5 feet of head. The capacity of the spillway, with 0.5 feet of head, is approximately 6.24 cfs, well in excess of 0.90 cfs.

DRAINAGE REPORT

for

GLENEAGLE

State Route No. 9 Widening Improvements

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