Detroit Water and Sewerage Department

Wastewater Master Plan

DWSD Project No. CS-1314

Greater Detroit Regional Sewer System Model Setup and Analyses

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GDRSS Model Setup and Analyses

1. Introduction

The GDRSS Phase III Model was completed in 1998. Both a Baseline (1998 Condition) and a Preferred Plan (Future Condition) version of the model were provided at that time. The Preferred Plan version of the model included the best representation of the City of Detroit's Long Term CSO Control Plan components based on planning level information available at that time. The model also included planned system improvements and CSO facilities located in suburban communities.

The Preferred Plan version of the GDRSS Model has been updated in 2001 to incorporate information currently available on various CSO Control Plan components using recently as-built information or Basis Of Design reports that have been completed. The updated model has been provided to the DWSD CS-1281 Project Team for their use in evaluating Detroit's Long Term CSO Control Plan Performance Update. The model updates were performed as part of the CS-1314 Wastewater Master Plan project as they are being included as part of the baseline conditions for the development of the Wastewater Master Plan (WWMP) Model currently underway.

This memorandum documents the items included in the GDRSS Model-2001 Update and compares the model results to the previous version of the model. Both the Event Model (RUNOFF/EXTRAN) and the Continuous Model (RUNOFF/TRANSPORT) have been updated. These updates include the following items:

2. Event Model (RUNOFF AND EXTRAN) Updates

2.1 In-System Storage (ISS) facilities

The model representation of the planned in-system storage facilities was updated using the most recent information provided by Applied Science, Inc. from the September 2000 Basis of Design report (DWSD CS-1329). This update included revising the locations of the facilities that changed during the basis of design, subdividing several subareas, and adding additional upstream conduits. Further details on this update are provided in Appendix A.

2.2 Screening and Disinfection (S&D) Facilities

This update included the addition of the Baby Creek, Leib, and St.Aubin screening and disinfection (S&D) facilities.

A Basis of Design report for the ***Leib Screening and Disinfection*** was completed in year 2002. Information from the Basis of Design Report and construction drawings were used to add a representation of the proposed facility to the GDRSS Model for the 2001 Update.

The ***Leib facility*** is located next to the Mt. Elliott sewer north of Kercheval, about 1 mile from the Detroit River. The Mt. Elliott sewer discharges to the Detroit River Interceptor (DRI) during dry weather.

The dry weather flows in the Mt. Elliott sewer at this location are quite small, on the order of 2-5 cfs, because its flows are diverted into the North Interceptor-East Arm (NIEA) approximately 1 mile upstream of this location. During wet weather when the flows exceed the capacity of the NIEA and the DRI, the sewer overflows to the Detroit River via the Leib outfall.

Under wet weather conditions, the towards-treatment sewer will convey the screenings and any associated flows to the DRI. The flows that pass through the screens will be disinfected and directed back into the Mt. Elliot Sewer downstream of the facility. An equivalent box conduit was used to represent the screens and weir of the facility. The width of the box was set to the length of the weirs, the invert of the upstream end was set at the height of the weir, and the Manning's coefficient was set to account for a hydraulic headloss of 1.7 feet, which was obtained from the Basis of Design report.

The facility's treatment capacity is 1,550cfs, but the facility is design to pass the hydraulic capacity of the sewer, which is 2000 cfs. This flow will proceed south to the existing Leib regulator at the DRI, which will be closed during a wet weather event, and continue through the existing outfall. If there is sufficient flow, they will discharge into the Detroit River. After an event, the regulator will open when sufficient capacity exists in the DRI. Flows downstream of the dam at the regulator that cannot drain back to the DRI by gravity because of the dam will be pumped The model is configured with head-dependent orifices for control of the Leib regulator at the DRI and for control of the dewatering of the outfall conduits after the end of a wet weather event.

A representation of the proposed ***St. Aubin screening and disinfection facility*** was added to the GDRSS Model for the 2001 Update. A basis of design report for the facility was completed July 1, 1998. The construction of the facility has been substantially completed (September 30, 2001). Information from the Basis of Design Report and construction drawings were used to add a representation of the proposed facility to the GDRSS Model for the 2001 Update.

The ***St. Aubin facility*** is located south of Atwater just west of Chene Park. The facility will intercept wet weather flows from three outfalls: Chene, DuBois, and St. Aubin. During dry weather, flows will enter the DRI through the existing regulators of each sewer. During wet weather, flows that bypass the regulators will be directed to the facility. The outfalls of Chene and St. Aubin have been completely blocked. At the DuBois outfall, an emergency sluice gate has been installed. The facility was designed with a screening and disinfection capacity of 250cfs. If the total wet weather flows exceed the treatment capacity of the facility, the sluice gate will be opened to allow the excess flows to discharge directly to the Detroit River without treatment.

An equivalent conduit is used to represent the facility and the sluice gate. The operation of the sluice gate was represented indirectly by defining an upper flow limit of 250cfs for the equivalent conduit. Flows in excess of this rate would cause the water level to rise behind the facility and discharge via the DuBois outfall.

Flows that are not in excess of the flow capacity of the facility are assumed to pass through the facility. This assumption is a simplification as the model does not distinguish the small volume of flow that would not pass through the screens at the beginning or end of an event.

Flows that pass through the facility either discharge to the river or are dewatered back to the DRI. The outfall pipe consists of a 1640-foot long 10-foot box sewer to provide a minimum contact time of 10-minutes at the design flow rate of 250cfs. To facilitate dewatering, the outfall pipes were designed with an adverse slope to allow for drainage back to the facility.

A toward-treatment sewer is used to convey the dewater flows and the screenings to the DRI after the event. The model is configured with head-dependent orifices for control of the dewatering of the facility after the end of a wet weather event. Flow that passes through the orifice is directed to a pseudo-storage node that represents the wet well of the facility. The model includes a pumping capacity of 5.7 cfs to dewater the facility within 24 hours.

2.3 CSO basins

This update included the refinement of the representation of the Seven Mile, Puritan Fenkell, and Conner Creek CSO basin facilities. Details on this update are available in the project files.

2.4 Dewatering

This update included a change to the EXTRAN code of the SWMM engine used by the GDRSS Model (SWMMRPO) to include orifice control, where an orifice (gate) is open or closed depending on the elevation at a specified node. This option has been used in the above updates to improve the model's representation of the facilities dewatering protocol.

2.5 Source Control (Downspout Disconnection)

This update incorporated the results of the Rain Water Control Pilot Project investigation into the impact of the downspout disconnection program. The previous representation estimated that the directly connected impervious area (DCIA), a key component in the model, would be reduced by 32% with downspouts disconnected. Pilot project results have indicated that the average reduction is 42% in the DCIA values, which has been incorporated into the model for residential areas of Detroit.

2.6 Catch-Basin Restriction

The previous model assumed use of catch basin inlet restrictions in select areas of Detroit. These did not reduce the volume of runoff, but changed the shape of the responding hydrograph by reducing the peak discharge. Representation of these inlet restrictions was not included in the present model configuration, as these are no longer being considered in the Preferred Plan.

2.7 Refined Area Delineation

A number of subarea delineations were refined to better align with the hydraulic changes already mentioned. These include the 7-Mile and Puritan Fenkell basins, the in-system storage facilities (using Basis of Design Report for CS-1329) and the Baby Creek S&D facility.

3.Continuous Model (RUNOFF & TRANSPORT) Updates

For the Continuous Model, the following changes were also made:

3.1 Precipitation Records

The precipitation records used for the continuous simulations has been expanded from 3 years (1984-1986) of hourly data to 36 years (1960-1995) of hourly rainfall record from Detroit Metropolitan Airport Gage. This hourly rainfall record was distributed into 15-minute rainfall using rainfall distributions typical of summer storm events in southeast Michigan using a method developed by James D. Sherrill, Wade-Trim while at the University of Michigan. Snowmelt data was added to this rainfall record to provide a better representation of the actual precipitation experienced in the GDRSS tributary areas. The result was 36 years (1960-1995) of 15-minute precipitation record (rainfall plus snowmelt) to be used in the updated continuous model.

3.2 Monthly Infiltration Capacities

As infiltration rates vary throughout the year due to changes in ground conditions, monthly infiltration capacities were included in the model. This is an improvement from the previous version of the continuous model which used the same infiltration rate for the entire year. These monthly infiltration values are based on E. Brater and J. Sherrill's work at the University of Michigan on rainfall-runoff relations for Southeast Michigan (Rainfall-runoff Relations on Urban and Rural Areas, EPA-670/2-75-046, May, 1975).

3.3 Depression Storage

The depression storage for pervious areas was assumed to be 0.29 inches in the previous version of the model. This value is reasonable for summer months only, and it also assumes average to dry antecedent conditions. For the continuous simulations, the depression storage value was changed to 0.1 inches as it better represents ground conditions over the entire calendar year, including winter months. This average value for depressions storage is also based on E. Brater and J. Sherrill's work at the University of Michigan on rainfall-runoff relations for Southeast Michigan (Rainfall-runoff Relations on Urban and Rural Areas, EPA-670/2-75-046, May, 1975).

3.4 Upper Rouge Tunnel

The configuration of the inflows into the Upper Rouge Tunnel was revised to account for individual drop shafts planned as part of this project. In addition, allowances were made in the model representation of the Upper Rouge Tunnel to account for surge control. These updates to the Upper Rouge Tunnel representation were developed under the Upper Rouge Tunnel Overflow Frequency Analysis.

3.5 Splitters

A complete review was made of all the rule-based flow splitters used in TRANSPORT to best represent flow diversions within the system based on the updated EXTRAN model.

3.6 Post-Processor

The "Super Spreadsheet" used to process and present results has been updated to handle the extended simulation length (from 3 years to 36 years) . Since the 36 year simulation length of the continuous model has been split into two 18-year segments for ease of modeling (1960-1977 and 1978-1995), this spreadsheet summarizes the 36 years by combining the results from the two simulations. In addition, the program has been updated from Lotus to Excel.

Table 1 summarizes the updated representation of the Long Term CSO Plan components in the Continuous Model. Information is included regarding dewatering protocol, decanting and/or shunting information, and total storage volume of the facility representation.

**Table 1. Long Term CSO Control Plan Components—
Treatment Facility Representation in the Continuous Model**

Treatment	Storage Volumes			Shunt	Decant	Dewatering Protocol		
	Facility Storage	Extended Storage	Total Storage			Minimum Dewatering Rate (cfs)	Maximum Dewatering Rate (cfs)	Controlled Dewatering
Basin								
Conner	30.0	32.1	62.1	no	no	0.0	54.1	yes
Hubbell-Southfield	22.0	0.0	39.6	yes	yes	0.0	22.3	yes
7-Mile	3.1	1.9	5.0	yes	yes	0.0	16.7	yes
Puritan-Fenkell	4.1	6.5	10.5	yes	yes	3.5	25.7	yes
Screening & Disinfection								
Baby Creek	0.0	30.4	30.4	no	no	0.0	220.0	yes
St. Aubin	0.0	2.4	2.4	no	no	0.0	7.4	yes
Leib	0.0	9.9	9.9	no	no	0.0	6.7	yes
Tunnel								
Upper Rouge	120.0	0.0	120.0	yes	no	0.0	172.7	yes

4. Results

With these updates and improved representations incorporated, the updated GDRSS Model was run for both design storm events and for 36 years of precipitation record. These simulations were made with the following conditions:

- 2020 projected dry weather flow (no change from previous model;
- WWTP capacity at 1700 MGD; and
- Detroit River elevation of 95 feet.

For the Event Model (RUNOFF/EXTRAN) simulations, the hydrologic conditions are set to account for the maximum 1-hour within a 24-hour event by reducing the depression storage capacity and infiltration capacity, consistent with previous model setup. Results for the Event Model simulations are compared to the previous model results in Tables 2 and 3. In these tables, the previous version of the model is labeled v3.12 while the current model version has been designated as v3.13.

Table 2 summarizes the wet weather response for the City of Detroit. As the updates only include refinements in the model representation relative to the City of Detroit's Long Term CSO Control Plan, the responses are the same for all the districts except Detroit. For Detroit, the wet weather response is reduced, though the reduction is relatively small. The reduction that is realized is due primarily to the impact of downspout disconnection being greater than originally estimated (the percent directly connected impervious areas are reduced by 42% in the updated model versus 32% in the previous model).

Table 2. Comparison of Wet Weather Response for Detroit*

10-Yr, 1-Hr Event		1-Yr, 1-Hr Event		1-Mth, 24-Hr Event	
v3.12 MG	v3.13 MG	v3.12 MG	v3.13 MG	v3.12 MG	v3.13 MG
3,567	3,550	1,559	1,541	501	484

*Includes Highland Park, Hamtramck, and portions of Redford Township, Dearborn Heights, Harper Woods and Dearborn.

Table 3 provides a comparison of overflows for the City of Detroit (again, as noted before, overflows results for the other districts did not change and therefore are not shown). As might be expected with a decrease in the wet weather response, the total overflows are also reduced.

Table 3. Comparison of Overflows Results for Detroit (page 1/2)

Location	Gate/ Regulator (ID)	Permit (No.)	EXTRAN Node v3.12 (ID)	EXTRAN Node v3.13 (ID)	10Yr, 1Hr v3.12 (MG)	10Yr, 1Hr v3.13 (MG)	1Yr, 1Hr v3.12 (MG)	1Yr, 1Hr v3.13 (MG)	1 Month v3.12 (MG)	1 Month v3.13 (MG)
Fox Creek backwater	B1	080	5800	5800	0.0	0.0	0.0	0.0	0.0	0.0
Freud P.S.	P20-27, P8-15	003	to CCk Basin							
Conner P.S./Gravity	P20-27, P8-15 / B2	002 / 001	to CCk Basin							
[Conner Creek Basin]			2908	2908	701	701	128	141	0.0	0.0
Pembroke	B87	079	to URT							
Glenhurst Siphon (west)	B82	075	to URT							
Seven Mile (east shore)	B85	077	to URT							
Riverdale/McNichols	B79,B80,B81	073, 074	to URT							
7-Mile Basin	B76,B83,B86	071,076,078	3543	3543	16	14	5.5	2.7	0.0	0.0
Puritan (east shore)	B77	072	to URT							
Puritan-Fenkell Basin	B75	070	3538	3538	15	17	0.0	2.0	0.0	0.0
Lyndon/Brammel	B71,B72	068, 069	to URT							
Schoolcraft Siphon	B70,B69	066, 067	to URT							
Lahser/Dolson	B67,B68	065	to URT							
Glendale (Schoolcraft Relief)	B65	064	to URT							
W. Chicago Siphon	B63,B64	062, 063	to URT							
W. Chicago	B60,B61,B62	061	to URT							
Trinity-Tireman	B56,B57,B58	060	to URT							
W. Warren Siphon	B54	059	to URT							
[Upper Rouge Tunnel]			370	370	478	430	75	44	0.0	0.0
Hubbell-Southfield Basin	B53	058	3602	3602	185	182	89	89	19	8.6
Carbon	B46	051	17785	17785	0.0	0.0	0.0	0.0	0.0	0.0
Flora	B47	052	1778	1778	0.0	0.0	0.0	0.0	0.0	0.0
Fort St (East)	B48	053	17786	17786	0.0	0.0	0.0	0.0	0.0	0.0
Fort St (West)	B49	056	not modeled		--	--	--	--	--	--
Fort St - NWI Siphon	B50	054	3406	3406	0.0	0.0	0.0	0.1	0.0	0.0
Baby Creek [S&D]	B52	057	1792	1792	325	344	76	103	0.0	0.0
Oakwood P.S.	P42-P47	082	1797	1797	62	62	27	27	7.5	7.5
McClellan	B3	005	1688	1688	34	31	15	13	0.1	0.0
Fischer P.S.	B4	006	1685	1685	0.0	0.0	0.0	0.0	0.0	0.0
Iroquois	B5	007	1682	1682	30	26	8.3	6.3	0.0	0.0
Helen	B6	008	1676	1676	31	29	11	9.5	0.1	0.1
Meldrum	B7	009	2830	2830	39	39	13	13	0.0	0.0
Leib (Mt Elliot) [S&D]	B8	010	2700	2700	84	98	26	23	0.0	0.0
Adair	B9	011	1664	1664	14	10	9.0	5.1	0.0	0.0
Joseph Campau	B10	012	1656	1656	63	61	28	26	5.1	4.6
Chene [closed --> S&D]	B11	013	1652	removed	7.8	--	2.8	--	0.0	--
Dubois [portion diverted to S&D]	B12	014	1648	1648	32	18	13	5.5	0.6	0.0
St. Aubin [S&D]	B13	015	1644	1644	5.6	17	1.9	7.1	0.0	0.0

Table 3. Comparison of Overflows Results for Detroit (page 2/2)

Location	Gate/ Regulator (ID)	Permit (No.)	EXTRAN Node v3.12 (ID)	EXTRAN Node v3.13 (ID)	10Yr, 1Hr v3.12 (MG)	10Yr, 1Hr v3.13 (MG)	1Yr, 1Hr v3.12 (MG)	1Yr, 1Hr v3.13 (MG)	1 Month v3.12 (MG)	1 Month v3.13 (MG)
Orleans (east/west)	B15,B14	016, 017	1640	1640	10	10	4.1	4.0	0.1	0.1
Riopelle	B16	018	1636	1636	4.1	3.9	1.2	1.1	0.0	0.0
Rivard	B17	019	1632	1632	9.4	8.3	4.5	3.4	0.0	0.0
Hastings	B18	020	1628	1628	7.1	7.0	2.9	2.9	0.0	0.0
Randolph	B19	021	1622	1622	12	9.6	4.8	2.7	0.0	0.0
Bates	B20	022	1618	1618	6.3	14	0.3	2.2	0.0	0.0
Woodward	B21	023	1614	1614	79	74	31	28	0.2	0.0
Griswold	B22	024	1610	1610	11	10	4.7	3.4	0.0	0.0
1st - Hamilton	B23	025	2105	2105	132	131	35	25	0.0	0.0
3rd	B24	026	1602	1602	29	28	12	11	0.0	0.0
Cabacier	B25	027	1094	1094	1.2	1.1	0.4	0.4	0.0	0.0
11th	B26	028	1090	1090	12	11	4.6	4.5	0.0	0.0
12th	B27	029	1086	1086	8.7	8.7	3.5	3.5	0.1	0.1
Vermont	B28	030	1082	1082	25	25	11	10	1.7	1.5
18th	B29	031	1076	1076	22	12	8.5	4.1	0.0	0.0
21st	B30	032	1072	1072	14	4.8	5.2	1.1	0.0	0.0
24th	B31	033	1068	1068	41	14	16	4.5	0.8	0.0
W. Grand	B32	034	1064	1064	1.7	1.5	0.4	0.4	0.0	0.0
Swain	B33	035	1060	1060	1.5	1.5	0.5	0.5	0.0	0.0
Scotten	B34	036	1056	1056	13	8.0	4.7	2.6	0.0	0.0
McKinstry	B35	037	1052	1052	8.8	7.1	2.3	1.6	0.0	0.0
Summit-Clark/Ferdinand	B36/B37	038/039	2006	2006	46	94	15	33	0.7	0.0
Ferdinand	B37	039	-----	-----	--	--	--	--	--	--
Morrell	B38	040	1040	1040	11	13	1.6	0.1	0.0	0.0
Junction	B39	041	1036	1036	18	16	0.0	0.0	0.0	0.0
Campbell	B40	042	1032	1032	23	23	7.8	7.6	0.0	0.0
Dragoon	B41	043	1026	1026	37	32	0.0	0.0	0.0	0.0
Schroeder	B42	044	1020	1020	20	20	6.2	6.1	0.0	0.0
Cary	B44	045	1012	1012	1.2	1.2	0.3	0.3	0.0	0.0
Dearborn	B45	046	1008	1008	27	26	10	9.8	0.7	0.6
Pulaski	B45	047	1004	1004	0.6	0.6	0.0	0.0	0.0	0.0
TREATED EFFLUENT					1,849	1,804	417	411	20	9
UNTREATED OVERFLOW					904	890	311	279	17	15
TOTAL					**2,752**	**2,694**	**729**	**691**	**37**	**23**

Notes:
-Underlined location indicates location of Task 1 Gate
-Shaded outfalls indicate location of basins and/or treatment facilities, items in square brackets [ ] depicts Preferred Plan facilities

Results for the Continuous Model (RUNOFF/TRANSPORT) simulations are compared to the previous model results in Tables 4 through 6. Table 4 gives the wet weather runoff volumes in MG/year for each Sanitary District, using the 36 years of precipitation versus the 3 years previously used in Level 3.12. All the districts are included shown to show the change due to the use of a longer precipitation record. The results indicate that the total wet weather volume is reduced by about 3,000 MG/yr (45,511 MG/yr to 42,492).

Table 5 gives the total flow to DWSD. The total flow is reduced slightly from 280,285 MG/yr to 280,041 MG/yr. Finally, Table 6 gives the total overflow in MG/yr for all the districts. The total overflow is reduced from 13,823 MG/yr to 11,776 MG/yr. This overflow includes treated effluent from the various treatment facilities that are part of the Long Term CSO Control Plan.

The updated Continuous Model has been used to support evaluation of the Long Term CSO Control Plan update completed in December 2001 as part of the CS-1281 project. Additional model results and evaluations are included in that report.

5. Summary

For the Master Plan project (CS-1314), the updated GDRSS Model (Event and Continuous) incorporates the best representation of existing and planned improvements to the greater Detroit wastewater collection system. The update provides the basis for the development of the Wastewater Master Plan (WWMP) Model currently underway.

Table 4. Summary of Runoff Volume by Sanitary District

Sanitary District	Wet Weather Runoff Volume (MG/year)				
	1998 CONDITIONS - Baseline Simulation with WWTP at 1520 MGD			2020 Conditions - Preferred Plan Simulations 1700 MGD	
	Level 2.0	Level 2.5	Level 3.0	Level 3.12	Level 3.13
Clinton Oakland	0	0	0	0	0
Macomb County	0	0	0	0	0
South Macomb	1,480	1,285	1,057	1,437	1,371
Northeast Wayne County	1,371	1,325	1,295	1,216	1,162
Evergreen-Farmington	1,341	1,199	750	750	763
Southeast-Oakland	8,527	7,678	7,309	7,307	7,000
Rouge Valley (Wayne Cty)	1,882	1,706	137	1,537	1,490
City of Farmington	0	0	0	0	0
City of Allen Park	0	0	0	0	0
City of Centerline	0	0	0	0	0
City of Melvindale	0	0	0	0	0
Grosse Pointe Park	570	408	387	0	0
Grosse Pointe Farms	515	428	410	411	394
City of Grosse Pointe	92	85	83	83	80
City of Dearborn	5,141	4,372	4,032	3,278	3,094
City of Detroit	37,103	34,168	34,379	29,492	27,139
TOTALS (to WWTP)	**58,022**	**52,654**	**49,839**	**45,511**	**42,492**

Table 5. Summary of Flow to DWSD by Sanitary District

Sanitary District	Total Flow to DWSD (MG/yr)				
	1998 CONDITIONS - Baseline Simulation with WWTP at 1520 MGD			2020 Conditions - Preferred Plan Simulations 1700 MGD	
	Level 2.0	Level 2.5	Level 3.0	Level 3.12	Level 3.13
Clinton Oakland	10,055	13,209	11,528	15,536	15,564
Macomb County	17,337	19,885	15,851	21,701	21,746
South Macomb	9,941	9,104	9,102	8,995	8,961
Northeast Wayne County	3,209	2,793	2,886	2,850	2,805
Evergreen-Farmington	17,183	16,725	16,353	17,913	17,935
Southeast-Oakland	25,702	27,075	25,759	26,416	26,190
Rouge Valley (Wayne Cty)	26,586	32,353	31,004	32,807	32,809
City of Farmington	863	897	827	784	785
City of Allen Park	564	1,056	570	508	499
City of Centerline	478	559	527	541	540
City of Melvindale	682	1,173	1,243	1,211	1,211
Grosse Pointe Park	1,055	877	867	624	623
Grosse Pointe Farms	1,126	844	834	833	825
City of Grosse Pointe	593	353	355	355	351
City of Dearborn	12,563	12,186	10,145	10,724	10,621
City of Detroit	133,900	141,659	138,769	138,487	138,573
TOTALS	**261,837**	**280,748**	**266,620**	**280,285**	**280,041**

Table 6. Summary of Overflow by Sanitary District

Sanitary District	Total Overflow (MG/yr)				
	1998 CONDITIONS - Baseline Simulation with WWTP at 1520 MGD			2020 Conditions - Preferred Plan Simulations 1700 MGD	
	Level 2.0	Level 2.5	Level 3.0	Level 3.12	Level 3.13
Clinton Oakland	0	0	0	0	0
Macomb County	0	0	0	0	0
South Macomb	369	149	229	227	213
Northeast Wayne County	378	361	388	337	335
Evergreen-Farmington	598	534	313	315	336
Southeast-Oakland	1,689	1,659	2,038	1,992	1,988
Rouge Valley (Wayne Cty)	1,018	1,047	999	862	842
City of Farmington	1	1	0	0	0
City of Allen Park	0	0	0	0	0
City of Centerline	0	0	0	0	0
City of Melvindale	0	0	0	0	0
Grosse Pointe Park	61	47	58	0	0
Grosse Pointe Farms	28	30	31	38	32
City of Grosse Pointe	0	0	0	0	0
City of Dearborn	1,873	1,609	1,833	638	585
City of Detroit	14,800	16,972	14,049	9,414	7,446
TOTALS	**20,815**	**22,409**	**19,938**	**13,823**	**11,776**

6. Other Updates

The updates described thus far were part of the GDRSS Model 2001 Release. Appendix B through D describes other updates that are part of the WWMP Model version of the GDRSS Model.

Appendix A
In-System Storage Facilities

The GDRSS Event Model representation of the proposed In-System Storage (ISS) dams that are part of the City of Detroit Long Term CSO Control Plan was improved by Applied Science as part of the CS-1329 Basis of Design project. During the development of the Basis of Design for these facilities, a number of changes were made to the preliminary design. The modifications required in the model included revising the locations of facilities that changed during the Basis of Design, subdividing tributary subareas to better account for flows tributary to the facilities, and adding additional upstream conduits. The changes also involved removal of several dams originally proposed.

Table A-1 lists the ISS dams and gives some baseline data regarding the amount of storage that is calculated to be provided by each dam. The table also gives a list at the bottom of the dams that were removed from further consideration during the development of the basis of design.

There were subarea changes made to better represent the tributary areas for the dams. A total of five areas were modified. These areas are for the Ashland sewer, the Outer Drive relief sewer, the Seven Mile sewer, the Wyoming and Wyoming relief sewers, and the Clark sewer. Table A-2 summarizes these changes by comparing the update to the official Phase III GDRSS Model.

Several sewers were added and/or extended as well. These are the Ashland sewer, the Fischer sewer, the Wyoming sewer, the Wyoming relief sewer, and Outer Drive sewers. These changes were incorporated into a modified version of the GDRSS Phase III Model by Applied Science during the development of the Basis of Design. The modified GDRSS Model used included changes made to refine the model's representation of the HGL in the West-Side area of Detroit (Rouge River and Hubbell-Southfield Districts) during investigations of various configurations of the Upper Rouge Tunnel. These changes included adding additional nodes (manholes) along existing modeled pipes and adding additional pipes.

Both the improved representation of the ISS devices and the increased detail in the west side area have been incorporated in the GDRSS Event Model-2001 Update.

Table A-1. In System Storage Facilities.

Device ID	Sewer	Sewer District	Total In-System Storage Provided (MG)	Existing In-System Storage (MG)	Ave. Dry Weather Flow Volume (MG)	Net In-System Storage Provided (MG)	Previous In-Sys. Storage (MG)
CC3	Conner Creek	Conner Creek	11.96	0	1.61	10.35	11.43
CME2	Conant -Mt. Elliott	Central	14.98	0.57	5.95	8.46	14.36
FH1A	First Hamilton	Central	11.13	0.89	2.11	8.13	8.43
ASH1	Ashland	E. Jefferson/Fox Creek	5.06	0	0.88	4.18	3.37
WR1	Wyoming Relief	Baby Creek	6.39	0.54	0.25	5.6	5.83
FH2	First Hamilton	Central	5.11	0	0.68	4.43	3.69
FH3	First Hamilton	Central	5.33	0	1.05	4.28	3.63
CC2A	Conner Creek	Conner Creek	5.7	0.09	0.34	5.27	8.18
FH2A	First Hamilton	Central	4.56	0	0.6	3.96	3.85
AR1A	Ashland Relief	E. Jefferson/Fox Creek	3.2	0	0.06	3.14	2.92
AR2	Ashland Relief	E. Jefferson/Fox Creek	3.82	0	0.05	3.77	2.87
JOY1	Joy	Baby Creek	4.38	0	0.8	3.58	3.45
SEV3	Seven Mile	Conner Creek	4.27	0	0.7	3.57	2.35
HUB2	Hubbell	Hubbell	4.04	0	0.44	3.6	3.96
WBY2	Wetherby	Wetherby	3.71	0	0.56	3.15	2.53
CC2	Conner Creek	Conner Creek	9.49	5.56	0.56	3.37	9.09
AR1	Ashland Relief	E. Jefferson/Fox Creek	3.25	0	0.07	3.18	4.21
ASH1A	Ashland	E. Jefferson/Fox Creek	3.22	0	0.55	2.67	2.42
LYN1	Lynch	Conner Creek	2.67	0	0.21	2.46	2.85
ULR1	Upper Livernois Re	Baby Creek	2.91	0	0.47	2.44	2.47
CLK1A	Clark	Central	4.22	1.56	0.26	2.4	3.51
Six2	Six Mile	Conner Creek	2.77	0	0.43	2.34	2.61
FH4	First Hamilton	Central	2.23	0	0.81	1.42	2.36
		Total	124.4	9.21	19.44	95.75	110.37
Following dams removed from consideration							
ODR1	Outer Drive Relief	Conner Creek					7.95
CC3A	Conner Creek	Conner Creek					4.68
SEV2A	Seven Mile	Conner Creek					3.43
FSH2	Fischer	Central					3.1
CC*	Conner Creek	Conner Creek					3.07
LR2	Livernois Relief	Central					3.37
LR3	Livernois Relief	Central					1.32

Table A-2 Changes in Subareas for ISS Basis of Design Update

Submodel	Location/ Sewer	Subarea I.D.	Area (acres) GDRSS	Update
FE	Ashland	5510	1,871	778
		5530	0	820
		5555	0	273
		total:	1,871	1,871
CC	7-mile	2350	2,740	1,089
		2355	0	1,651
		total:	2,740	2,740
CC	Clark	1039	470	410
		1047	29	0
		1051	317	270
		1055	384	256
		1067	1,193	414
		1071	373	132
		1075	649	370
		2030	0	548
		2040	164	261
		2056	193	832
		2060	317	0
		2160	587	648
		20111	0	535
		total:	4,676	4,676
CC	Outer Dr.	600	0	250
		630	0	396
		650	0	813
		2315	0	1,075
		2990	2,534	0
		total:	2,534	2,534
CC	Wyoming	1310	0	420
		1320	0	318
		1335	2,357	240
		1345	0	1,305
	Wy.Relief	1215	0	110
		1220	0	62
		1225	0	90
		1230	0	365
		1260	553	0
		total:	2,910	2,910

Appendix B
Macomb Sanitary District Submodel Development and Calibration

1. Introduction

This technical memorandum describes the expansion of the GDRSS Model for the Macomb Sanitary District (MSD). There are 11 communities within this district. These communities are: Chesterfield Township, Lenox Township, New Haven, Clinton Township, Fraser City, Harrison Township, Sterling Heights City, Macomb Township, Shelby Township, Washington Township, and Utica City. These communities are all served by separate sanitary sewers that are tributary to DWSD owned interceptors in this district.

The flows from these areas are measured and monitored through 19 billing meters. The meters have tributary areas ranging from 258 to 38,000 acres. The previous GDRSS Model framework used one subarea to represent this district. It also did not include the DWSD-owned interceptors in this district.

For the Macomb Sanitary District Submodel development, a total of 22 subareas were defined. The flow monitoring data obtained from the meters were analyzed to determine the wet weather response for these areas. The results were utilized to develop the Rainfall Dependent Inflow/Infiltration (RDI/I) hydrograph parameters using three actual rain events. RDII is the fraction of rainfall that enters the collection system due to precipitation after satisfying the requirements of initial abstraction. The latter represents the capacity of soil to sorb water.

In addition to increasing the level of detail in the subarea delineations, the model was expanded to include the DWSD-owned interceptors in this district.

2. . RUNOFF Model Development
2.1 Data Collection

The data collected within each tributary flowmeter area included flow data and rainfall data. These data are discussed in the following sections.

***Flow Data*:**
Flow monitoring data were obtained from the 19 billing meters installed in the Macomb County tributary areas. The data collected from the meters covered a time period ranging from October 2000 to September 2001. The five-minute data was averaged into 15-minute interval data for analysis. The locations of the flowmeters and associated tributary areas are shown on Figure 1. In some cases, more than one community is tributary to one billing meter. For the model, these tributary areas were further divided to make each subarea unique with respect to community. Table 1 provides a list of the

meters and associated community and tributary areas. It also gives the district or sub area IDs for the areas that were delineated for the model.

Figure 1. Macomb Sanitary District Meters and Tributary Areas

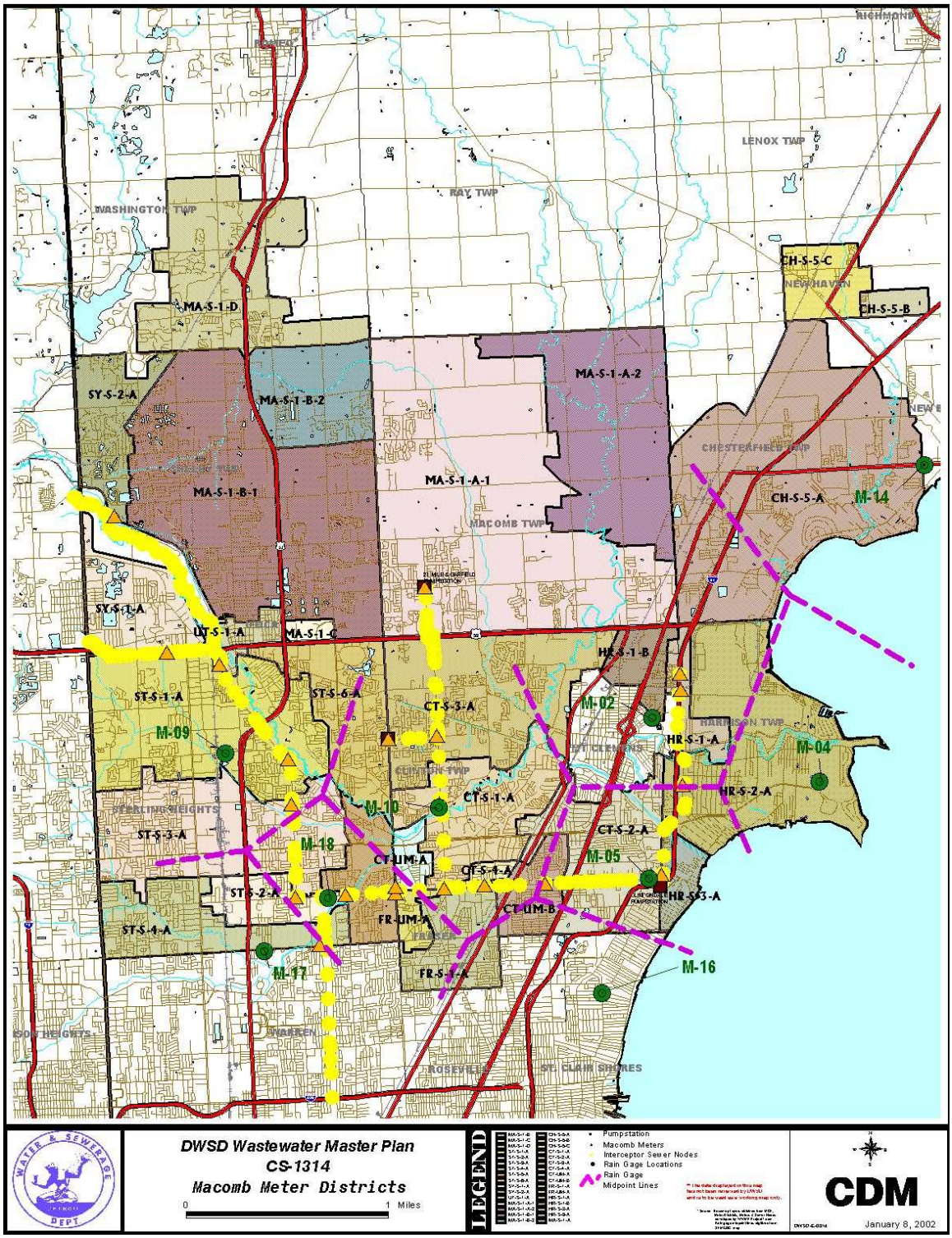


Table 1. Macomb Sanitary District Meters

Meter	District (Subarea)	Community	Area (acres)	Area (sq. mi)
CH-S-5	CH-S-5-A	Chesterfield Township	11,134	17.4
	CH-S-5-B	Lenox Township	477	0.7
	CH-S-5-C	New Haven	1,786	2.8
CT-S-1	CT-S-1-A	Clinton Township	3,917	6.1
CT-S-2	CT-S-2-A	Clinton Township	4,214	6.6
CT-S-3	CT-S-3-A	Clinton Township	6,585	10.3
CT-S-4	CT-S-4-A	Clinton Township	1,380	2.2
FR-S-1	FR-S-1-A	Frasier	2,186	3.4
HR-S-1	HR-S-1-A	Harrison Township	982	1.5
	HR-S-1-B	Clinton Township	1,125	1.8
HR-S-2	HR-S-2-A	Harrison Township	7,886	12.3
HR-S-3	HR-S-3-A	Harrison Township	879	1.4
MA-S-1	MA-S-1-A	Macomb Township	16,339	25.5
	MA-S-1-B	Shelby Township	16,058	25.1
	MA-S-1-C	Utica	302	0.5
	MA-S-1-D	Washington Township	5,629	8.8
ST-S-1	ST-S-1-A	Sterling Heights	7,631	11.9
ST-S-2	ST-S-2-A	Sterling Heights	1,407	2.2
ST-S-3	ST-S-3-A	Sterling Heights	6,220	9.7
ST-S-4	ST-S-4-A	Sterling Heights	3,163	4.9
ST-S-5	ST-S-5-A	Sterling Heights	1,862	2.9
ST-S-6	ST-S-6-A	Sterling Heights	3,283	5.1
SY-S-1	SY-S-1-A	Shelby Township	2,645	4.1
SY-S-2	SY-S-2-A	Shelby Township	2,347	3.7
UT-S-1	UT-S-1-A	Utica	850	1.3
Unmetered	CT-UM-A	Clinton Township	572	0.9
	CT-UM-B	Clinton Township	258	0.4
	FR-UM-C	Frasier	482	0.8
	Total		**111,599**	**174**

Rainfall Data

Rainfall data were obtained from the Southeast Michigan Council of Governments' (SEMCOG) rainfall database located on their web site at "www. SEMCOG.org". At the time of the analysis, data were available through June 2001. The data were of hourly and daily time interval. The rain gages from which the rainfall data were obtained are M2, M4, M5, M9, M10, M14, M16, M17, and M18. These rain gages were selected because they are located within the watershed boundary of the planning service area in Macomb County. The locations of these rain gages are shown in Figure 1.

To determine the distributed rainfall depths over the tributary areas, the Thiessen Polygon method was used to determine the percent of each rain gage to assign to each area. Each tributary area (flow meter) received different weights of the rainfall depth of the neighboring rain gages. The resulted rainfall depth that was assigned for each tributary area was used specifically in the calibration process. Table 2 shows the weighted rainfall depth factors for each flow meter at any given event. A sample of an application of these factors for April 1-19 storm event is shown in Table 3.

Table 2: Weighted Rainfall Calculations

Meter ID	Weighted Rainfall Depth
Ch-s-5	0.22M2 + 0.78M14
Ct-s-1	1.0M10
Ct-s-2	0.04M2+ 0.76M5+ 0.12M10+ 0.08M16
Ct-s-3	0.29M2+0.71M10
Ct-s-4	0.26M5+0.32M10+0.42M16
Fr-s-1	0.2M10+0.36M16+0.44M18
Hr-s-1	1.0M2
Hr-s-2	0.3M2+0.58M4+0.12M5
Hr-s-3	1.0M5
Ma-s-1	0.3M2+0.3M9+0.3M10
St-s-1	1.0M9
St-s-2	0.66M17+0.34M18
St-s-3	0.64M9+0.11M17+0.25M18
St-s-4	0.9M17+0.1M18
St-s-5	0.23M10+0.77M18
St-s-6	0.46M9+0.54M10
Sy-s-1	1.0M9
Sy-s-2	1.0M9
Ut-s-1	1.0M9

Table 3. Weighted Rainfall Depths for April Event (April 1 – April 19, 2001)

Rainfall At Each Gage (inch)								
M2	M4	M5	M9	M10	M14	M16	M17	M18
1.55	1.56	1.89	1.78	1.94	1.9	2.43	1.32	1.78

Meter	Rain Gage Weighing Factor				Weighed Rainfall Depth (inch)				Total Rainfall (inch)
Ch-s-5	M2	M14			M2	M14			1.82
	0.22	0.78			0.341	1.482			
Hr-s-1	M2				M2				1.55
	1.0				1.55				
Hr-s-2	M2	M4	M5		M2	M4	M5		1.60
	0.3	0.58	0.12		0.465	0.9048	0.2268		
Hr-s-3	M5				M5				1.89
	1.0				1.89				
Ct-s-1	M10				M10				1.94
	1.0				1.94				
Ct-s-2	M2	M5	M10	M16	M2	M5	M10	M16	1.93
	0.04	0.76	0.12	0.08	0.062	1.4364	0.2328	0.1944	
Ct-s-3	M2	M10			M2	M10			1.83
	0.29	0.71			0.4495	1.3774			
Ct-s-4	M5	M10	M16		M5	M10	M16		2.13
	0.26	0.32	0.42		0.4914	0.6208	1.0206		
Fr-s-1	M10	M16	M18		M10	M16	M18		2.05
	0.2	0.36	0.44		0.388	0.8748	0.7832		
Ma-s-1	M2	M9	M10		M2	M9	M10		1.58
	0.3	0.3	0.3		0.465	0.534	0.582		
St-s-1	M9				M9				1.78
	1.0				1.78				
St-s-2	M17	M18			M17	M18			1.48
	0.66	0.34			0.8712	0.6052			
St-s-3	M9	M17	M18		M9	M17	M18		1.73
	0.64	0.11	0.25		1.1392	0.1452	0.445		
St-s-4	M17	M18			M17	M18			1.37
	0.9	0.1			1.188	0.178			
St-s-5	M10	M18			M10	M18			1.82
	0.23	0.77			0.4462	1.3706			
St-s-6	M9	M10			M9	M10			1.87
	0.46	0.54			0.8188	1.0476			
Sy-s-1	M9				M9				1.78
	1.0				1.78				
Sy-s-2 (Tmpzz1)	M9				M9				1.78
	1.0				1.78				
Ut-s-1	M9				M9				1.78
	1.0				1.78				

2.2 Flow Data Analysis

To analyze the flow data for each meter for the specified period of time, a computer program called Shape was used. This program was developed by CDM to facilitate the dry weather and wet weather analyses of sewer system flow monitoring data. The SHAPE program has several routines to perform the following tasks:

- Converts the flow monitoring data and the rainfall data into a format that can be used by the program;
- Determines the DWF diurnals and averages for weekdays and weekends;
- Determines the RDII flow volumes and peaks for defined wet weather events; and
- Computes the percent of rainfall (RDII response) that enters the sewer system over the sewered area for individual events.

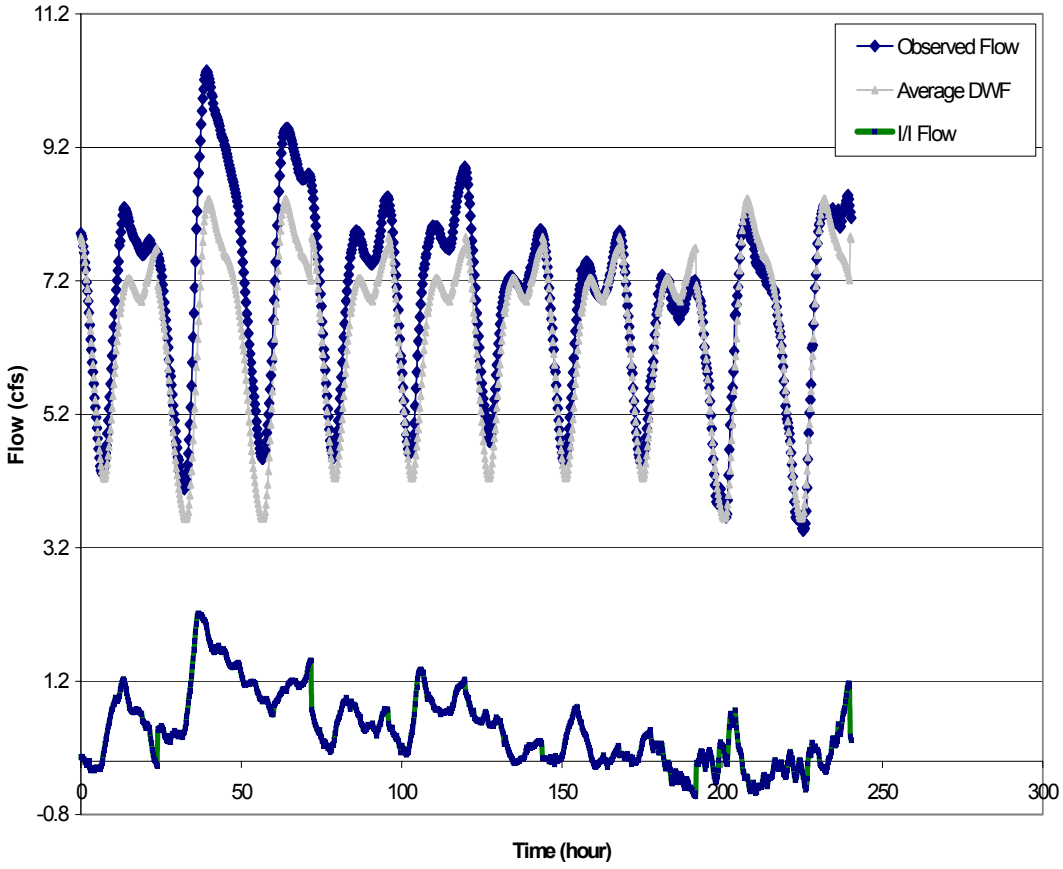
The dry weather evaluations allow dry weather weekend and weekdays diurnal patterns to be identified from the recording period. For this evaluation, the program plots the flow data day by day as compared to an average flow pattern for the period of record. Through this process, the days that appear to have flows affected by wet weather flows are flagged by the user. The dry weather flows for the remaining days are used to determine the average, maximum, and minimum dry weather flows for both weekend and weekday for each monitoring location.

The observed flows consist of dry weather flow (DWF) and any wet weather responses due to rainfall events (RDI/I). The DWF includes groundwater infiltration (GWI) and base wastewater flow. During dry seasons, the observed flow is approximately equal to the dry weather flow. GWI rate changes seasonally, and does not vary rapidly. Therefore, GWI is considered constant during a rainfall event. The analysis procedures included the adjustment of GWI to reflect that fact. The RDI/I can then be calculated by subtracting the average weekday and weekend dry weather flow hydrographs from the observed flows during the rainfall events. The program results provide the percentage of rainfall over the sewered area that enters the sewer system.

The SHAPE analysis includes the ability to account for seasonal variation in the GWI flows. This parameter was carefully examined since it affects the RDI/I volume that is calculated. The GWI adjustment was performed by having the RDI/I flows be approximately equal to zero during dry periods that were not directly affected by RDI/I events. Specifically, the RDI/I flows should be approximately zero before and after a RDI/I event. Figure 2 shows a sample of a SHAPE hydrograph plot consisting of observed flows, DWF, and the RDI/I.

The SHAPE program was used for analysis of the flow data from the 19 meters. However, for 4 of the meters, it was found that the data was too noisy for the program to work. For these meters, the data were analyzed by averaging the data by day and using Excel spreadsheets to determine the dry weather and wet weather parameters. Those meters were Fr-s-1, Hr-s-2, Hr-s-3, and Ma-s-1.

Figure 2. SHAPE Hydrograph Plots



2.3 Results

There were 8 individual events identified. These time periods of these events are shown in Table 4.

Table 4: Rainfall Events

Event No.	Time Period
1	10/23/00 – 10/28/00
2	11/7/00 – 11/15/00
3	11/25/00 – 11/30/00
4	4/1/01 – 4/19/01
5	4/20/01 – 4/29/01
6	5/7/01 – 5/19/01
7	5/21/01 – 5/31/01
8	6/1/01 – 6/10/01

The wet weather responses from December 2000 through the end of March 2001 were not considered in this analysis. The reason was that these responses would generally be due to snow melting and it is difficult to determine the amount of snowmelt to correlate to these wet weather responses. The total rainfall depths for each event along with the corresponding RDI/I depths (inches) were plotted for each meter. The scattered points were used to produce a best-fit line. The slope of the straight line represents the RDII C factor. This factor is the fraction of the rainfall excess depth that enters the sewer system during and after the events. In general, there were two distinct seasons identified in this analysis for C factors determination: Dormant Season (from November to April) and Growth Season (from June to September). May and October were classified as being transition months. Each of these seasons exhibits different RDI/I behavior.

The data points representing the events in the months of October, November, and April were used to determine the C factor for the Dormant Season. For the two events in May, a transitional month, one event was considered an outlier, and the other event was considered to be indicating a Growth Season response. The June event was excluded from the analysis as it appeared to be impacted by the wet weather at the end of May. Plots showing these results are provided in Attachment 1.

C factors are affected by the initial abstraction Vo which is the rainfall depth below which wet weather response is not observed in the collection system. The Vo values are obtained graphically by intercepting C lines with X-axis. The results of C factors in addition to Vo's for both Dormant and Growth Seasons are presented in Tables 5 and 6. Figure 3 shows a sample of the RDI/I scattered points along with the best-fit lines for Dormant and Growth.

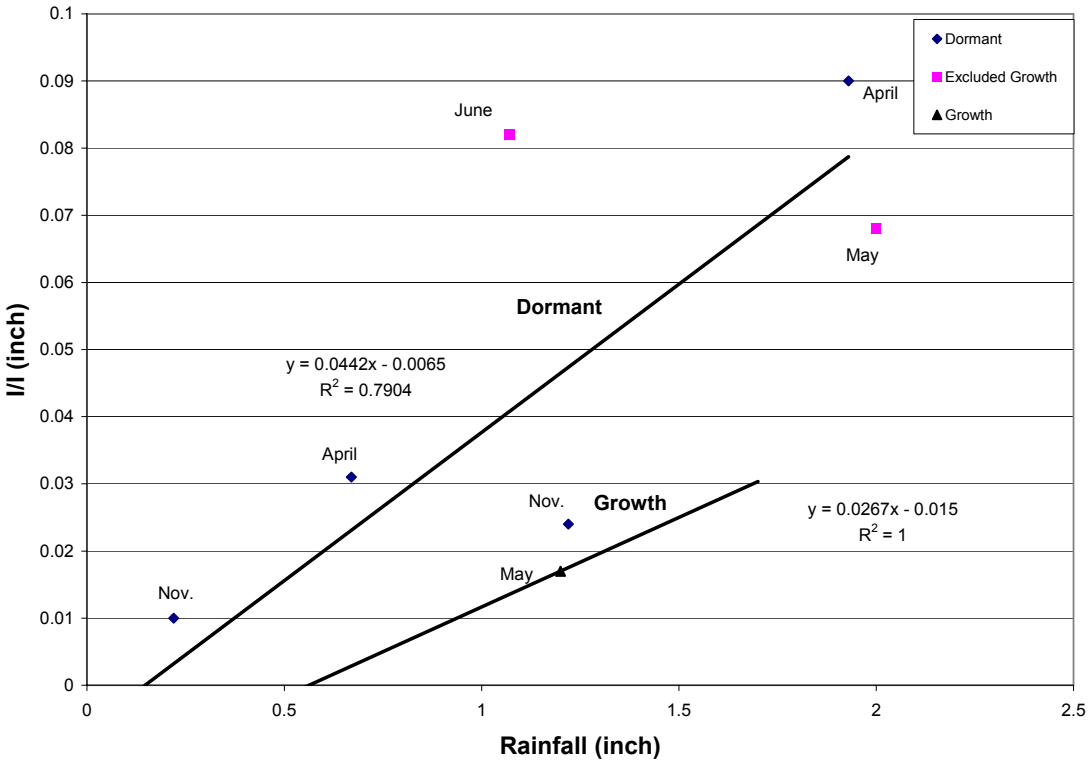
Table 5. Estimation of C and Vo Values (Dormant)

Equation is in the form of		Y= Ax + B					
Meter ID.	**Equation**	**R^2**	**A**	**B**	**Intercept with x Axis**	**C**	**Initial Abstraction (V_o)**
Ch-s-5	Y=0.0104x - 0.003	0.89	0.0104	-0.003	0.29	0.010	0.29
Ct-s-1	Y= 0.0265x - 0.0044	1.00	0.0265	-0.0044	0.17	0.027	0.17
Ct-s-2	Y=0.0442x - 0.0065	0.79	0.0442	-0.0065	0.15	0.044	0.15
Ct-s-3	Y=0.0057x - 0.0016	0.85	0.0057	-0.0016	0.28	0.006	0.28
Ct-s-4	Y=0.0736x - 0.015	0.92	0.0736	-0.015	0.20	0.074	0.20
Fr-s-1	Y=0.0836x - 0.0292	0.91	0.0836	-0.0292	0.35	0.084	0.35
Hr-s-1	Y=0.0209x - 0.0033	0.90	0.0209	-0.0033	0.16	0.021	0.16
Hr-s-2	Y=0.0101x - 0.0016	0.81	0.0101	-0.0016	0.16	0.010	0.16
Hr-s-3	Y=0.0218x - 0.003	0.73	0.0218	-0.003	0.14	0.022	0.14
Ma-s-1	-	-	-	-	-	-	-
St-s-1	Y=0.0369x - 0.016	0.79	0.0369	-0.016	0.43	0.037	0.43
St-s-2	Y=0.0938x - 0.014	0.73	0.0938	-0.014	0.15	0.094	0.15
St-s-3	Y=0.0566x - 0.02	0.94	0.0566	-0.02	0.35	0.057	0.35
St-s-4	Y=0.0621x - 0.02	0.91	0.0621	-0.02	0.32	0.062	0.32
St-s-5	Y=0.0394x - 0.0059	0.93	0.0394	-0.0059	0.15	0.039	0.15
St-s-6	Y=0.0051x - 0.001	0.78	0.0051	-0.001	0.20	0.005	0.20
Sy-s-1	-	-	-	-	-	-	-
Sy-s-2 (Tmpzz1)	-	-	-	-	-	-	-
Ut-s-1	Y=0.0237x - 0.0087	0.95	0.0237	-0.0087	0.37	0.024	0.37
					Average=	**0.038**	**0.24**
(-) Data is not Avaliable							

Table 6. Estimation of C and Vo Values (Growth)

Equation is in the form of		Y= Ax + B					
Meter ID.	Equation	R^2	A	B	Intercept with x Axis	C	Initial Abstraction (V_o)
Ch-s-5	-	-	-	-	-	-	-
Ct-s-1	Y= 0.0048x - 0.0047	1.00	0.0048	-0.0047	0.98	0.005	0.98
Ct-s-2	Y=0.0267x - 0.015	0.28	0.0267	-0.015	0.56	0.027	0.56
Ct-s-3	Y=0.0038x - 0.0035	0.54	0.0038	-0.0035	0.92	0.004	0.92
Ct-s-4	Y=0.0401x - 0.022	1.00	0.0401	-0.022	0.55	0.040	0.55
Fr-s-1	Y=0.0215x - 0.02	1.00	0.0215	-0.02	0.93	0.022	0.93
Hr-s-1	Y=0.0169x - 0.007	0.90	0.0169	-0.007	0.41	0.017	0.41
Hr-s-2	Y=0.0034x - 0.0025	1.00	0.0034	-0.0025	0.74	0.003	0.74
Hr-s-3	Y=0.0101x - 0.006	0.94	0.0101	-0.006	0.59	0.010	0.59
Ma-s-1	-	-	-	-	-	-	-
St-s-1	Y=0.0103x - 0.0062	0.95	0.0103	-0.0062	0.60	0.010	0.60
St-s-2	Y=0.0667x - 0.035	0.93	0.0667	-0.035	0.52	0.067	0.52
St-s-3	Y=0.0357x - 0.03	1.00	0.0357	-0.03	0.84	0.036	0.84
St-s-4	Y=0.0265x - 0.02	1.00	0.0265	-0.02	0.75	0.027	0.75
St-s-5	Y=0.0122x - 0.011	0.83	0.0122	-0.011	0.90	0.012	0.90
St-s-6	Y=0.0031x - 0.002	1.00	0.0031	-0.002	0.65	0.003	0.65
Sy-s-1	-	-	-	-	-	-	-
Sy-s-2 (Tmpzz1)	-	-	-	-	-	-	-
Ut-s-1	-	-	-	-	-	-	-
					Average=	**0.020**	**0.71**
(-) Data is not Avaliable							

Figure 3. RDI/I Scattered Points with the Best-Fit Lines for Dormant and Growth



3. Model Calibration

The SHAPE analysis was used to determine the RDII C factor and the Vo. The goal of the calibration process was to adjust the RDII shape parameters in RUNOFF within a range of reasonable limits to obtain flow hydrographs that compare favorably with measured flow data.

The data utilized for calibration consisted of rainfall and flow data. Three rainfall events were selected. A total of twenty-five sets of data were used in the calibration process. The storm events and flow meters associated with them used in the model calibration are listed below:

Rainfall Event	**Flowmeters used for Calibration**
April 1 – 19, 2001	Ch5, Ct1, Ct2, Ct4, Hr1, St2, St4, St5 & Ut1
April 20 - 29, 2001	Ct1, Ct2, Ct4, Hr1, St2, St4, & St5
May 21 – 31, 2001	Ch5, Ct1, Ct2, Ct3, Hr1, St2, St4, St5 & Ut1

The remaining flowmeters were excluded from the calibration process for one of the following reasons:

- Flowmeters data had noisy hydrographs and no clear peaks, or
- Missing data (Flowmeters were out of services).

The calibration process included the adjustment of the RUNOFF model parameters (i.e., C, V_o, T, and K). The parameters T and K define the triangular Unit Hydrograph (UH) generated by the RUNOFF to compute the subcatchments I/I response. T is the time to peak of the UH and K is the ratio of the recession limb to time to peak. The final outcome of this process was a calibrated computer model that responds to rainfall in a manner similar to the actual collection system.

C factor was determined for each meter tributary area associated with three rainfall events with an initial V_o equals to 0.15. The C factors were then divided into inflow (C1 factor) and infiltration (C3 factor). In addition, initial values for T1, K1, T3, and K3 were set in the RUNOFF. A simple 1-pipe EXTRAN model was configured to allow the use of Model Turbo View–Extran (MTVE) to compare the RUNOFF output with the calibration data. The parameters were adjusted and the model runs were repeated until the volume, peak, and shape of hydrographs matched reasonably the measured ones. The final results of the model parameters are presented in Table 7. A sample of the actual and predicted hydrographs after calibration is shown in Figure 4.

**Figure 4. Measured and Predicted Flows after Calibration
(model results shown as a solid line, measured data shown with *)**

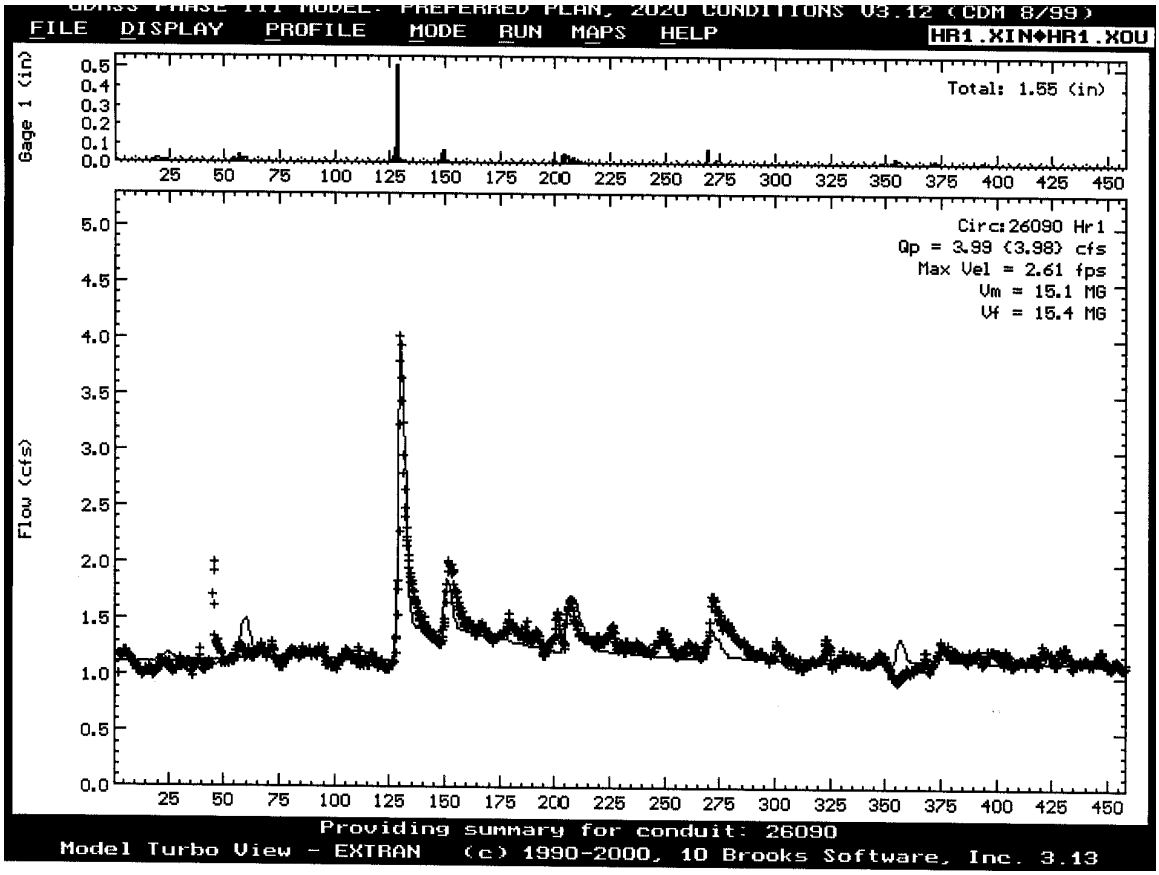


Table 7. Macomb County RUNOFF Event Parameters

Meter I.D.	Event 1 (April 1-19)						Event 2 (April 21-29)						Event 3 (May 21-31)					
	Vo (in)	C (in/in)	T1 (hr)	K1	T3 (hr)	K3	Vo (in)	C (in/in)	T1 (hr)	K1	T3 (hr)	K3	Vo (in)	C (in/in)	T1 (hr)	K1	T3 (hr)	K3
Ch-s-5	0.50	0.0210	2.00	7.00	12.00	8.00	N/A						0.15	0.0045	2.00	2.30	1.00	100.00
Ct-s-1	0.15	0.0254	1.00	3.00	2.50	70.00	0.00	0.0208	1.00	2.00	3.00	45.00	0.15	0.0253	0.70	6.00	1.00	65.00
Ct-s-2	0.10	0.0486	1.00	5.00	1.00	103.00	0.10	0.0544	1.00	4.00	2.50	50.00	0.50	0.0453	0.40	24.00	0.50	115.00
Ct-s-3	N/A						N/A						0.20	0.0097	0.50	7.00	1.00	70.00
Ct-s-4	0.00	0.0664	1.17	3.00	2.00	80.00	0.00	0.0649	0.50	1.40	0.50	50.00	N/A					
Hr-s-1	0.03	0.0184	1.60	3.00	3.00	30.00	0.10	0.0273	1.00	2.00	0.28	200.00	0.25	0.0259	1.00	2.50	0.50	50.00
St-s-2	0.00	0.0555	2.00	3.00	3.00	30.00	0.10	0.0537	1.00	4.50	3.00	35.00	0.40	0.0669	0.75	3.00	1.00	50.00
St-s-4	0.00	0.0322	1.00	4.40	3.00	50.00	0.05	0.0268	3.00	0.50	0.50	140.00	0.45	0.0291	1.00	3.00	1.00	45.00
St-s-5	0.00	0.0356	1.15	3.00	3.00	90.00	0.00	0.0266	1.50	2.00	1.00	60.00	0.20	0.0220	0.90	2.50	1.00	30.00
Ut-s-1	0.15	0.0196	3.00	1.00	4.50	18.00	N/A						0.22	0.0252	1.00	1.50	2.00	13.00

Notes:

1) Meters Fr-s-1, Hr-s-2, Hr-s-3, Ma-s-1, St-s-1, St-s-3, St-s-6, Sy-s-1, and Sy-s-2 (Tmpzz1) were not presented in this Table, because they were either not working properly or out of service during the flow monitoring period.

2) N/A indicates that flow monitoring data could not be utilized because of the noisy nature of the readings. Therefore, the "C" values associated with these particular meters and events were not calculated.

4. Design Values

4.1 RDII Parameters

The design values to use for the RDII parameters were determined by taking an average of the event specific values determined during the calibration process. This analysis is provided in Table 8 for the RDII parameters T1, T3, K1, K3, C1, and C3. The design

values for the flowmeters not included in the calibration process were estimated based on their geographical proximity locations among the calibrated meters. Results are provided in Table 8. The C and V_0 values for dormant season were used as design values for each flowmeter. The RDII parameter values for the unmetered areas Ct-um-A, Ct-um-B, and Fr-um-A were lumped together, as an average, to have only one common value for each parameter.

An area-weighted C value for dormant conditions was estimated to be 2.2%, as shown in Table 8. This compares well with the estimate used previously in GDRSS Model of 2.7%.

4.2 DWF Factors

The GDRSS Model uses monthly dry weather flow factors to account for seasonal variation in dry weather flows by month. The SHAPE analysis provided the daily averages for each day which was selected during the dry weather flow analyses. These results were used to calculate monthly dry weather flow averages for each flowmeter, as given in Table 9.

Dry weather flows for the month of October were chosen for all flowmeters as the base values as typically the dry weather flow for this month is the lowest for the entire year. All other dry weather flows were divided by the October base values. The results are the DWF factors as shown in Table 10. These factors were equal to 1 for the month of October while others were smaller or larger than 1. As can be seen, for this year, several months had lower DWFs than recorded for October.

These factors are used in the EXTRAN Model. The DWF factors for the flowmeters having no monthly DWF averages were estimated based on geographical proximity locations to the flowmeters whose estimated DWF's were available. Tables 11 and 12 show how the missing factors were filled.

Dry weather flow factors were lumped together into 11 sets instead of 22 sets due to the limitation in the total number DWFF sets that can be defined in the EXTRAN block. Weighted area averages were used to lump the tributary areas that are located in the same city or township to come up with a common DWF factor for them as shown in Table 13.

5. EXTRAN Model Development

The sewer system in Macomb Sanitary District (MSD) consists of six major gravity Interceptors and three DWSD pumping stations. These Interceptors are: Edison Corridor, Oakland Arm including Avon Arm, 15-Mile Road, Romeo Arm including Sterling Heights Arm, Lakeshore, and Garfield (under construction). The pumping stations are: Garfield (will be abandoned after the Garfield Interceptor is in place), Clintondale, and Northeast pumping station. Interceptors and pumping stations locations are shown in Figure 5.

EXTRAN input file was developed using the data obtained from DWSD plan-profile drawings for all the gravity sewer Interceptors. The data collected included all the

parameters needed to develop the EXTRAN block of the sewer system. Those parameters included node numbering; conduit numbering; length; diameter; and roughness coefficient. The pumping data included: on and off levels, and three data points of the pumping curves for each pump. The selection of node locations along the Interceptors were based on EXTRAN criteria in terms of maximum and minimum lengths, change in direction, change in diameter, change in slope, change in material and inflow points.

The data representation reflects the current and future conditions of the sewer system for the current force main that connects Garfield pumping station and Romeo Arm Interceptor, and the future Garfield interceptor. The future condition information is included in the model as commented lines. When Garfield Interceptor is put into service, the Garfield pumping station and the force main will be abandoned. The model code can be updated at that time by removing the pump and force main lines and "turning on" the lines that represent the Garfield Interceptor.

6. Summary

The GDRSS Model has been expanded to include 22 subareas to represent the wet weather response in the Macomb Sanitary District (MSD). These areas were analyzed and incorporated into the model using flow and rainfall data collected from fall of 2000 through June of 2001. While the overall response compares closely to the response used previously in the GDRSS Model, the increase spatial resolution improves the variation in the response within the MSD area. The model has also been expanded to include the DWSD-owned interceptors in this area. The improved spatial resolution and expanded sewer network detail will improve the ability of the model to account for projected growth within the region and to determine capacity constraints and needs for the WWMP planning.

A copy of the Macomb RUNOFF and EXTRAN submodels are included as Attachments A and B, respectively, for reference.

Table 8. Macomb County Average RUNOFF Event Parameters

Event #	RUNOFF Parameters	Meter I.D.									
		Ch-s-5	**Ct-s-1**	**Ct-s-2**	**Ct-s-3**	**Ct-s-4**	**Hr-s-1**	**St-s-2**	**St-s-4**	**St-s-5**	**Ut-s-1**
1	Vo (in)	0.50	0.15	0.10	N/A	0.00	0.03	0.00	0.00	0.00	0.15
2		N/A	0.00	0.10	N/A	0.00	0.10	0.10	0.05	0.00	N/A
3		0.15	0.15	0.50	0.20	N/A	0.25	0.40	0.45	0.20	0.22
	Average	0.33	0.10	0.23	0.20	0.00	0.13	0.17	0.17	0.07	0.19
1	C (in/in)	0.021	0.025	0.049	N/A	0.066	0.018	0.056	0.032	0.036	0.020
2		N/A	0.021	0.054	N/A	0.065	0.027	0.054	0.027	0.027	N/A
3		0.005	0.025	0.045	0.010	N/A	0.026	0.067	0.029	0.022	0.025
	Average	0.01	0.02	0.05	0.01	0.07	0.02	0.06	0.03	0.03	0.02
1	C1 (% from C)	30.00	20.00	19.00	N/A	40.00	40.00	40.00	30.00	40.00	20.00
2		N/A	19.00	15.00	N/A	70.00	18.00	55.00	28.00	52.00	N/A
3		30.00	31.00	35.00	38.00	N/A	33.00	18.00	30.00	70.00	30.00
	Average	30.00	23.33	23.00	38.00	55.00	30.33	37.67	29.33	54.00	25.00
1	C3 (% from C)	70.00	80.00	81.00	N/A	60.00	60.00	60.00	70.00	60.00	80.00
2		N/A	81.00	85.00	N/A	30.00	82.00	45.00	72.00	48.00	N/A
3		70.00	69.00	65.00	62.00	N/A	67.00	82.00	70.00	30.00	70.00
	Average	70.00	76.67	77.00	62.00	45.00	69.67	62.33	70.67	46.00	75.00
1	T1 (hr)	2.00	1.00	1.00	N/A	1.17	1.60	2.00	1.00	1.15	3.00
2		N/A	1.00	1.00	N/A	0.50	1.00	1.00	3.00	1.50	N/A
3		2.00	0.70	0.40	0.50	N/A	1.00	0.75	1.00	0.90	1.00
	Average	2.00	0.90	0.80	0.50	0.84	1.20	1.25	1.67	1.18	2.00
1	K1	7.00	3.00	5.00	N/A	3.00	3.00	3.00	4.40	3.00	1.00
2		N/A	2.00	4.00	N/A	1.40	2.00	4.50	0.50	2.00	N/A
3		2.30	6.00	24.00	7.00	N/A	2.50	3.00	3.00	2.50	1.50
	Average	4.65	3.67	11.00	7.00	2.20	2.50	3.50	2.63	2.50	1.25
1	T3 (hr)	12.00	2.50	1.00	N/A	2.00	3.00	3.00	3.00	3.00	4.50
2		N/A	3.00	2.50	N/A	0.50	0.28	3.00	0.50	1.00	N/A
3		1.00	1.00	0.50	1.00	N/A	0.50	1.00	1.00	1.00	2.00
	Average	6.50	2.17	1.33	1.00	1.25	1.26	2.33	1.50	1.67	3.25
1	K3	8.00	70.00	103.00	N/A	80.00	30.00	30.00	50.00	90.00	18.00
2		N/A	45.00	50.00	N/A	50.00	200.00	35.00	140.00	60.00	N/A
3		100.00	65.00	115.00	70.00	N/A	50.00	50.00	45.00	30.00	13.00
	Average	54.00	60.00	89.33	70.00	65.00	93.33	38.33	78.33	60.00	15.50

Table 9. Macomb County Design RUNOFF Parameters Used in Model Calibration

Meter I.D.	Dormant		Growth		Design							
	Vo (in)	C (in/in)	Vo (in)	C (in/in)	Vo (in)	C (in/in)	C1 (%)	C3 (%)	T1 (hr)	K1	T3 (hr)	K3
Ch-s-5	0.29	0.010	0.68	0.005	0.29	0.010	30.00	70.00	2.00	4.65	6.50	54.00
Ct-s-1	0.17	0.027	0.98	0.005	0.17	0.027	23.33	76.67	0.90	3.67	2.17	60.00
Ct-s-2	0.15	0.044	0.56	0.027	0.15	0.044	23.00	77.00	0.80	11.00	1.33	89.33
Ct-s-3	0.28	0.006	0.92	0.004	0.28	0.006	38.00	62.00	0.50	7.00	1.00	70.00
Ct-s-4	0.18	0.014	0.50	0.007	0.18	0.014	55.00	45.00	0.84	2.20	1.25	65.00
Fr-s-1	0.35	0.084	0.93	0.022	0.35	0.084	27.33	72.67	0.89	3.48	2.05	60.63
Hr-s-1	0.16	0.021	0.41	0.017	0.16	0.021	30.33	69.67	1.20	2.50	1.26	93.33
Hr-s-2	0.16	0.010	0.74	0.003	0.16	0.010	25.44	74.56	0.93	8.17	1.31	90.66
Hr-s-3	0.14	0.022	0.59	0.010	0.14	0.022	24.59	75.41	0.89	9.15	1.31	90.20
Ma-s-1	0.22	0.018	0.71	0.011	0.22	0.018	32.14	67.86	1.50	5.00	4.32	60.78
St-s-1	0.43	0.037	0.60	0.010	0.43	0.037	38.47	61.53	1.49	2.58	1.56	71.54
St-s-2	0.15	0.094	0.52	0.067	0.15	0.094	37.67	62.33	1.25	3.50	2.33	38.33
St-s-3	0.35	0.057	0.84	0.036	0.35	0.057	38.39	61.61	1.46	2.67	1.64	68.22
St-s-4	0.32	0.062	0.75	0.027	0.32	0.062	29.33	70.67	1.67	2.63	1.50	78.33
St-s-5	0.15	0.039	0.90	0.012	0.15	0.039	54.00	46.00	1.18	2.50	1.67	60.00
St-s-6	0.20	0.005	0.65	0.003	0.20	0.005	34.43	65.57	1.37	4.53	3.22	63.11
Sy-s-1	0.43	0.037	0.60	0.010	0.43	0.037	33.04	66.96	1.50	4.54	3.85	61.71
Tmpzz1	0.23	0.019	0.70	0.017	0.23	0.019	32.20	67.80	1.50	4.97	4.29	60.84
Ut-s-1	0.37	0.024	0.62	0.01	0.37	0.024	25.00	75.00	2.00	1.25	3.25	15.50
CT-UM-A	0.16	0.023	0.88	0.01	0.16	0.023	36.00	64.00	0.86	5.08	1.82	64.93
CT-UM-B	0.21	0.05	0.74	0.02	0.21	0.05	25.17	74.83	0.85	7.24	1.69	74.95
FR-UM-A	0.21	0.045	0.95	0.01	0.21	0.045	34.74	65.26	0.98	3.39	1.95	60.66
Avg CT-FR*	0.20	0.04	0.82	0.02	0.20	0.04	29.61	70.39	0.88	5.97	1.78	69.77
Area Weighted Average						**0.022**						

Note:

1)These highlighted values were calculated by taking the area weighted average values for the meters geographically surrounding the meter under investigation and with actual measured flow data. However, in the case of meter # Sy-s-1, none of the surrounding flow meters had actual measured data. Therefore, the newly calculated values for the surrounding meters were used to calculate the weighted average Vo and C values for that meter.

2) CT-FR* represents area weighted average of unmetered areas CT-UM-A, CT-UM-B and FR-Um-A which were lumped together to limit the total the number of Unit Hydrographs to 20 (RUNOFF F4 card is limited to 20 U.H.).

Table 10. Monthly Average DWF (cfs)

Meter I.D.	Month-Year											
	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-00	Nov-00	Dec-00
Ch-s-5	6.62	6.93	7.20	6.89	6.47	6.73	5.71	6.51	-	6.59	6.68	6.51
Ct-s-1	3.60	3.98	4.05	3.78	3.60	3.49	3.07	3.06	*2.86*	-	3.44	3.51
Ct-s-2	4.98	5.59	5.33	5.30	4.88	4.71	4.08	4.04	-	4.59	4.80	4.54
Ct-s-3	5.03	5.18	5.06	5.01	4.97	4.91	4.57	4.68	4.45	4.95	4.99	5.01
Ct-s-4	0.44	0.42	0.40	0.43	0.41	0.39	0.34	0.35	-	0.39	0.41	0.41
Fr-s-1	-	-	2.78	3.25	2.56	-	-	-	-	2.45	2.46	-
Hr-s-1	1.11	-	1.12	1.12	1.08	1.08	0.94	1.00	-	1.10	1.09	1.08
Hr-s-2	-	-	2.82	2.83	2.80	-	-	-	-	2.69	2.59	-
Hr-s-3	-	-	0.88	0.88	0.88	-	-	-	-	0.86	0.82	-
Ma-s-1	-	-	11.33	11.33	11.00	-	-	-	-	-	-	-
St-s-1	7.61	-	8.31	8.03	7.68	7.60	6.78	6.77	-	7.37	7.40	7.50
St-s-2	3.28	-	3.28	3.18	3.12	3.17	2.81	2.87	2.58	3.08	3.12	3.13
St-s-3	9.05	-	9.55	9.56	9.39	9.40	8.65	8.70	-	9.09	9.07	9.10
St-s-4	2.23	2.50	2.40	2.37	2.19	2.22	1.91	1.91	1.88	2.07	2.12	2.19
St-s-5	1.61	-	1.62	1.64	1.57	1.60	1.46	1.45	1.38	1.50	1.55	1.54
St-s-6	2.94	-	2.98	3.03	3.00	2.99	2.86	2.87	-	3.03	3.05	3.04
Sy-s-1	-	-	-	2.03	1.82	1.27	1.29	1.35	-	-	-	-
Tmpzz1	-	-	-	1.66	1.62	1.63	-	-	-	-	-	-
Ut-s-1	1.15	-	-	1.23	1.18	1.13	0.98	0.95	-	1.08	1.08	1.09
CT-UM-A	-	-	-	-	-	-	-	-	-	-	-	-
CT-UM-B	-	-	-	-	-	-	-	-	-	-	-	-
FR-UM-A	-	-	-	-	-	-	-	-	-	-	-	-

Note:

" - " : Flow meter data were not available

Table 11. Completed Monthly DWF Factors (Measured and Calculated)

Meter	Month-Year											
	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-00	Nov-00	Dec-00
Ch-s-5	1.01	1.05	1.09	1.05	0.98	1.02	0.87	0.99	*0.90*	1.00	1.01	0.99
Ct-s-1	*1.08*	*1.12*	*1.07*	*1.12*	*1.03*	*1.01*	*0.91*	*0.92*	*0.89*	*1.00*	*1.02*	*1.02*
Ct-s-2	1.08	1.22	1.16	1.15	1.06	1.03	0.89	0.88	*0.89*	1.00	1.04	0.99
Ct-s-3	1.02	1.05	1.02	1.01	1.00	0.99	0.92	0.95	0.90	1.00	1.01	1.01
Ct-s-4	1.14	1.09	1.04	1.11	1.07	1.01	0.88	0.90	*0.89*	1.00	1.06	1.07
Fr-s-1	*1.14*	*1.09*	1.14	1.33	1.04	*1.04*	*0.93*	*0.93*	*0.89*	1.00	1.00	*1.05*
Hr-s-1	1.01	*1.11*	1.01	1.02	0.98	0.98	0.85	0.91	*0.90*	1.00	0.99	0.98
Hr-s-2	*1.05*	*1.22*	1.05	1.05	1.04	*1.00*	*0.87*	*0.90*	*0.89*	1.00	0.96	*0.98*
Hr-s-3	*1.08*	1.22	1.03	1.03	1.03	*1.03*	*0.89*	*0.88*	*0.89*	1.00	0.96	*0.99*
Ma-s-1	*1.01*	*1.05*	*1.03*	*1.04*	*1.01*	*1.00*	*0.90*	*0.93*	*0.90*	1.00	*1.00*	*1.00*
St-s-1	1.03	*1.05*	1.13	1.09	1.04	1.03	0.92	0.92	*0.89*	1.00	1.00	1.02
St-s-2	1.06	*1.17*	1.06	1.03	1.01	1.03	0.91	0.93	0.84	1.00	1.01	1.02
St-s-3	1.00	*1.13*	1.05	1.05	1.03	1.03	0.95	0.96	*0.89*	1.00	1.00	1.00
St-s-4	1.08	1.21	1.16	1.15	1.06	1.07	0.92	0.92	0.91	1.00	1.02	1.06
St-s-5	1.07	*1.14*	1.08	1.09	1.05	1.07	0.97	0.96	0.92	1.00	1.03	1.03
St-s-6	0.97	*1.07*	0.98	1.00	0.99	0.99	0.94	0.95	*0.91*	1.00	1.01	1.00
Sy-s-1	*1.05*	*1.05*	*1.13*	*1.09*	*1.05*	*1.04*	*0.91*	*0.90*	*0.89*	1.00	*1.00*	*1.01*
Tmpzz1	*1.03*	*1.05*	*1.08*	*1.07*	*1.03*	*1.02*	*0.91*	*0.92*	*0.89*	1.00	*1.00*	*1.01*
Ut-s-1	1.06	*1.05*	*1.06*	1.14	1.09	1.04	0.91	0.88	*0.89*	1.00	1.00	1.01
CT-UM-A	*1.07*	*1.12*	*1.08*	*1.09*	*1.05*	*1.07*	*0.97*	*0.96*	*0.92*	*1.00*	*1.03*	*1.03*
CT-UM-B	*1.11*	*1.15*	*1.11*	*1.20*	*1.06*	*1.02*	*0.89*	*0.89*	*0.89*	*1.00*	*1.04*	*1.03*
FR-UM-A	1.07	1.10	1.11	1.21	1.05	1.07	0.97	0.96	0.92	1.00	1.02	1.03
Average	1.06	1.11	1.08	1.10	1.03	1.03	0.91	0.92	0.90	1.00	1.01	1.01

Note:

1) The highlighted monthly DWF factors were calculated by taking the average of the monthly DWF factors for the surrounding meters with available data only. However, in some cases where all surrounding meters have no existing DWF factors, the newly calculated values will be used to calculated the DWF factor for that meter.

2) DWF factors associated with unmetered areas CT-UM-A, CT-UM-B, and FR-UM-A were determined using Area Weighted Average of all surounding meters including those no actual measured values.

Table 12. Completed Averages DWF (Measured and Calculated) (cfs)

Meter I.D.	Month-Year											
	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-00	Nov-00	Dec-00
Ch-s-5	6.62	6.93	7.20	6.89	6.47	6.73	5.71	6.51	5.92	6.59	6.68	6.51
Ct-s-1	3.60	3.98	4.05	3.78	3.60	3.49	3.07	3.06	2.86	3.44	3.44	3.51
Ct-s-2	4.98	5.59	5.33	5.30	4.88	4.71	4.08	4.04	4.09	4.59	4.80	4.54
Ct-s-3	5.03	5.18	5.06	5.01	4.97	4.91	4.57	4.68	4.45	4.95	4.99	5.01
Ct-s-4	0.44	0.42	0.40	0.43	0.41	0.39	0.34	0.35	0.34	0.39	0.41	0.41
Fr-s-1	2.79	2.67	2.78	3.25	2.56	2.55	2.28	2.28	2.18	2.45	2.46	2.57
Hr-s-1	1.11	1.22	1.12	1.12	1.08	1.08	0.94	1.00	0.99	1.10	1.09	1.08
Hr-s-2	2.83	3.28	2.82	2.83	2.80	2.69	2.34	2.42	2.40	2.69	2.59	2.64
Hr-s-3	0.93	1.05	0.88	0.88	0.88	0.88	0.76	0.75	0.76	0.86	0.82	0.85
Ma-s-1	11.11	11.55	11.33	11.33	11.00	11.00	9.90	10.23	9.90	11.00	11.00	11.00
St-s-1	7.61	7.74	8.31	8.03	7.68	7.60	6.78	6.77	6.56	7.37	7.40	7.50
St-s-2	3.28	3.61	3.28	3.18	3.12	3.17	2.81	2.87	2.58	3.08	3.12	3.13
St-s-3	9.05	10.27	9.55	9.56	9.39	9.40	8.65	8.70	8.09	9.09	9.07	9.10
St-s-4	2.23	2.50	2.40	2.37	2.19	2.22	1.91	1.91	1.88	2.07	2.12	2.19
St-s-5	1.61	1.71	1.62	1.64	1.57	1.60	1.46	1.45	1.38	1.50	1.55	1.54
St-s-6	2.94	3.24	2.98	3.03	3.00	2.99	2.86	2.87	2.63	3.03	3.05	3.04
Sy-s-1	1.63	1.63	1.76	2.03	1.82	1.27	1.29	1.35	1.39	1.56	1.56	1.57
Tmpzz1	1.64	1.67	1.67	1.66	1.62	1.63	1.45	1.46	1.41	1.59	1.59	1.60
Ut-s-1	1.15	1.14	1.14	1.23	1.18	1.13	0.98	0.95	0.96	1.08	1.08	1.09
CT-UM-A	*2.96*	*3.25*	*3.26*	*3.09*	*2.95*	*2.88*	*2.55*	*2.54*	*2.38*	*2.82*	*2.83*	*2.87*
CT-UM-B	*3.91*	*4.26*	*4.21*	*4.19*	*3.82*	*3.71*	*3.24*	*3.22*	*3.15*	*3.62*	*3.70*	*3.65*
FR-UM-A	2.95	3.21	3.23	3.10	2.92	2.86	2.53	2.52	2.37	2.79	2.80	2.85

Notes:

1)These highlighted values were calculated by taking the average of the normalized measured flow values (i.e. actual measured flows divided by the corresponding DWF factors) of the meter under investigation, then multiplied by its DWF factor for that particular month.

2) Flows associated with unmetered areas CT-UM-A, CT-UM-B, and FR-UM-A were determined using Area Weighted Average of all surounding meters including those with no actual measured values.

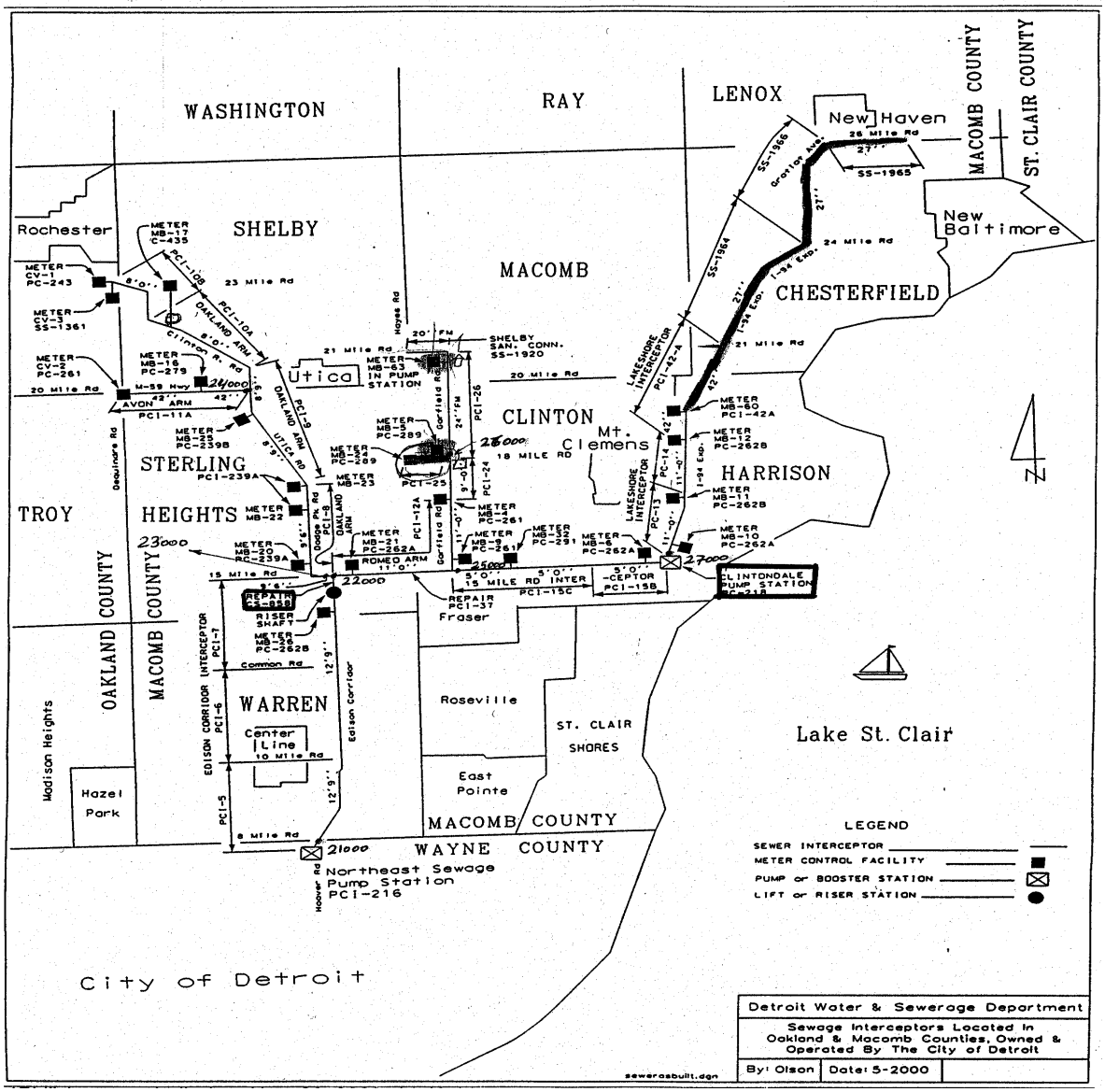
Table 13. City or Township Monthly DWF Factors

Meter I.D.	Month-Year											
	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-00	Nov-00	Dec-00
Ch-s-5	1.01	1.05	1.09	1.05	0.98	1.02	0.87	0.99	*0.90*	1.00	1.01	0.99
CT*	1.05	1.11	1.07	1.08	1.03	1.01	0.91	0.92	0.90	1.00	1.02	1.01
Fr-s-1	*1.14*	*1.09*	1.14	1.33	1.04	*1.04*	*0.93*	*0.93*	*0.89*	1.00	1.00	*1.05*
Hr-s*	*1.04*	*1.19*	*1.04*	*1.04*	*1.03*	*1.00*	*0.87*	*0.90*	*0.89*	*1.00*	*0.97*	*0.98*
Ma-s-1	*1.01*	*1.05*	*1.03*	*1.04*	*1.01*	*1.00*	*0.90*	*0.93*	*0.90*	1.00	*1.00*	*1.00*
St-s*	1.02	1.11	1.08	1.07	1.03	1.03	0.94	0.94	0.89	1.00	1.01	1.02
Sy-s*	*1.04*	*1.05*	*1.10*	*1.08*	*1.04*	*1.03*	*0.91*	*0.91*	*0.89*	*1.00*	*1.00*	*1.01*
Ut-s-1	1.06	*1.05*	*1.06*	1.14	1.09	1.04	0.91	0.88	*0.89*	1.00	1.00	1.01
CT-UM-A	*1.07*	*1.12*	*1.08*	*1.09*	*1.05*	*1.07*	*0.97*	*0.96*	*0.92*	*1.00*	*1.03*	*1.03*
CT-UM-B	*1.11*	*1.15*	*1.11*	*1.20*	*1.06*	*1.02*	*0.89*	*0.89*	*0.89*	*1.00*	*1.04*	*1.03*
FR-UM-A	1.07	1.10	1.11	1.21	1.05	1.07	0.97	0.96	0.92	1.00	1.02	1.03

Notes:

1)These DWF factors are overall values representing the entire city or township. For cities or townships that have more than one flow meter, an area weighted average method was used to determine the DWF value.
2) CT* represents area weighted average DWF factor for all meters in Clinton Twp (I.e. Ct-1,Ct-2, Ct-3 & Ct-4)
3) Hr-s* represents area weighted average DWF factor for all meters in Harrison Twp (I.e. Hr-1, Hr-2, Hr-3)
4) St-s* represents area weighted average DWF factor for all meters in Sterling Heights (I.e. St-1,St-2, St-3, St-4, St-5 & St-6)
5) Sy-s* represents area weighted average DWF factor for all meters in Shelby Twp (I.e. Sy-1 & Tmpzz1)

Figure 5. Macomb County Interceptors



Appendix C
Clinton-Oakland Sanitary District Submodel Development

1. Introduction

This Technical Memorandum describes the work performed by SIGMA Associates, Inc. regarding expanding in the GDRSS Model vs. 3.12. The work represented the Clinton-Oakland Sanitary District in Oakland County includes adapting an existing Clinton-Oakland sub-model represented by RUNOFF and TRANSPORT modules to replace the existing district in the GDRSS. The sub-model was verified and then validated for actual rainfall events. The revised Clinton-Oakland model was linked to the recently expanded Macomb Sanitary District RUNOFF and EXTRAN models and validated for a single rainfall event downstream of the NE. pumping station.

The Clinton-Oakland Sanitary District is under the jurisdiction of the Oakland County Drain Commissioner. There are 13 communities within the Clinton-Oakland Sanitary District. These communities are all served by separate sanitary sewers which are tributary to Oakland County owned interceptors in this district. Most of the sewer district enters the DWSD Sewer System through the Oakland Arm Interceptor in Macomb County. A small area in the Southeast corner of Rochester Hills enters the Avon Arm Interceptor separately. The flows from these areas are measured and monitored through two DWSD billing meters, OC-S-2 and RC-S-1.

The flow monitoring data obtained from the two flow meters were analyzed to determine the wet weather response for these areas. The results were utilized to develop the Rainfall Dependent Inflow/Infiltration (RDII) hydrograph parameters using three actual rainfall events.

The existing GDRSS Model used two sub-areas (i.e., 1899 and 1900) in the RUNOFF model as inflows loaded at two separate nodes just upstream of Northeast Pumping Station to represent the Clinton-Oakland Sewer District. With the new development to COSD sub-model, the flows were routed in RUNOFF through the two sub-areas and consequently through the sub-area representing Macomb County to the GDRSS EXTRAN model at the Northeast Pumping Station. The RUNOFF and TRANSPORT models developed for the Oakland County Drain Commissioner which was utilized as the basis for the expansion are described in this memorandum.

2. Clinton-Oakland Sanitary District

The Clinton-Oakland Sanitary District (COSD) comprises the Northeastern part of Oakland County. It includes the communities West, North and East of the City of Pontiac.

The COSD is under the jurisdiction of the Oakland County Drain Commissioner. There are 13 communities which are entirely or partly within the Clinton-Oakland Sanitary District: Auburn Hills, Clarkston, Independence Township, Lake Angelus, Lake Orion

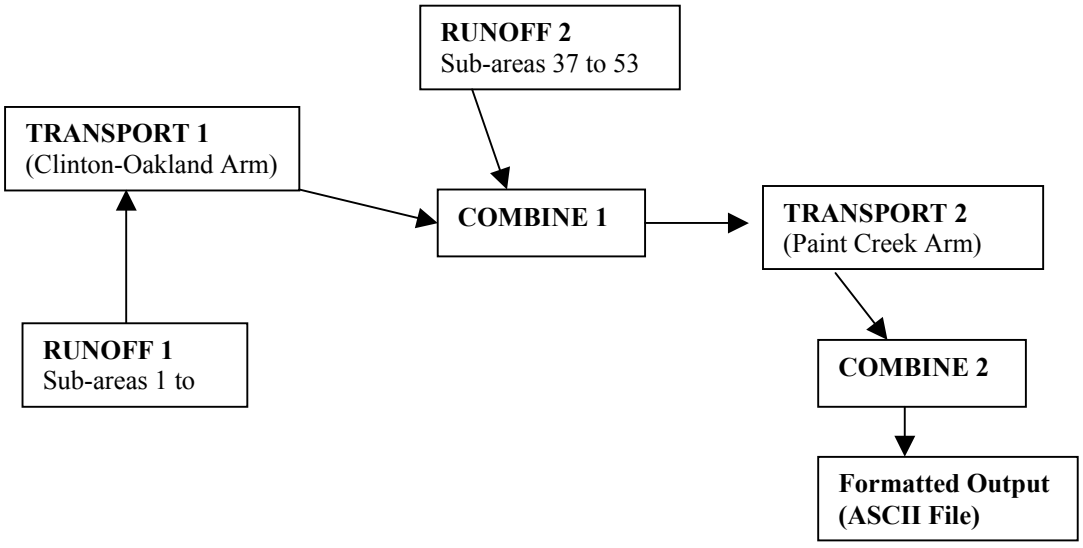
Village, Oakland Township, Orion Township, Oxford Township, Oxford Village, Rochester, Rochester Hills, Waterford Township and West Bloomfield Township. These communities are all served by separate sanitary sewers that are tributary to Oakland County owned interceptors in this district. The district contains two major interceptors, the Paint Creek Interceptor and the Clinton-Oakland Interceptor, which flow by gravity to the Oakland County boundary with Macomb County and enter DWSD's Oakland Arm Interceptor. A small area in the Southeast corner of Rochester Hills enters the Avon Arm Interceptor separately. The meters have tributary areas of 73,835 acres (Oakland Arm meter) and 5,264 acres (Avon Arm meter).

There are two major interceptors in the COSD. The Clinton-Oakland Interceptor extends west from the boundary with Macomb County at 23 Mile and Dequindre along the valley of the Clinton River. It serves the Southern part of the COSD, sub-areas 1 through 36 in the RUNOFF input (see Section III below). It has several branches off the main Interceptor. The other major Interceptor is the Paint Creek Interceptor. This joins the Clinton-Oakland Interceptor near the confluence of Paint Creek and the Clinton River. This sewer serves the Northern part of the COSD, sub-areas 37 through 53 (see Section III below).

3. Existing Sub-Model

An existing sub-model of the sewer system in the Clinton-Oakland Sewer District was developed in RUNOFF and TRANSPORT modules in 1991 by Consoer Townsend Envirodyne (CTE) consulting engineers for the Oakland County Drain Commissioners Office. This model (referred to hereafter as the CTE model) was used as the basis of the GDRSS model expansion.

The existing sub-model was implemented in SWMM version 4.04. The existing sub-model was arranged as shown below:



The model has been divided into 4 major components, two sets of RUNOFF input data and two sets of TRANSPORT input data with two COMBINE operations to collate and combine the output for transfer between the SWMM program units and for final output. This structure was necessitated because a "downstream" unit of SWMM can only accept one interface file as an input.

The two sets of RUNOFF input data divide the 53 sub-areas that comprise the Clinton-Oakland Sewer District into two blocks of 36 and 17 sub-areas respectively. The first set of RUNOFF input data is for sub-areas 1 to 36. These sub-areas are those draining to the Clinton-Oakland Interceptor west of the intersection with the Paint Creek Interceptor. These include all the sub-areas located in West Bloomfield Township, Waterford Township, Independence Township, Clarkston, Lake Angelus, Auburn Hills, a single area in Orion Township and 13 of the 17 sub-areas in Rochester Hills. The second set of RUNOFF input data is for sub-areas 37 to 53. These are the sub-areas draining to the Paint Creek Interceptor and include all the areas in Oxford Township, Oxford Village, Oakland Township and Lake Orion Village, most of the sub-areas in Orion Township, and the remaining 4 sub-areas in Rochester Hills. Note that the RUNOFF input data does not include a sub-area for the City of Rochester as the community operated its own WWTP when the CTE Model was implemented.

There were two sets of TRANSPORT input data. The first represents the Clinton-Oakland Interceptor from upstream limits to the junction with the Paint Creek Interceptor. The second set represents the Paint Creek Interceptor from its upstream limit to the junction with the Clinton-Oakland Interceptor and the Clinton-Oakland Interceptor from the junction to the boundary meter.

The two COMBINE operations have different functions. The first COMBINE collates the output from the Paint Creek RUNOFF set and the Clinton-Oakland Interceptor TRANSPORT for input with the Paint Creek TRANSPORT input. The second COMBINE operation formats the collated output from the TRANSPORT data in an ACSII format for printing or import into another program for post-processing.

4. RUNOFF Model Development

The RUNOFF data inputs in the existing sub-model considered the DCIA methodology to represent the Rainfall Dependent Infiltration and Inflow (RDII). Therefore, new RUNOFF models had to be developed considering the RDII in the COSD to match the existing GDRSS criteria.

4.1 Model Validation

The existing sub-model (CTE Sub-Model) was run and 53 flow hydrographs, corresponding to the total tributary areas, were obtained from the results. These hydrographs were then used as field data for validation. The tributary areas were divided into seven sets, each set has similar shape of hydrographs. An average hydrograph (peak and volume) was chosen from each set for validation. Maximum and

minimum hydrographs from each set were used for verification. The tributary areas of each set are included in the accompanying CD for further information. The validation process was performed using the same storm event that it was in the existing model.

4.2 C-Value Determination:

The C value for each tributary area was determined based on the existing C values in the CTE Sub-Model. Each C value of a specific area was multiplied by the ratio of the area in CTE Model to the corresponding area in the Wastewater Master Plan, see Table1

Table 1. Clinton-Oakland Sanitary District C Values

Subcatchment ID	$Area_{TE}$	C_{CTE}	$Area_{MP}$	C_{MP}
901	57.92	0.55	6238.882	0.0051
902	2.6	0.55	287.594	0.0050
903	6.42	0.55	1012.415	0.0035
904	125.76	0.55	6862.53	0.0101
905	5.51	0.55	1272.337	0.0024
906	118.8	0.55	6672.889	0.0098
907	37.72	2.00	1390.507	0.0543
908	33.22	0.55	1420.611	0.0129
909	57.24	0.55	5188.803	0.0061
910	20.05	0.55	1111.139	0.0099
911	18.85	0.55	1014.419	0.0102
912	15.49	0.55	1070.765	0.0080
913	12.68	0.55	1452.445	0.0048
914	35.08	0.55	3103.661	0.0062
915	5.21	0.55	1421.659	0.0020
916	4.54	0.55	808.921	0.0031
917	1.94	0.55	333.714	0.0032
918	1.27	0.55	1061.718	0.0007
919	3.00	0.55	849.165	0.0019
920	10.92	0.55	1002.243	0.0060
921	7.73	0.55	1330.35	0.0032
922	1.31	0.45	209.256	0.0028
923	5.29	0.45	609.084	0.0039
924	3.54	0.45	295.636	0.0054
925	4.51	0.45	730.437	0.0028
926	4.91	0.45	584.289	0.0038
927	38.59	0.45	2947.697	0.0059
928	4.22	0.45	674.182	0.0028
929	1.9	0.45	396.492	0.0022
930	4.3	0.45	180.084	0.0107
931	25.42	0.45	3044.002	0.0038
932	3.09	0.45	473.177	0.0029
933	7.27	0.45	689.203	0.0047
934	23.59	0.45	3226.447	0.0033
935	0.23	0.45	180.29	0.0006
936	2.55	0.45	579.947	0.0020
937	0.35	0.25	188.63	0.0005
938	0.47	0.25	149.68	0.0008
939	5.07	0.25	891.583	0.0014
940	0.06	0.25	307.6	0.0000
941	3.63	0.25	1162.559	0.0008
942	1.46	0.25	413.472	0.0009
943	2.01	0.25	944.298	0.0005
944	3.04	0.25	634.505	0.0012
945	8.46	0.25	2115.133	0.0010
946	0.95	0.25	933.288	0.0003
947	4.94	0.25	2745.672	0.0004
948	0.05	0.25	147.081	0.0001
949	1.54	0.25	1548.391	0.0002
950	0.4	0.45	364.078	0.0005
951	4.3	0.45	673.032	0.0029
952	0.84	0.45	326.563	0.0012
953	2.28	0.45	561.997	0.0018
Total	**752.52**		**73,834.55**	
Weighted C_{MP}	**0.006**			

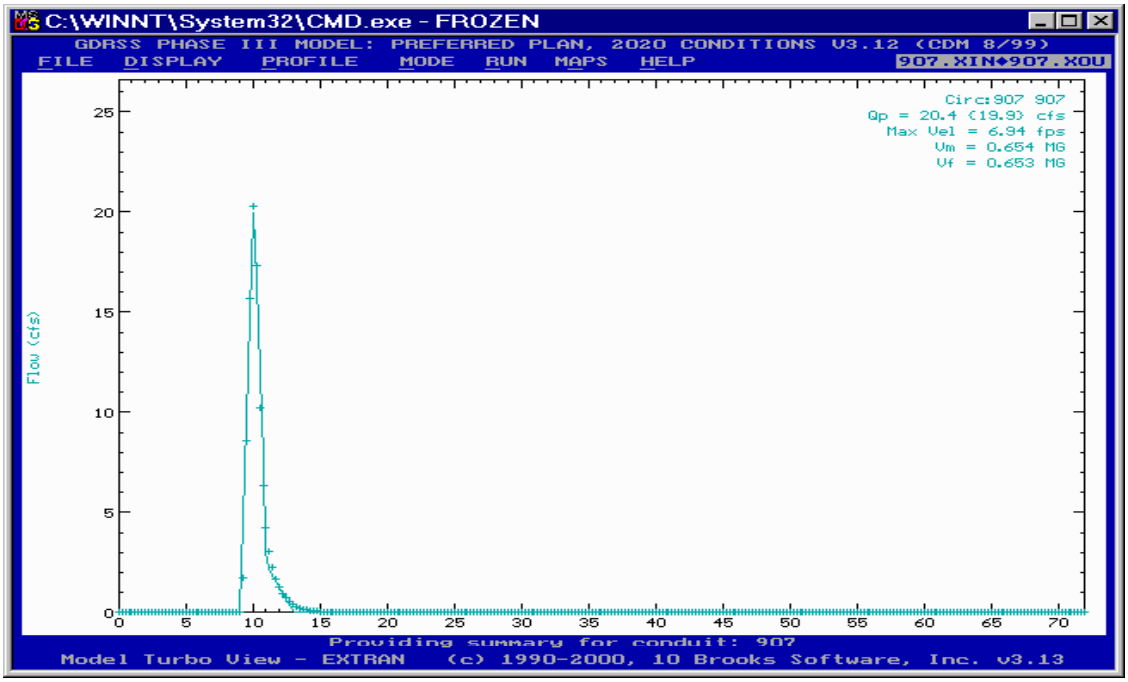
4.3 RUNOFF Parameters:

Initial values for the RUNOFF parameters (i.e., T1, K1, T3, K3, and V_o) in addition to the calculated C values were used in the RUNOFF block to perform the validation process. The resulted RUNOFF parameters were then used for verification by selecting the maximum and minimum hydrographs for each set for this purpose. Table 2 shows the average RUNOFF parameters for each set. A sample of predicted hydrograph compared to the field hydrograph for set 1 subarea 907 is shown on Figure 1.

Table 2. Clinton-Oakland Sanitary District RUNOFF Parameters

Set	Subcatchment	Area (acres)	T_1	K_1	T_3	K_3	C	C_1/C_3
1	905	1273	1	1	1	3.5	0.001855	0.84/0.16
1	907 (Max)	1389	1	1	1	3	0.010482	0.70/0.30
1	917 (Min)	334	1	1.25	1	3.5	0.002405	0.71/0.29
	Average		**1**	**1.083**	**1**	**3.333**		**0.75/0.25**
2	932	473	1	1.3	1.75	2.9	0.002611	0.77/0.23
2	933 (Max)	689	1	1.2	1.75	2.4	0.004611	0.70/0.30
2	950 (Min)	364	1	1.3	1.75	2.9	0.000360	0.80/0.20
	Average		**1**	**1.267**	**1.75**	**2.733**		**0.76/0.24**
3	939	840	1	1.45	1.8	2.7	0.002178	0.70/0.30
3	920 (Max)	1002	1	1.5	1.9	2.7	0.003292	0.67/0.33
3	915 (Min)	1422	1	1.4	2.2	2.2	0.000942	0.61/0.39
	Average		**1**	**1.450**	**1.967**	**2.533**		**0.66/0.34**
4	941	1163	1	3.25	1	10	0.001000	0.60/0.40
4	911 (Max)	1014	1	3.3	1	10	0.006255	0.62/0.38
4	949 (Min)	1548	1	2.5	1	9	0.000221	0.79/0.21
	Average		**1**	**3.017**	**1**	**9.667**		**0.67/0.33**
5	926	584	1	3.5	2	4.25	0.002876	0.63/0.37
5	908 (Max)	1421	1.2	2.5	1.2	8	0.007644	0.56/0.44
5	918 (Min)	1062	1	3.5	2	5	0.000240	0.63/0.37
	Average		**1.067**	**3.167**	**1.733**	**5.75**		**0.60/0.40**
6	931	3044	1	4.25	2	6.75	0.002303	0.56/0.44
6	901 (Max)	6239	1.125	4.25	1.5	9.5	0.002948	0.44/0.56
6	937 (Min)	186	1	4.25	2	11	0.000583	0.33/0.67
	Average		**1.042**	**4.25**	**1.833**	**9.083**		**0.44/0.56**
7	909	5189	1.3	5.75	1.7	11.25	0.002889	0.52/0.48
7	904 (Max)	6863	1.25	5	2.25	8.5	0.004743	0.45/0.55
7	947 (Min)	2746	1.1	5.5	2.25	10	0.000219	0.51/0.49
	Average		**1.217**	**5.417**	**2.067**	**9.917**		**0.49/0.51**

Figure 1. Predicted and Field Hydrographs for set 1 subarea 907



5. Model Validation

Model validation was necessary to check the feasibility of the RUNOFF parameters that were obtained from the validation process. The validation process was performed by utilizing actual flow and rainfall data for the Clinton-Oakland Sewer District. Design RUNOFF parameters were then determined and tabulated.

5.1 Data Collection

The data collected within each tributary flowmeter area included flow data and rainfall data. These data are discussed in the following sections.

5.1.1 Flow Data:

Flow monitoring data were obtained from the two billing meters installed at the Clinton-Oakland Sewer District boundary with Macomb County. These meters are OC-S-2 at the connection to the Oakland Arm and RC-S-1 at the connection to the Avon Arm. The data collected from the meters covered the period from November 3, 1997 to February 5, 2002. The data were represented in hourly intervals.

5.1.2 Rainfall Data

Rainfall data were obtained from the Southeast Michigan Council of Governments' (SEMCOG) rainfall database located on their web site at "www. SEMCOG.org". At the time of the analysis, data were available through October 2001. The data were of hourly and daily time interval. The rain gages from which the rainfall data were obtained are

O3, O4, O5, O7, O8 and O9. These rain gages were selected because they are located within or close to the designated boundary of the planning service area of the Clinton-Oakland Sewer District.

To determine the applicable rainfall data over the two tributary areas, the Thiessen Polygon method was used. For the single sub-area tributary to the Oakland Arm, the rainfall for rain gage O3 was used as all of this area falls in the polygon for that gage. For the area tributary to the Oakland Arm, the entire area was divided into Thiessen polygons and a weighting for each raingage for the entire area was determined. Table 2 shows the weighted rainfall depth factors for entire area. A sample of an application of these factors for the April (20-24), 2000 storm event is shown in Table 3.

Table 3. Weighted Rainfall Depths for April Event (20 - 24, 2000)

Rain gage Number	Weighting Factor	Rainfall Depth (in)	Weighting Rainfall Depth (in)
O-03	0.045	2.24	0.10
O-04	0.026	1.97	0.05
O-05	0.164	2.05	0.34
O-07	0.367	2.17	0.80
O-08	0.158	2.21	0.35
O-09	0.240	1.87	0.45

5.2 Flow Data Analysis

Flow data analysis included identifying the wet weather responses using Shape program and the corresponding rainfall event, duration and intensity. The program determined the RDII data points which were used to estimate the overall C values.

There were 19 individual events identified for the Oakland Arm tributary area for the period from April 2000 to October 2001. For the area tributary to the Avon Arm, 25 events were identified for the same period. The events time periods are shown in Tables 4 and 5.

Table 4: Rainfall Events for the Oakland Arm

Event No.	Start Date	End Date
1	4/20/00	4/24/00
2	5/9/00	5/16/00
3	5/16/00	5/28/00
4	6/13/00	6/16/00
5	6/24/00	7/1/00
6	7/3/00	7/13/00
7	7/27/00	8/12/00
8	8/22/00	8/29/00
9	9/8/00	9/19/00
10	9/20/00	9/26/00
11	4/6/01	4/14/01
12	4/20/01	4/25/01
13	5/15/01	5/19/01
14	5/27/01	6/6/01
15	7/20/01	7/26/01
16	8/16/01	8/24/01
17	9/19/01	9/28/01
18	10/5/01	10/9/01
19	10/11/01	10/27/01

Table 5: Rainfall Events for the Avon Arm

Event No.	Start Date	End Date
1	4/20/00	4/29/00
2	5/9/00	5/15/00
3	5/16/00	5/27/00
4	6/11/00	6/17/00
5	6/24/00	7/1/00
6	7/2/00	7/8/00
7	7/9/00	7/17/00
8	7/26/00	8/15/00
9	8/15/00	9/1/00
10	9/10/00	9/20/00
11	9/20/00	9/29/00
12	10/4/00	10/10/00
13	11/7/00	11/18/00
14	4/6/01	4/15/01
15	4/21/01	4/28/01
16	5/28/01	6/10/01
17	6/10/01	6/14/01
18	6/15/01	6/18/01
19	7/21/01	7/27/01
20	8/16/01	8/22/01
21	9/7/01	9/13/01
22	9/19/01	9/28/01
23	10/4/01	10/9/01
24	10/11/01	10/22/01
25	10/22/01	10/28/01

The wet weather responses from December 2000 through the end of March 2001 were not considered in this analysis. The reason was that these responses would generally be due to snow melting and it is difficult to determine the amount of snowmelt to correlate to these wet weather responses. The total rainfall depths for each event along with the corresponding RDI/I depths (inches) were plotted for each meter. The scattered points were used to produce a best-fit line. The slope of the straight line represents the RDII C factor. This factor is the fraction of the rainfall excess depth that enters the sewer system during and after the events. In general, there were two distinct seasons identified in this analysis for C factors determination: Dormant Season (from November to April) and Growth Season (from June to September). May and October were classified as being transition months. Each of these seasons exhibits different RDI/I behavior.

C factors are affected by the initial abstraction Vo which is the rainfall depth below which wet weather response is not observed in the collection system. However, the Vo values were obtained from the GDRSS model and therefore, the C lines were forced to intercept the X-axis at those values. Figures 2 and 3 show the RDI/I scattered points along with the best-fit lines for Dormant and Growth for Oakland Arm and Avon Arm Interceptors, respectively.

Figure 2. RDI/I Scattered Points with the Best-Fit Lines for Dormant and Growth (Oakland Arm)

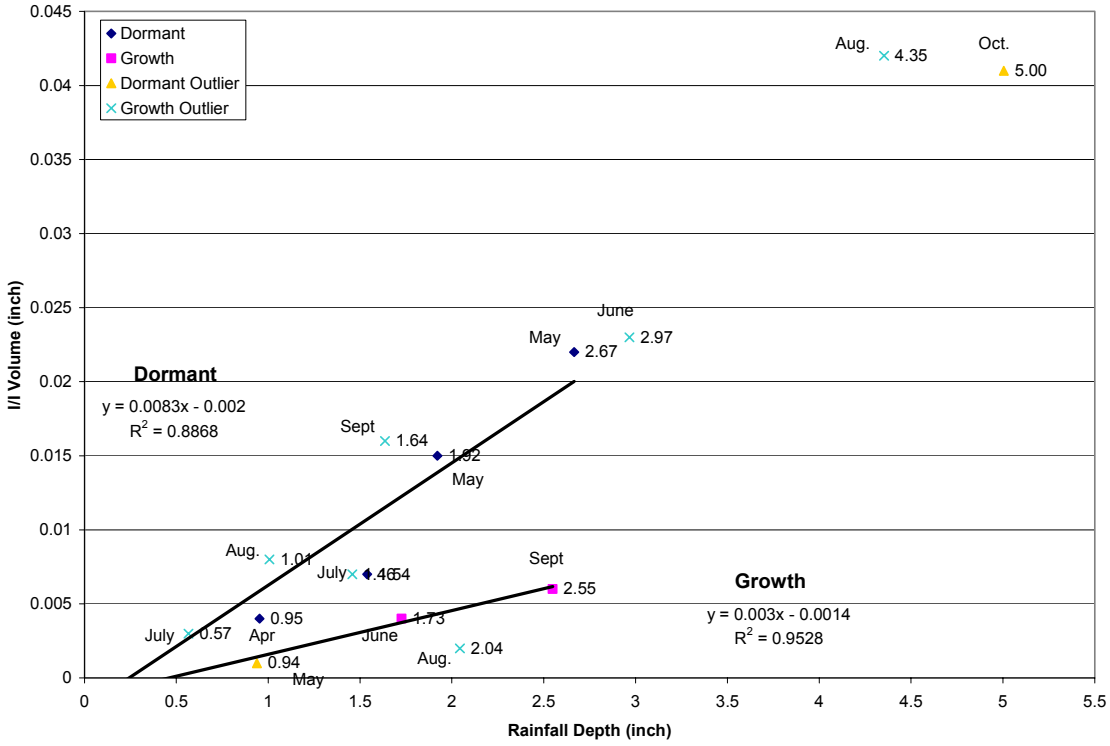
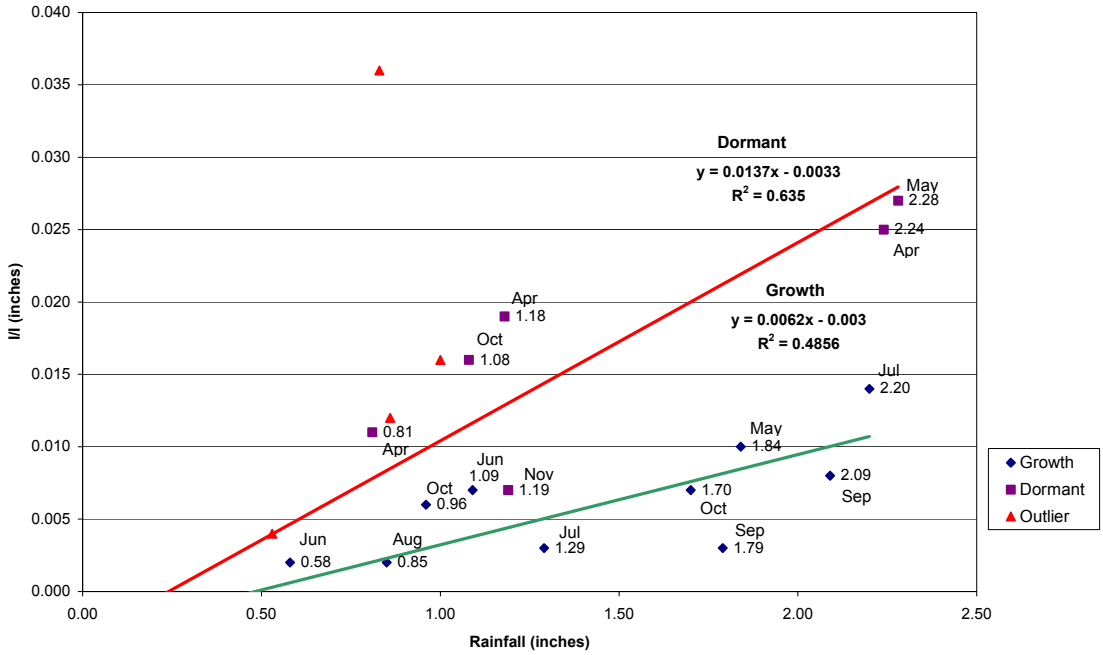


Figure 3. RDII Scattered Points with the Best –Fit Lines for Dormant and Growth (Avon)



Three rainfall events were selected for both Clinton-Oakland and Avon areas. The storm events used in the model validation in addition to RUNOFF parameters are shown on Tables 6 and 7:

Table 6. Clinton-Oakland Sanitary District RUNOFF Event Parameters

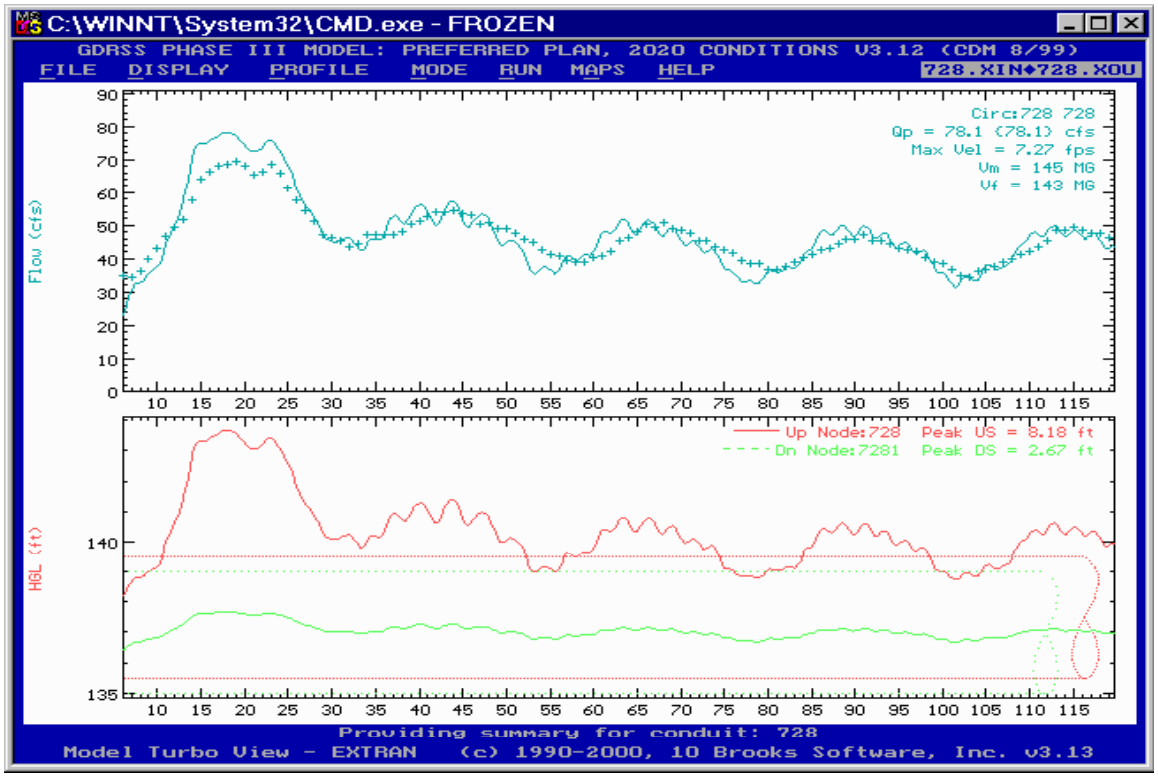
Set	Event	Vo	T_1	K_1	T_3	K_3	Weighted C	C1/C3
1	April 20-24 2000	0.24	3.5	1.30	3.50	5.33	0.0049	
1	May27-June6 2001	0.24	3	3.25	3.00	10.00	0.0087	0.75/0.25
1	Sept. 19-28 2001	0.48	1.29	1.40	1.29	4.30	0.0029	
1	**Average**		**2.60**	**1.98**	**2.60**	**6.54**		
2	April 20-24 2000	0.24	3.5	1.52	6.13	4.37	0.0049	
2	May27-June6 2001	0.24	3	3.80	5.25	8.20	0.0087	0.77/0.23
2	Sept. 19-28 2001	0.48	1.29	1.63	2.26	3.53	0.0029	
2	**Average**		**2.60**	**2.32**	**4.54**	**5.37**		
3	April 20-24 2000	0.24	3.5	1.74	6.88	4.05	0.0049	
3	May27-June6 2001	0.24	3	4.35	5.90	7.60	0.0087	0.66/0.34
3	Sept. 19-28 2001	0.48	1.29	1.87	2.54	3.27	0.0029	
3	**Average**		**2.60**	**2.65**	**5.11**	**4.97**		
4	April 20-24 2000	0.24	3.5	3.62	3.50	15.47	0.0049	
4	May27-June6 2001	0.24	3	9.05	3.00	29.00	0.0087	0.67/0.33
4	Sept. 19-28 2001	0.48	1.29	3.89	1.29	12.47	0.0029	
4	**Average**		**2.60**	**5.52**	**2.60**	**18.98**		
5	April 20-24 2000	0.24	3.73	3.80	6.07	9.2	0.0049	
5	May27-June6 2001	0.24	3.20	9.50	5.20	17.25	0.0087	0.60/0.40
5	Sept. 19-28 2001	0.48	1.38	4.09	2.24	7.42	0.0029	
5	**Average**		**2.77**	**5.80**	**4.50**	**11.29**		
6	April 20-24 2000	0.24	3.65	5.10	6.42	14.53	0.0049	
6	May27-June6 2001	0.24	3.13	12.75	5.50	27.25	0.0087	0.44/0.56
6	Sept. 19-28 2001	0.48	1.34	5.48	2.37	11.72	0.0029	
6	**Average**		**2.70**	**7.78**	**4.76**	**17.83**		
7	April 20-24 2000	0.24	4.26	6.50	7.23	15.87	0.0049	
7	May27-June6 2001	0.24	3.65	16.25	6.20	29.75	0.0087	0.49/0.51
7	Sept. 19-28 2001	0.48	1.57	6.99	2.67	12.79	0.0029	
7	**Average**		**3.16**	**9.91**	**5.37**	**19.47**		

Table 7. RUNOFF Event Parameters for Avon Arm

Event	DWF cfs)	Vo	T_1	K_1	T_3	K_3	$C_{calibration}$	C_1/C_3
July 9-17 2000	2.7	0.48	2	5	5.7	7.25	0.008140	0.5/0.5
April 20-26 2001	3	0.24	1.5	4	3	5	0.018966	0.25/0.75
Oct. 11-21 2001	2.8	0.24	1.5	2.5	4	4.25	0.010979	0.35/0.7
Average			**1.67**	**3.83**	**4.23**	**5.50**		**0.36/0.64**

The C factors were then divided into inflow (C1 factor) and infiltration (C3 factor) for all the 53 areas. The parameters were adjusted and the model runs were repeated until the volume, peak, and shape of hydrographs matched reasonably the field flow data. The final results of the model parameters are presented in Table 7. A sample of the actual and predicted hydrographs after validation is shown in Figure 4

Figure 4. Actual and Predicted Hydrographs



6. Design Parameters

6.1 Runoff Parameters

The RUNOFF design parameters of T1, T3, K1, K3, C1, and C3 are shown in Table8.

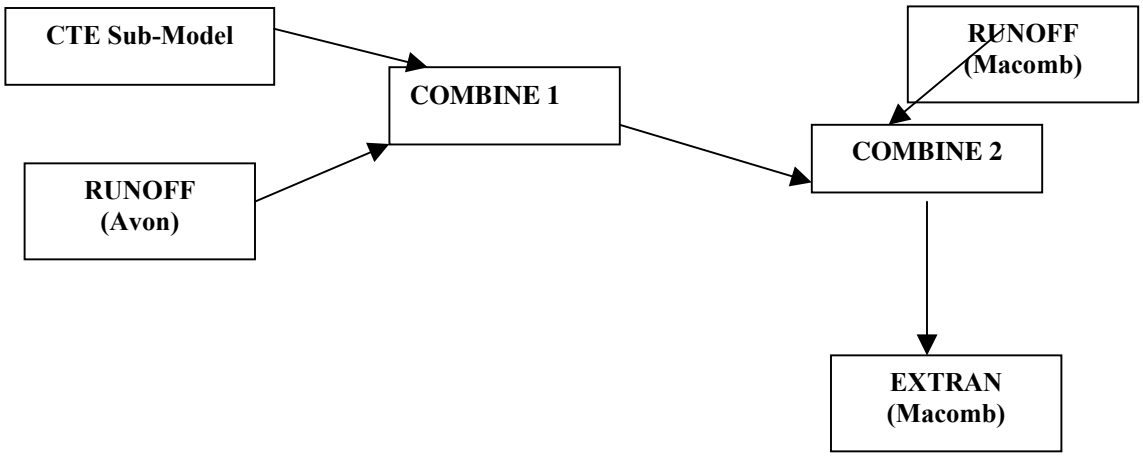
Table 8. Clinton-Oakland Sanitary District Design RUNOFF Parameters

Set	Dormant		Growth		Design					
No./Area	Vo (in)	C (in/in)	Vo (in)	C (in/in)	C1 (%)	C3 (%)	T1 (hr)	K1	T3 (hr)	K3
1	0.24	0.0137	0.48	0.0062	75.00	25.00	3.00	3.25	3.00	10.00
2					76.00	24.00	3.00	3.80	5.25	8.20
3					66.00	34.00	3.00	4.35	5.90	7.60
4					67.00	33.00	3.00	9.05	3.00	29.00
5					60.00	40.00	3.20	9.50	5.20	17.25
6					44.00	56.00	3.13	12.75	5.50	27.25
7					49.00	51.00	3.65	16.25	6.20	29.75
Avon	0.24	0.0083	0.48	0.0030	36.00	64.00	1.67	3.83	4.23	5.50

7. Clinton-Oakland-Macomb Sub-Model Validation

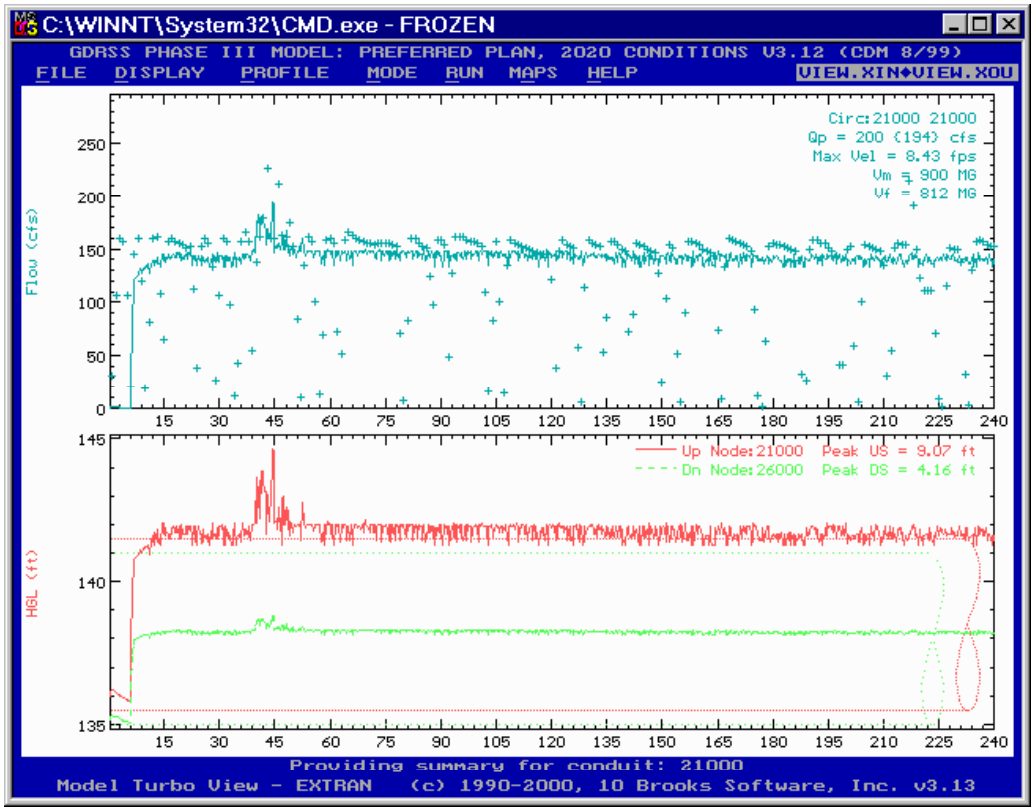
The Clinton-Oakland sub-model was connected to the preciously developed Macomb sub-model through two inflow junctions located at the most upstream limits of Oakland Arm and Avon Arm Interceptors. The flowmeter data upstream of the Northeast Pumping Station were used to check the validation of the two sub-models after the connection.

For this purpose, a common storm event (April 20-29, 2001) was chosen to use in the RUNOFF blocks. C values were recalculated for that storm event and new RUNOFF input files were developed for the sub-models. The flow chart that represented the new set-up of the sub-models is shown below:



The predicted hydrograph just down stream of the Northeast Pumping Station compared to the field data at the same location is shown in Figure 5.

Figure 5. Actual and Predicted Hydrographs U/S of Northeast Pumping Station



For further information and more details, all tables and necessary calculations are available in the accompanying CD.

8. Summary

The GDRSS Model has been expanded to include 54 subareas to represent the wet weather response in the COSD. These areas were analyzed and incorporated into the model using flow and rainfall data collected from fall of 2000 through June of 2001. While the overall response compares closely to the response used in the GDRSS Model previously, the increase spatial resolution improves the variation in the response within the COSD area. The improved resolution will improve the ability of the model to account for projected growth within the region and to determine capacity constraints and needs for the WWMP planning.

Appendix D
Updating the GDRSS/WWMP Model SWMM Engine

1. Summary

The GDRSS/WWMP Event Model, 2001 Update, Version 3.13, was updated to use version 4.4GU of the EPA SWMM program. Results were reviewed and compared to the previous results. Differences in the results were found to be negligible. One instance of an instability occurred, which was eliminated by slightly increasing the storage at that node. The review confirms that the features and improvements added to the previous in-house version of the SWMM program have been incorporated into the EPA SWMM program for RUNOFF (event) and EXTRAN. The Continuous Model (continuous RUNOFF and TRANSPORT) was not reviewed or updated at this time.

2. Introduction

2.1 Overview

The GDRSS/WWMP Model has been updated to make use of a new version of the EPA SWMM program. This memo describes the modifications required to the data files to use the new SWMM program. To verify the new program, the model outputs are compared to previous model outputs.
The changes are currently limited to the Event Model components; that is, the RUNOFF and EXTRAN data files as configured to run short-term (1 to several days) simulations. The Continuous Model components, Continuous RUNOFF (with monthly infiltration) and TRANSPORT, configured to run years of rainfall records, have not been updated at this time. When (if) those changes are made, this memo will be updated to incorporate those updates at that time.

2.2 Background

EPA SWMM is a hydrologic/hydraulic program written in FORTRAN. The program code is public domain and is available to the users of the program. As a result, it has undergone numerous changes and updates over the years. Version numbers have been used to track these changes as they have been incorporated into the official EPA SWMM program. The current version of the SWMM program is 4.4GU. The first letter is used to denote incremental changes. The second letter U denotes that the version has been reviewed and posted by Wayne Huber on the Oregon State University web site. Changing the number is avoided unless there is a substantial change to the computation as a new version number raises a red flag with some regulatory agencies. There is a more recent version, SWMM 4.4H, but it is a beta release only and it was not used for this update. The release date of the SWMM 4.4GU program used is March 28, 2000.

Details of what the changes are for these various SWMM versions are not provided in this memo; such information can be found within various SWMM documentations. One

other point to make, however, is that the two versions of SWMM use different compilers; therefore, the interface files are not compatible.

When the GDRSS Model was first being developed (latter 1980's), the version of SWMM used was version 3. During the GDRSS Phase III Modeling project, the model was updated to use version 4.3 of the SWMM program. A number of features and enhancements were added to the SWMM program to improve the GDRSS Model's capabilities and its representation of the greater Detroit regional collection system. This in-house version of the SWMM program was labeled version 4.3R and has been supported only by CDM's Detroit office. The program was named SWMMRPO, where the term RPO stands for Rouge Project Office. Some of the changes made to the SWMM program were originally for use of the GDRSS Model with the Rouge River Wet Weather Demonstration Project.

Some of these enhanced features and improvements included the RDII routines, one-way conduits, being able to specify upper flow limits in conduits, and complex flow splitters with basins to account for treated and untreated discharge, to name several. Most of these changes have since been incorporated into the official version of the SWMM program, available from the Oregon State University web site. In fact, all of the changes made for RUNOFF and EXTRAN relative to the Event Model have been incorporated into the EPA SWMM 4.4 program. A distinction is made relative to the RUNOFF data files being for event simulation as the RUNOFF data files set for continuous simulation has infiltration in combined sewered areas variable by month. This feature is not currently available in EPA SWMM 4.4 program.

2.3 Purpose

Because the various features and enhancements made to the program for the Event Model are in the official EPA SWMM 4.4 program, there is no longer the need to maintain the SWMMRPO version. More importantly, there have been a number of updates and improvements to the SWMM code, including corrections to some of the routines, that makes it desirable to update the GDRSS Model to use the current SWMM. In addition, there are several SWMM interface tools, that only work or work better with the data files being in the standard SWMM format. One of these programs is MIKE SWMM, which is anticipated to be the tool that will be used for the Wastewater Master Plan version of the GDRSS Model.

3. Changes Required to the Model

This section describes the changes required to the data files to work with EPA SWMM 4.4. A copy of the SWMM 4.4 documentation is included on the accompanying CD to this memo (see folder SWMM). The GDRSS Model updated and reviewed is the GDRSS/WWMP Event Model, 2001 Update, version 3.13. This model represents future conditions; that is, known elements of the Detroit's Long Term CSO Control Plan are incorporated into this model. To satisfy MDEQ's concerns, the model was configured

with and without source control. These variations have been referred to as Plan A and Plan B, respectively. In the following, only the Plan A files results are presented.

3.1 RUNOFF Changes

The GDRSS/WWMP Model has 6 RUNOFF data files that required modifications. These files are as follows:

RUNOFF Data File	Description
CC.RIN	Central City (Detroit)
EF.RIN	Evergreen-Farmington
FE.RIN	Fox Creek & East Side (of Detroit)
SO.RIN	Southeast Oakland
WS.RIN	West Side (Detroit)
WW.RIN	Western Wayne (North Huron Valley/Rouge Valley)

The RUNOFF data files required only one change to work with the new version of SWMM. In SWMMRPO, a negative IVAP parameter tells the program to not allow evaporation to occur from conduits and channels. This feature was implemented as large, wide channels are used to account for internal routing and attenuation of the local collection system that is not modeled directly in the GDRSS Model. In SWMM 4.4, a negative IVAP tells the program to not allow evaporation to occur during wet or wet/dry time steps. During dry time steps, evaporation can occur. In SWMM 4.4, an optional parameter, IVCHAN, needs to be set to prevent evaporation during any condition.

One other incidental change was made and that was to change the year number from a 2-digit number, 98, to a 4-digit number, 1998, for the parameter IYRSTR. This parameter is also on the B1 line. The program automatically will assume the century to be 1900, so this was not needed. However, this change was made to reduce the potential for confusion in the future.

3.2 EXTRAN Changes

The GDRSS Model has 4 EXTRAN data files that required modifications, as described in the following table:

EXTRAN Data File	Description
EF.XIN	Evergreen-Farmington
GD.XIN	Greater Detroit
SO.XIN	Southeast Oakland
WW.XIN	Western Wayne

Several changes were made to the EXTRAN data files, as follows:

The BB line precedes the B1 line in SWMMRPO data files. It now is sequenced to follow the BA line in SWMM 4.4. This change was made to make the B lines identifiers sequential, as in B0 through B9, followed by BA, BB, BC, BD, etc. As the defaults are used for the BB line parameters, this line was removed instead of moving the line to the correct location.

The B1 line now allows a date to be set for the EXTRAN simulation. EXTRAN will follow the date of any preceding simulations, if it reads results from a previous run. If the file does not have any input from a previous run, however, the simulation assumes that the month is January. This caused a problem with the hot start files, because the steady state dry weather flow rates in January are different from the April rates, which was the month used for the design storm event simulations. To fix this problem, a dummy SETDATE runoff file was used to set the correct date for the hot-start files in the GDRSS Model. Now, with the new date parameter, the use of the SETDATE runoff files is no longer needed. The specification of an inflow interface file was removed from EF_HOT.XIN, SO_HOT.XIN and WW_HOT.XIN by changing the JIN(1) parameter from 9 to 0 and commenting out the "@ 9 'bin\SETDATE.RBD" line. A date value of 19980417 was added to the B1 line.

The B3 line specifies how many conduits and nodes will be defined for detailed printing and plotting in the following B4 through B7 lines. Previously, at least one conduit and one node had to be defined for the B6 and B7 lines; otherwise, the program would stop. These can now be eliminated without causing a problem in the simulation. The printouts and plots are typically not used as other tools are available for review of the model output. Thus, the B3 line was change to specify 0 conduits and nodes, and the B4 through B7 lines removed.

The B9 lines in SWMMRPO specify the dry weather flow factors (DWFF). In SWMM44, the line ID used for these lines is BD. These lines were changed accordingly. They did not have to be moved in the data files as the data files do not have any B lines that would be between B9 and BD.

The D1 lines (node data) had to be revised to include the x and y location of the junctions. The documentation indicates that these parameters are optional; however, if the IWHICH term is used, which specifies which DWFF set to use from the BD lines, they are not. The SWMM 4.4 program does not use the x and y parameters; therefore, zero's were inserted on all the D1 lines. These are intended for use by post-processor tools such as MIKE SWMM. As needed, actual values for the x and y parameters may be added at a later date.

Another incidental, but required, change was to the G1 lines contained in the Evergreen Farmington EXTRAN data files. These lines contained comments at the end of the data. An asterisk was not used to indicate that the information following should be

interpreted as a comment, thus, the program continued to try to read data. No other incident of this was discovered, however, because the program makes use for optional parameters on many of the input lines, the potential exists for this type of problem to occur. The standard protocol in SWMM 4.4 now is to use an asterisk to denote comments.

3.3 Other Changes

The RUN.BAT file used to run the model was modified to remove the line for executing the SETDATE.RIN file and to change the name of the SWMM program from SWMMRPO to SWMM44GU. No other changes were required.

4. Comparison of Results

The updated data files were run for three design storm events. These events are the same as used extensively during the GDRSS modeling project: the one month, one day (01MD) event (0.62 inches), the one-year, one-hour (01YH) event (1.0 inches), and the 10-year, 1-hour (10YH) event (1.8 inches). As mentioned previously, the updated data files were run using SWMM 4.4GU, release date March 28, 2000.

4.1 RUNOFF Output Comparisons

The RUNOFF outputs were compared by reviewing the continuity results and by comparing the total flows seen at each defined inlet.

Continuity results are provided for surface water (combined sewered areas), I/I (separated sewer areas), and channels/pipes. The results for the surface water and the I/I continuity checks for the two SWMM programs are identical. For the channel/pipe continuity check, the SWMM44 gives a slightly higher outflow volume for the 1-month event only. For the other two events, the results are identical. The total outflow (all submodels) for this event increased from 888 MG to 894 MG, a 0.7% increase. For this event, however, the error is reduced. It is likely that the reduction in the error is due to SWMM44 using greater level of precision in the data variables.

A summary of the results are provided in the following table.

Table 1. Comparison of RUNOFF output

		Volume (MG) by Event and SWMM Version					
		01MD		01YH		10YH	
Model	Item	44GU	RPO	44GU	RPO	44GU	RPO
CC	Surface Runoff	404.5	404.5	1,176.5	1,176.5	2,644.2	2,644.2
	RDII	35.3	35.3	65.5	65.5	128.6	128.6
	Channel Outflow	438.3	435.4	1,243.2	1,243.2	2,773.1	2,773.1
EF	Surface Runoff	10.3	10.3	61.7	61.7	164.2	164.2
	RDII	28.3	28.3	51.6	51.6	100.1	100.1
	Channel Outflow	38.6	38.4	113.3	113.3	264.3	264.3
FE	Surface Runoff	99.0	99.0	336.5	336.5	793.5	793.5
	RDII	13.2	13.2	24.1	24.1	46.8	46.8
	Channel Outflow	111.9	111.1	360.8	360.8	840.3	840.3
SO	Surface Runoff	123.9	123.9	408.3	408.3	956.7	956.7
	RDII	7.1	7.1	13.0	13.0	25.3	25.3
	Channel Outflow	130.8	130.2	421.2	421.2	997.5	997.5
WS	Surface Runoff	97.5	97.5	365.0	365.0	884.2	884.2
	RDII	1.2	1.2	2.2	2.2	4.3	4.3
	Channel Outflow	98.2	97.4	367.6	367.6	888.5	888.5
WW	Surface Runoff	24.9	24.9	91.9	91.9	221.8	221.8
	RDII	51.2	51.2	93.3	93.3	181.1	181.1
	Channel Outflow	76.0	75.8	185.4	185.4	403.0	403.0
All	Surface Runoff	760.2	760.2	2,440.0	2,440.0	5,664.6	5,664.6
	RDII	136.4	136.4	249.7	249.7	486.1	486.1
	Channel Outflow	893.7	888.3	2,691.5	2,691.5	6,166.7	6,166.7

C:\AY\WWMP\MODEL\GD313S44\EVENT\PlanA\[SWMM-Update.xls]RUNOFF

A complete comparison of the continuity results for all 6 submodels and all three events are provided in Appendix A for reference. In addition, a table comparing the total volume for each inlet is also provided in Appendix B

4.2 EXTRAN Output Comparisons

One instance of instability was triggered that caused the results to be invalid for that simulation. This instance was for the WW submodel and for the 10-year, 1-hour event. The instability occurred at Node 4521. A slight increase in the variable storage at this node prevented the instability at that location. No other changes where made to the data files in generating the results presented in this section.

The EXTRAN outputs were compared by reviewing the continuity results and by comparing the total inflows and outflows seen at each node recorded with the continuity check portion of the output.

The continuity results for the 4 submodels and for the 3 design events are provided in Table 2. Generally, as can be seen from a review of the table, the results are very similar for the two versions of SWMM.

Appendix C compares the total inflows and outputs recorded for each node in each model and for each event.

Table 2. Comparison of EXTRAN output

		Total Volume (MG) by Event and SWMM Version					
		01MD		01YH		10YH	
Model	Item	44GU	RPO	44GU	RPO	44GU	RPO
EF	INITIAL SYSTEM VOLUME	10.7	10.9	10.7	10.9	10.7	10.9
	TOTAL SYSTEM INFLOW VOLUME	246.6	246.4	321.3	321.3	472.4	472.4
	INFLOW + INITIAL VOLUME	257.3	257.3	332.0	332.2	483.1	483.3
	TOTAL SYSTEM OUTFLOW	244.7	248.2	314.0	316.9	462.2	464.9
	VOLUME LEFT IN SYSTEM	10.9	11.1	18.2	18.5	20.6	20.8
	OUTFLOW + FINAL VOLUME	255.5	259.3	332.3	335.3	482.8	485.7
	ERROR IN CONTINUITY, PERCENT	0.68	-0.77	-0.06	-0.92	0.06	-0.49
GD	INITIAL SYSTEM VOLUME	253.3	253.3	253.3	253.3	253.3	253.3
	TOTAL SYSTEM INFLOW VOLUME	2,825.3	2,823.1	4,260.6	4,261.3	6,907.4	6,908.4
	INFLOW + INITIAL VOLUME	3,078.6	3,076.5	4,513.8	4,514.6	7,160.7	7,161.8
	TOTAL SYSTEM OUTFLOW	2,740.4	2,743.4	4,039.2	4,051.1	6,652.1	6,702.2
	VOLUME LEFT IN SYSTEM	355.3	357.2	548.5	534.6	579.7	579.2
	OUTFLOW + FINAL VOLUME	3,095.7	3,100.5	4,587.7	4,585.8	7,231.8	7,281.4
	ERROR IN CONTINUITY, PERCENT	-0.56	-0.78	-1.64	-1.58	-0.99	-1.67
SO	INITIAL SYSTEM VOLUME	16.8	16.9	16.8	16.9	16.8	16.9
	TOTAL SYSTEM INFLOW VOLUME	395.2	394.6	685.6	685.6	1,261.8	1,261.8
	INFLOW + INITIAL VOLUME	412.0	411.5	702.4	702.5	1,278.7	1,278.7
	TOTAL SYSTEM OUTFLOW	399.0	398.9	689.0	688.7	1,265.3	1,265.7
	VOLUME LEFT IN SYSTEM	17.5	17.5	17.5	17.5	17.5	17.5
	OUTFLOW + FINAL VOLUME	416.5	416.4	706.5	706.2	1,282.8	1,283.2
	ERROR IN CONTINUITY, PERCENT	-1.1	-1.21	-0.58	-0.53	-0.32	-0.35
WW	INITIAL SYSTEM VOLUME	16.8	16.8	16.8	16.8	16.8	16.8
	TOTAL SYSTEM INFLOW VOLUME	489.2	488.9	598.5	598.5	816.0	816.0
	INFLOW + INITIAL VOLUME	506.0	505.8	615.3	615.3	832.9	832.9
	TOTAL SYSTEM OUTFLOW	489.1	488.9	596.8	597.1	809.2	8.2E+02
	VOLUME LEFT IN SYSTEM	16.9	16.9	16.9	16.9	17.9	18.0
	OUTFLOW + FINAL VOLUME	506.0	505.8	613.7	614.0	827.2	838.4
	ERROR IN CONTINUITY, PERCENT	0	-0.01	0.26	0.22	0.68	-0.67
ALL	INITIAL SYSTEM VOLUME	297.6	297.9	297.6	297.9	297.6	297.9
	TOTAL SYSTEM INFLOW VOLUME	3,956.2	3,953.2	5,866.0	5,866.7	9,457.7	9,458.6
	INFLOW + INITIAL VOLUME	4,253.9	4,251.1	6,163.6	6,164.7	9,755.4	9,756.7
	TOTAL SYSTEM OUTFLOW	3,873.2	3,879.5	5,639.1	5,653.8	9,188.9	9.3E+03
	VOLUME LEFT IN SYSTEM	400.6	402.7	601.0	587.5	635.7	635.5
	OUTFLOW + FINAL VOLUME	4,273.8	4,282.1	6,240.1	6,241.3	9,824.6	9,888.7
	ERROR IN CONTINUITY, PERCENT	not applicable					

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5. Summary

The GDRSS/WWMP Model SWMM engine has been updated. Comparison of the Model output results confirms that the new SWMM engine gives comparable results and that it contains the features and improvements that were used in SWMMRPO version of the EPA SWMM program. The updates were accomplished for the Event Model only at this time.

Appendix A Comparison of RUNOFF Continuity Results

Results are given for the 6 submodels – 1 per page. Volumes are given in units of MG. The nomenclature used in the tables is defined in the following table.

Process/Item	**Represents the following (from RUNOFF output)**
1Initial	***Summary of input data***
1No_Sub	TOTAL NUMBER OF SUBCATCHMENTS
2Total_Trib_ac	TOTAL TRIBUTARY AREA (ACRES)
3Imp_Area_ac	IMPERVIOUS AREA (ACRES)
4Perv_Area_ac	PERVIOUS AREA (ACRES)
5Perc_Imp_%	PERCENT IMPERVIOUSNESS
6Total_Iiarea_ac	TOT. SEWERED AREA (separate sanitary, acres)
2Surface	***Continuity Check for Surface Water***
1Precip	Total Precipitation (Rain plus Snow)
2Infilt	Total Infiltration
3Evap	Total Evaporation
4Runoff	Surface Runoff from Watersheds
5Stor	Total Water remaining in Surface Storage
6InfPerv	Infiltration over the Pervious Area
7Total1	(Inf.+Evap.+Surf.Runoff + …+ Water remaining…)
8Total2	Total Precipitation + Initial Storage
9Error_Surface_%	Error

3I/I	***Continuity Check for Infiltration/Inflow***
1Precip	Approx Total Rain for I/I (Avg of hyetographs)
2I/I_Excess	Total I/I Excess (Rain minus storage losses)
3I/I_in	Approx Total Infiltration (Ratio*I/I Excess)
4Curve1	Total Curve 1 Outflow Volume
5Curve2	Total Curve 2 Outflow Volume
6Curve3	Total Curve 3 Outflow Volume
7I/I_out	Total I/I Outflow Volume
8Error_I/I_%	Approximate Continuity Error
4Channel	***Continuity Check for Channel/Pipes***
1Stor_Initial	Initial Channel/Pipe Storage
2Stor_Final	Final Channel/Pipe Storage
3Runoff	Surface Runoff from Watersheds
4Total_I/I	Total I/I Volume
5Ground	Groundwater Subsurface Inflow
6Evap	Evaporation Loss from Channels
7Chan_Out	Channel/Pipe/Inlet Outflow
8Stor+Inflow	Initial Storage + Inflow
9Stor+Outflow	Final Storage + Outflow
AError_Channel_%	Error

Sum of Amt_MG		Event SWMM					
		01MD		01YH		10YH	
Model	Inlet	RPO	44GU	RPO	44GU	RPO	44GU
CC.RBD	600	1.60	1.62	4.62	4.62	10.26	10.26
	630	1.35	1.35	2.46	2.46	4.78	4.78
	640	2.54	2.56	7.32	7.32	16.26	16.26
	650	5.24	5.27	15.02	15.02	33.36	33.36
	1000	1.75	1.76	3.55	3.55	6.82	6.82
	1003	0.72	0.73	1.47	1.47	2.82	2.82
	1007	4.03	4.07	12.76	12.76	29.29	29.29
	1011	0.29	0.29	0.85	0.85	1.89	1.89
	1019	4.73	4.76	12.98	12.98	28.37	28.37
	1025	0.50	0.50	1.10	1.10	2.19	2.19
	1031	4.77	4.79	13.09	13.09	28.64	28.64
	1035	5.97	6.00	16.83	16.83	37.18	37.18
	1039	1.63	1.64	6.45	6.45	15.76	15.76
	1043	0.70	0.70	1.98	1.98	4.37	4.37
	1051	1.81	1.83	5.08	5.08	11.17	11.17
	1055	1.80	1.81	4.90	4.90	10.67	10.67
	1059	0.53	0.54	1.08	1.08	2.08	2.08
	1063	0.30	0.31	0.97	0.97	2.21	2.21
	1067	3.05	3.07	8.06	8.06	17.38	17.38
	1071	1.29	1.30	2.91	2.91	5.85	5.85
	1075	3.07	3.08	7.56	7.56	15.87	15.87
	1081	5.50	5.53	13.53	13.53	28.36	28.36
	1085	2.09	2.10	5.00	5.00	10.35	10.35
	1089	3.35	3.37	7.45	7.45	14.94	14.94
	1093	0.38	0.39	0.72	0.72	1.34	1.34
	1125	0.35	0.35	1.01	1.01	2.15	2.15
	1130	0.40	0.40	1.15	1.15	2.45	2.45
	1150	4.80	4.84	16.23	16.23	38.01	38.01
	1185	8.94	8.99	23.29	23.29	49.98	49.98
	1190	3.35	3.38	11.27	11.27	26.33	26.33
	1215	0.47	0.48	1.77	1.77	4.27	4.27
	1220	0.26	0.27	1.00	1.00	2.41	2.40
	1225	0.39	0.39	1.45	1.45	3.49	3.49
	1230	1.56	1.57	5.87	5.87	14.15	14.15
	1310	2.05	2.07	7.05	7.05	16.56	16.56
	1320	7.15	7.20	19.76	19.76	43.36	43.36
	1335	1.17	1.18	4.03	4.03	9.46	9.46
	1345	5.59	5.65	21.00	21.00	50.61	50.61
	1515	2.19	2.21	7.09	7.09	16.37	16.37
	1535	3.96	4.00	16.10	16.10	39.59	39.59
	1545	5.51	5.54	19.19	19.19	45.38	45.38
	1550	1.29	1.30	4.73	4.73	11.33	11.33
	1570	18.06	18.18	52.55	52.55	117.46	117.46
	1601	9.39	9.45	19.85	19.85	38.96	38.96
	1605	5.50	5.54	10.71	10.71	20.23	20.23
	1609	2.31	2.33	4.41	4.41	8.26	8.26
	1613	18.91	19.03	44.53	44.53	91.67	91.67
	1617	1.98	1.99	4.48	4.48	9.06	9.06
	1621	1.85	1.87	3.74	3.74	7.16	7.16

Sum of Amt_MG		Event SWMM					
		01MD		01YH		10YH	
Model	Inlet	RPO	44GU	RPO	44GU	RPO	44GU
CC.RBD	1627	2.63	2.64	5.56	5.56	10.91	10.91
	1631	1.51	1.52	3.74	3.74	7.85	7.85
	1635	0.85	0.86	2.16	2.16	4.56	4.56
	1639	2.18	2.19	5.17	5.17	10.65	10.65
	1643	1.50	1.51	3.56	3.56	7.35	7.35
	1647	8.06	8.10	19.63	19.63	40.98	40.98
	1651	1.29	1.30	4.26	4.27	9.90	9.90
	1655	9.55	9.61	27.31	27.31	60.67	60.67
	1663	0.88	0.89	2.66	2.66	6.01	6.01
	1667	0.11	0.12	0.36	0.36	0.81	0.81
	1675	3.78	3.82	14.23	14.23	34.31	34.31
	1681	3.73	3.77	14.39	14.39	34.93	34.93
	1683	1.65	1.67	6.23	6.23	15.00	15.00
	1687	1.55	1.56	5.97	5.97	14.48	14.48
	1690	1.98	2.00	7.65	7.65	18.57	18.57
	1731	0.74	0.74	2.70	2.70	6.47	6.47
	1759	2.46	2.46	4.48	4.48	8.70	8.70
	1782	21.93	22.07	58.67	58.67	127.41	127.41
	1785	0.44	0.44	1.23	1.23	2.69	2.69
	1795	10.57	10.63	29.38	29.38	64.62	64.62
	1898	18.52	18.52	33.70	33.70	65.42	65.42
	1899	6.65	6.65	13.40	13.40	27.51	27.51
	1952	8.80	8.86	28.93	28.93	67.23	67.23
	2030	4.04	4.06	10.66	10.66	23.00	23.00
	2040	1.24	1.25	4.33	4.33	10.25	10.25
	2056	6.41	6.45	16.51	16.51	35.24	35.24
	2160	3.16	3.20	10.87	10.87	25.55	25.55
	2200	6.88	6.93	26.18	26.18	63.41	63.41
	2315	6.94	6.98	19.86	19.86	44.10	44.10
	2345	3.27	3.30	12.31	12.31	29.70	29.70
	2350	4.34	4.38	17.15	17.15	41.88	41.88
	2355	6.56	6.63	25.98	25.98	63.47	63.47
	2389	3.07	3.10	12.46	12.46	30.64	30.64
	2397	1.88	1.90	7.25	7.25	17.60	17.60
	2505	7.28	7.32	18.96	18.96	40.67	40.67
	2520	3.87	3.91	13.13	13.13	30.75	30.75
	2560	6.25	6.29	14.65	14.65	30.09	30.09
	2575	7.87	7.92	20.98	20.98	45.39	45.39
	2605	0.90	0.91	2.93	2.93	6.75	6.75
	2725	0.42	0.43	1.20	1.20	2.64	2.64
	2730	2.32	2.33	5.25	5.25	10.60	10.60
	2735	0.48	0.48	1.18	1.18	2.45	2.45
	2740	5.17	5.20	14.40	14.40	31.67	31.67
	2765	2.24	2.26	7.40	7.40	17.18	17.18
	2770	0.40	0.41	1.55	1.55	3.75	3.75
	2805	0.24	0.24	0.49	0.49	0.93	0.93
	2817	9.74	9.83	28.99	28.99	65.30	65.30
	2915	7.00	7.05	19.45	19.45	42.73	42.73
	2920	0.62	0.62	3.38	3.38	8.82	8.82

Sum of Amt_MG		Event SWMM					
		01MD		01YH		10YH	
Model	Inlet	RPO	44GU	RPO	44GU	RPO	44GU
CC.RBD	2930	1.99	2.01	7.48	7.48	18.03	18.03
	2935	4.56	4.61	18.04	18.04	44.06	44.06
	2960	0.71	0.72	2.90	2.90	7.12	7.12
	2965	2.16	2.18	7.95	7.95	19.04	19.04
	2980	0.65	0.66	4.30	4.30	11.58	11.57
	3200	0.15	0.15	0.28	0.28	0.54	0.54
	3300	0.62	0.62	1.14	1.14	2.21	2.21
	3408	1.11	1.11	2.02	2.02	3.91	3.91
	3409	3.10	3.10	5.64	5.64	10.94	10.94
	3411	36.02	36.26	110.11	110.11	250.60	250.60
	3600	0.02	0.02	0.04	0.04	0.08	0.08
	20111	3.94	3.96	10.41	10.41	22.45	22.45
CC.RBD Total		435.40	438.30	1,243.21	1,243.21	2,773.05	2,773.05
EF.RBD	6065	0.66	0.66	1.20	1.20	2.32	2.32
	6070	0.27	0.27	0.49	0.49	0.96	0.96
	6090	0.42	0.42	0.77	0.77	1.49	1.49
	6095	0.02	0.02	0.04	0.04	0.08	0.08
	6100	10.87	10.87	19.79	19.79	38.41	38.41
	6120	0.57	0.57	1.05	1.05	2.03	2.03
	6125	0.42	0.42	0.76	0.76	1.48	1.48
	6130	0.32	0.32	0.59	0.59	1.14	1.14
	6136	1.33	1.33	2.42	2.42	4.70	4.70
	6145	1.03	1.03	1.87	1.87	3.63	3.63
	6150	0.68	0.68	1.24	1.24	2.41	2.41
	6156	2.01	2.04	12.08	12.08	32.04	32.04
	6160	0.26	0.26	0.48	0.48	0.93	0.93
	6165	11.38	11.38	20.71	20.71	40.20	40.20
	6166	5.00	5.07	31.97	31.97	85.56	85.56
	6167	3.10	3.14	17.73	17.73	46.66	46.66
	6168	0.08	0.08	0.15	0.15	0.30	0.30
EF.RBD Total		38.42	38.57	113.33	113.33	264.32	264.32
FE.RBD	5030	4.83	4.86	10.14	10.14	19.85	19.85
	5040	3.06	3.10	11.53	11.53	27.80	27.80
	5105	1.55	1.56	4.93	4.93	11.30	11.30
	5108	0.58	0.59	2.00	2.00	4.70	4.70
	5110	1.03	1.05	4.11	4.11	10.03	10.03
	5115	1.63	1.64	7.04	7.04	17.56	17.56
	5250	1.87	1.88	7.21	7.21	17.49	17.49
	5255	6.64	6.68	25.44	25.44	61.74	61.74
	5415	0.26	0.26	0.95	0.95	2.26	2.26
	5420	1.12	1.13	4.57	4.57	11.25	11.25
	5510	3.09	3.12	12.24	12.24	29.90	29.90
	5530	3.25	3.28	12.90	12.90	31.51	31.51
	5555	1.08	1.09	4.30	4.30	10.49	10.49
	5615	3.01	3.04	11.61	11.61	28.18	28.18
	5710	2.29	2.32	8.63	8.63	20.82	20.82
	5729	8.09	8.15	31.89	31.89	77.92	77.92
	5802	1.25	1.26	4.94	4.94	12.07	12.07
	5879	2.16	2.18	6.08	6.08	13.64	13.64

Sum of Amt_MG		Event SWMM					
		01MD		01YH		10YH	
Model	Inlet	RPO	44GU	RPO	44GU	RPO	44GU
FE.RBD	7003	3.76	3.80	12.82	12.82	30.06	30.06
	7004	3.16	3.19	10.60	10.60	24.73	24.73
	7011	0.85	0.85	1.55	1.55	3.00	3.00
	7031	20.63	20.77	66.55	66.55	153.89	153.89
	7035	0.69	0.69	1.25	1.25	2.43	2.43
	7040	1.54	1.54	2.81	2.81	5.45	5.45
	7041	21.00	21.13	64.70	64.70	147.85	147.85
	7045	0.92	0.92	1.67	1.67	3.24	3.24
	7046	10.04	10.09	25.26	25.26	55.05	55.05
	7050	0.55	0.55	1.00	1.00	1.95	1.95
	7060	1.16	1.16	2.11	2.11	4.10	4.10
FE.RBD Total		111.11	111.86	360.82	360.82	840.29	840.29
SO.RBD	8015	3.06	3.06	5.57	5.57	10.80	10.80
	8075	4.09	4.09	7.45	7.45	14.46	14.46
	8205	123.08	123.63	408.17	408.17	972.32	972.32
SO.RBD Total		130.23	130.78	421.18	421.18	997.58	997.58
WS.RBD	3454	0.85	0.86	3.69	3.69	9.19	9.19
	3455	1.26	1.27	6.29	6.29	16.16	16.16
	3465	1.81	1.82	7.83	7.83	19.53	19.53
	3470	1.55	1.56	7.44	7.44	18.97	18.97
	3474	0.35	0.35	1.69	1.69	4.31	4.31
	3480	3.84	3.86	11.53	11.53	26.04	26.04
	3500	0.93	0.94	2.71	2.71	6.05	6.05
	3505	0.18	0.18	0.92	0.92	2.38	2.38
	3511	0.50	0.50	2.08	2.08	5.15	5.15
	3514	0.22	0.22	0.93	0.93	2.29	2.29
	3515	1.03	1.04	4.20	4.20	10.33	10.33
	3516	0.25	0.25	1.05	1.05	2.60	2.60
	3520	0.10	0.10	0.42	0.42	1.03	1.03
	3521	0.21	0.21	0.75	0.75	1.80	1.80
	3524	0.75	0.76	2.98	2.98	7.27	7.27
	3525	1.49	1.51	7.79	7.79	20.17	20.17
	3526	0.12	0.12	0.49	0.49	1.22	1.22
	3529	0.10	0.10	0.40	0.40	0.99	0.99
	3532	0.13	0.13	0.54	0.54	1.33	1.34
	3533	0.49	0.49	2.05	2.05	5.07	5.07
	3535	2.08	2.10	9.99	9.99	25.48	25.48
	3537	0.09	0.09	0.39	0.39	0.96	0.95
	3540	1.17	1.18	6.39	6.39	16.68	16.68
	3541	0.22	0.22	0.93	0.93	2.29	2.29
	3544	0.60	0.61	2.53	2.53	6.25	6.25
	3546	0.24	0.24	1.01	1.01	2.48	2.48
	3548	0.49	0.50	1.60	1.60	3.68	3.68
	3550	3.36	3.39	15.02	15.02	37.75	37.75
	3553	0.18	0.18	0.76	0.76	1.87	1.87
	3565	2.14	2.16	9.57	9.57	24.05	24.05
	3569	0.07	0.08	0.43	0.43	1.14	1.14
	3570	3.01	3.04	13.95	13.95	35.32	35.32
	3580	1.23	1.23	2.24	2.24	4.34	4.34

Sum of Amt_MG		Event SWMM					
		01MD		01YH		10YH	
Model	Inlet	RPO	44GU	RPO	44GU	RPO	44GU
WS.RBD	3620	0.48	0.48	1.93	1.93	4.75	4.75
	3625	1.23	1.24	3.70	3.70	8.36	8.36
	3635	2.72	2.75	9.17	9.17	21.42	21.42
	3640	5.08	5.11	14.79	14.79	33.03	33.03
	3645	4.16	4.18	12.49	12.49	28.19	28.19
	3655	2.21	2.23	7.16	7.16	16.53	16.53
	3660	1.85	1.87	7.56	7.56	18.60	18.60
	3662	1.56	1.57	6.19	6.19	15.10	15.10
	3665	2.57	2.60	8.17	8.17	18.76	18.76
	3670	8.47	8.51	33.32	33.32	81.43	81.43
	3710	1.97	1.98	8.51	8.51	21.24	21.24
	3720	3.09	3.12	12.60	12.60	30.99	30.99
	3725	1.09	1.10	4.33	4.33	10.57	10.57
	3730	1.95	1.96	6.18	6.18	14.19	14.19
	3735	1.85	1.86	7.13	7.13	17.30	17.30
	3740	1.14	1.15	4.52	4.52	11.03	11.03
	3745	1.44	1.45	3.82	3.82	8.23	8.23
	3750	2.61	2.63	10.33	10.33	25.25	25.25
	3755	2.18	2.20	9.15	9.15	22.67	22.67
	3760	2.94	2.96	11.04	11.04	26.64	26.64
	3763	1.77	1.78	7.41	7.41	18.37	18.37
	3764	1.42	1.44	5.36	5.36	12.91	12.91
	3765	0.29	0.30	1.14	1.14	2.75	2.75
	3770	2.43	2.46	10.21	10.21	25.30	25.30
	3775	1.75	1.76	6.58	6.58	15.86	15.86
	3780	2.48	2.50	10.41	10.41	25.79	25.79
	3895	2.66	2.67	5.31	5.31	10.14	10.14
	35215	0.45	0.45	1.88	1.88	4.65	4.65
	36300	2.51	2.52	6.64	6.64	14.31	14.31
WS.RBD Total		97.36	98.16	367.62	367.62	888.52	888.52
WW.RBD	3086	0.09	0.09	0.16	0.16	0.31	0.31
	4046	0.13	0.14	1.01	1.01	2.74	2.74
	4050	0.06	0.06	0.11	0.11	0.21	0.21
	4086	0.10	0.10	0.49	0.49	1.27	1.27
	4105	0.00	0.00	0.00	0.00	0.00	0.00
	4106	0.63	0.64	2.06	2.06	4.88	4.88
	4130	0.00	0.00	0.00	0.00	0.00	0.00
	4131	1.46	1.47	6.53	6.53	16.48	16.48
	4145	0.87	0.87	1.58	1.58	3.07	3.07
	4170	0.71	0.71	1.28	1.28	2.49	2.49
	4175	0.00	0.00	0.01	0.01	0.01	0.01
	4220	0.10	0.10	0.19	0.19	0.37	0.37
	4270	2.55	2.55	4.64	4.64	9.00	9.00
	4271	1.33	1.33	2.42	2.42	4.69	4.69
	4319	0.43	0.44	1.48	1.48	3.47	3.47
	4322	0.09	0.09	0.16	0.16	0.31	0.31
	4326	0.15	0.15	0.27	0.27	0.53	0.53
	4327	10.98	11.03	30.17	30.17	66.55	66.55
	4331	0.03	0.03	0.05	0.05	0.09	0.09

Sum of Amt_MG		Event SWMM					
		01MD		01YH		10YH	
Model	Inlet	RPO	44GU	RPO	44GU	RPO	44GU
WW.RBD	4332	0.18	0.18	0.33	0.33	0.64	0.64
	4333	0.07	0.07	0.12	0.12	0.23	0.23
	4341	0.34	0.34	1.69	1.69	4.32	4.32
	4361	3.85	3.88	11.68	11.68	26.80	26.80
	4363	0.16	0.16	0.62	0.62	1.50	1.50
	4365	0.04	0.04	0.07	0.07	0.14	0.14
	4371	1.97	1.99	7.47	7.47	18.25	18.25
	4374	0.53	0.53	1.60	1.60	3.74	3.74
	4386	1.68	1.70	7.08	7.08	17.53	17.53
	4389	0.37	0.37	0.67	0.67	1.31	1.31
	4411	0.08	0.09	0.40	0.40	1.02	1.02
	4421	0.09	0.10	0.62	0.62	1.67	1.67
	4423	0.07	0.07	0.13	0.13	0.26	0.26
	4431	0.46	0.46	2.19	2.19	5.58	5.58
	4435	0.04	0.04	0.07	0.07	0.13	0.13
	4436	0.12	0.12	0.22	0.22	0.42	0.42
	4437	0.13	0.14	0.46	0.46	1.07	1.07
	4450	0.61	0.61	1.10	1.10	2.14	2.14
	4451	0.04	0.04	0.07	0.07	0.14	0.14
	4461	1.72	1.72	3.13	3.13	6.07	6.07
	4470	0.03	0.03	0.06	0.06	0.11	0.11
	4473	0.20	0.20	0.37	0.37	0.72	0.72
	4476	0.42	0.42	0.76	0.76	1.48	1.48
	4480	0.11	0.11	0.21	0.21	0.40	0.40
	4501	1.40	1.40	2.54	2.54	4.93	4.93
	4506	0.52	0.53	1.97	1.97	4.73	4.73
	4508	0.33	0.33	1.21	1.21	2.89	2.89
	4511	0.39	0.40	1.44	1.44	3.43	3.43
	4513	0.36	0.37	1.34	1.34	3.20	3.20
	4521	0.36	0.36	1.60	1.60	4.01	4.01
	4526	0.14	0.14	0.51	0.51	1.21	1.21
	4530	0.20	0.20	0.36	0.36	0.69	0.69
	4531	0.76	0.76	2.85	2.85	6.86	6.86
	4535	0.23	0.23	0.42	0.42	0.81	0.81
	4541	0.16	0.16	0.62	0.62	1.50	1.50
	4545	0.87	0.87	1.59	1.59	3.09	3.09
	4560	0.26	0.26	0.48	0.48	0.94	0.94
	4565	0.13	0.13	0.24	0.24	0.47	0.47
	4568	2.18	2.18	3.96	3.96	7.69	7.69
	4575	0.02	0.02	0.04	0.04	0.07	0.07
	4576	3.13	3.13	5.70	5.70	11.07	11.07
	4580	0.12	0.12	0.22	0.22	0.42	0.42
	4585	0.26	0.26	0.47	0.47	0.91	0.91
	4600	0.95	0.95	1.72	1.72	3.34	3.34
	4601	2.62	2.62	4.77	4.77	9.26	9.26
	4616	1.53	1.53	2.79	2.79	5.42	5.42
	4618	0.58	0.58	1.05	1.05	2.04	2.04
	4620	0.03	0.03	0.05	0.05	0.09	0.09
	4631	1.69	1.69	3.08	3.08	5.99	5.99

Sum of Amt_MG		Event SWMM					
		01MD		01YH		10YH	
Model	Inlet	RPO	44GU	RPO	44GU	RPO	44GU
WW.RBD	4650	0.04	0.04	0.08	0.08	0.15	0.15
	4672	0.22	0.22	0.40	0.40	0.77	0.77
	4676	0.02	0.02	0.04	0.04	0.07	0.07
	4680	0.04	0.04	0.08	0.08	0.15	0.15
	4685	0.06	0.06	0.11	0.11	0.21	0.21
	4695	0.78	0.78	1.42	1.42	2.76	2.76
	4700	0.01	0.01	0.02	0.02	0.04	0.04
	4706	0.02	0.02	0.04	0.04	0.07	0.07
	4708	0.01	0.01	0.02	0.02	0.03	0.03
	4710	0.70	0.70	1.27	1.27	2.46	2.46
	4711	0.02	0.02	0.04	0.04	0.07	0.07
	4713	0.08	0.08	0.14	0.14	0.28	0.28
	4715	0.10	0.10	0.18	0.18	0.35	0.35
	4717	0.02	0.02	0.03	0.03	0.05	0.05
	4755	0.06	0.06	0.11	0.11	0.22	0.22
	4775	0.17	0.17	0.31	0.31	0.60	0.60
	4820	0.05	0.05	0.08	0.08	0.16	0.16
	4857	0.23	0.23	0.41	0.41	0.80	0.80
	4955	0.01	0.01	0.02	0.02	0.03	0.03
	4975	0.02	0.02	0.05	0.05	0.09	0.09
	4985	0.34	0.34	0.61	0.61	1.19	1.19
	4990	0.28	0.28	0.51	0.51	1.00	1.00
	4991	1.33	1.33	2.42	2.42	4.70	4.70
	7760	0.08	0.08	0.14	0.14	0.28	0.28
	7765	0.32	0.32	0.57	0.57	1.11	1.11
	7800	1.55	1.55	2.82	2.82	5.47	5.47
	7955	1.31	1.31	2.38	2.38	4.62	4.62
	9012	1.56	1.56	2.85	2.85	5.53	5.53
	9020	3.13	3.13	5.70	5.70	11.07	11.07
	9040	1.78	1.78	3.24	3.24	6.30	6.30
	9045	0.42	0.42	0.76	0.76	1.47	1.47
	9080	2.36	2.36	4.29	4.29	8.34	8.34
	9205	0.08	0.08	0.14	0.14	0.28	0.28
	9206	0.86	0.86	3.43	3.43	8.47	8.47
	9210	0.07	0.07	0.13	0.13	0.26	0.26
	9225	0.37	0.37	0.67	0.67	1.30	1.30
	9230	0.11	0.11	0.19	0.19	0.38	0.38
	9235	0.05	0.05	0.10	0.10	0.19	0.19
	9236	0.32	0.32	1.34	1.34	3.39	3.39
	9241	4.09	4.10	12.05	12.05	27.91	27.91
	9245	0.35	0.35	0.64	0.64	1.24	1.24
	9325	0.01	0.01	0.02	0.02	0.03	0.03
	9341	0.19	0.19	0.77	0.77	1.91	1.91
WW.RBD Total		75.83	76.04	185.36	185.36	403.00	403.00
Grand Total		888.34	893.70	2,691.54	2,691.54	6,166.77	6,166.76

Appendix B Comparison of Total Volume by Inlet from RUNOFF

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
EF	INFLOW	6065	4.24	4.24	4.78	4.78	5.91	5.91
		6070	1.15	1.15	1.37	1.37	1.84	1.84
		6090	0.94	0.94	1.29	1.29	2.01	2.01
		6095	0.19	0.19	0.20	0.20	0.24	0.24
		6100	131.90	131.90	140.81	140.81	159.43	159.43
		6120	1.78	1.78	2.25	2.25	3.23	3.23
		6125	4.10	4.10	4.45	4.45	5.17	5.17
		6130	3.71	3.71	3.97	3.97	4.52	4.52
		6136	9.05	9.05	10.14	10.14	12.42	12.42
		6145	7.38	7.38	8.22	8.22	9.99	9.99
		6150	4.10	4.10	4.66	4.66	5.83	5.83
		6156	5.88	5.86	15.92	15.92	35.87	35.87
		6160	1.01	1.01	1.23	1.23	1.67	1.67
		6165	51.85	51.85	61.17	61.17	80.72	80.72
		6166	10.80	10.73	37.71	37.71	91.28	91.28
		6167	8.25	8.21	22.85	22.85	51.78	51.78
		6168	0.25	0.25	0.32	0.32	0.46	0.46
	INFLOW Total		246.59	246.44	321.35	321.35	472.37	472.37
	OUTFLOW	2250	244.66	248.23	279.79	282.61	323.53	325.66
		6075					2.13	2.63
		61560			7.06	7.06	27.00	27.00
		61660			20.24	20.24	73.77	73.77
		61670			6.96	6.96	35.80	35.80
	OUTFLOW Total		244.66	248.23	314.04	316.86	462.23	464.85
EF Total			491.24	494.67	635.39	638.21	934.60	937.23
GD	INFLOW	600	4.15	4.14	7.16	7.16	12.80	12.80
		630	5.28	5.28	6.39	6.39	8.71	8.71
		640	2.56	2.54	7.31	7.31	16.25	16.25
		650	13.32	13.30	23.08	23.08	41.43	41.43
		1000	19.69	19.67	21.47	21.47	24.75	24.75
		1003	3.07	3.06	3.81	3.81	5.15	5.15
		1007	9.58	9.53	18.26	18.26	34.80	34.80
		1011	0.46	0.46	1.02	1.02	2.06	2.06
		1019	11.44	11.41	19.67	19.67	35.06	35.06
		1020	0.00	0.00				
		1025	6.19	6.19	6.79	6.79	7.88	7.88
		1031	12.65	12.63	20.95	20.95	36.49	36.49
		1035	18.75	18.72	29.59	29.59	49.92	49.92
		1039	10.82	10.80	15.63	15.63	24.92	24.92
		1043	2.25	2.24	3.52	3.52	5.92	5.92
		1047	2.49	2.49	2.49	2.49	2.49	2.49
		1051	5.18	5.16	8.43	8.43	14.51	14.51
		1055	9.93	9.92	13.02	13.02	18.78	18.78
		1059	0.68	0.68	1.23	1.23	2.23	2.23
		1063	3.34	3.33	3.99	3.99	5.24	5.24
		1067	16.09	16.07	21.09	21.09	30.41	30.41
		1071	6.65	6.64	8.26	8.26	11.20	11.20
		1075	7.76	7.75	12.24	12.24	20.54	20.54
		1081	10.09	10.06	18.09	18.09	32.93	32.93

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	INFLOW	1085	3.32	3.31	6.23	6.23	11.58	11.58
		1089	5.39	5.37	9.46	9.46	16.95	16.95
		1093	0.41	0.40	0.74	0.74	1.36	1.36
		1125	0.35	0.34	1.01	1.01	2.15	2.15
		1130	0.40	0.39	1.15	1.15	2.45	2.45
		1150	4.83	4.79	16.21	16.21	37.99	37.99
		1160	9.39	9.39	9.39	9.39	9.39	9.39
		1185	19.16	19.11	33.46	33.46	60.14	60.14
		1190	15.17	15.14	23.06	23.06	38.12	38.12
		1200	7.01	7.01	7.01	7.01	7.01	7.01
		1215	1.85	1.84	3.15	3.15	5.65	5.65
		1220	1.04	1.04	1.77	1.77	3.18	3.18
		1225	1.51	1.50	2.57	2.57	4.61	4.61
		1230	6.13	6.12	10.43	10.43	18.71	18.71
		1310	7.31	7.29	12.29	12.29	21.80	21.80
		1320	11.17	11.12	23.74	23.74	47.32	47.32
		1335	4.17	4.16	7.01	7.01	12.45	12.45
		1345	22.53	22.47	37.86	37.86	67.50	67.50
		1515	2.21	2.19	7.08	7.08	16.36	16.36
		1535	22.17	22.13	34.27	34.27	57.73	57.73
		1545	22.95	22.92	36.60	36.60	62.78	62.78
		1550	5.51	5.50	8.95	8.95	15.55	15.55
		1570	46.91	46.79	81.25	81.25	146.15	146.15
		1601	17.56	17.50	27.97	27.97	47.07	47.07
		1605	13.25	13.22	18.42	18.42	27.93	27.93
		1609	7.67	7.66	9.76	9.76	13.60	13.60
		1613	45.25	45.12	70.76	70.76	117.92	117.92
		1617	6.12	6.10	8.60	8.60	13.18	13.18
		1621	9.28	9.27	11.15	11.15	14.57	14.57
		1627	4.70	4.69	7.62	7.62	12.97	12.97
		1631	2.92	2.90	5.14	5.14	9.24	9.24
		1635	4.16	4.16	5.46	5.46	7.87	7.87
		1639	3.80	3.79	6.77	6.77	12.26	12.26
		1643	2.69	2.68	4.74	4.74	8.53	8.53
		1647	17.22	17.18	28.75	28.75	50.08	50.08
		1651	3.49	3.48	6.45	6.45	12.10	12.10
		1655	22.01	21.94	39.71	39.71	73.07	73.07
		1663	4.11	4.10	5.89	5.89	9.23	9.23
		1667	2.39	2.39	2.63	2.64	3.09	3.09
		1675	18.58	18.54	29.00	29.00	49.08	49.08
		1681	15.02	14.99	25.65	25.65	46.18	46.18
		1683	1.67	1.65	6.22	6.22	15.00	15.00
		1687	6.65	6.64	11.05	11.05	19.56	19.56
		1690	8.96	8.94	14.61	14.61	25.52	25.52
		1731	2.85	2.84	4.81	4.81	8.57	8.57
		1759	6.97	6.97	8.99	8.99	13.21	13.21
		1782	46.06	45.92	82.65	82.65	151.35	151.35
		1785	7.36	7.36	8.15	8.15	9.61	9.61
		1795	29.65	29.59	48.40	48.40	83.63	83.63

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	INFLOW	1898	178.49	178.49	193.68	193.68	225.40	225.40
		1899	115.24	115.24	121.99	121.99	136.10	136.10
		1952	36.35	36.29	56.42	56.42	94.70	94.70
		2030	4.06	4.03	10.66	10.66	22.99	22.99
		2040	3.52	3.51	6.61	6.61	12.53	12.53
		2056	9.25	9.21	19.30	19.30	38.03	38.03
		2060	5.05	5.05	5.05	5.05	5.05	5.05
		2160	12.28	12.25	19.95	19.95	34.65	34.65
		2200	27.82	27.77	47.07	47.07	84.34	84.34
		2250	164.56	167.12	193.50	195.26	237.17	238.22
		2315	21.61	21.58	34.50	34.50	58.75	58.75
		2345	12.78	12.75	21.79	21.79	39.16	39.16
		2350	15.89	15.84	28.65	28.65	53.38	53.38
		2355	24.07	24.00	43.40	43.40	80.89	80.89
		2389	11.10	11.07	20.46	20.46	38.66	38.66
		2397	8.04	8.02	13.40	13.40	23.74	23.74
		2505	14.37	14.33	26.02	26.02	47.73	47.73
		2520	12.05	12.01	21.27	21.27	38.89	38.89
		2560	8.61	8.57	16.97	16.97	32.41	32.41
		2575	14.43	14.38	27.50	27.50	51.89	51.89
		2605	3.10	3.09	5.11	5.11	8.94	8.94
		2725	0.98	0.98	1.75	1.75	3.20	3.20
		2730	3.38	3.37	6.30	6.30	11.65	11.65
		2735	0.91	0.91	1.61	1.61	2.88	2.88
		2740	17.21	17.18	26.42	26.42	43.69	43.69
		2765	7.22	7.20	12.36	12.36	22.14	22.14
		2770	1.52	1.52	2.66	2.66	4.86	4.86
		2780	299.26	299.13	346.10	345.17	360.22	359.10
		2805	0.33	0.33	0.57	0.57	1.01	1.01
		2817	25.13	25.04	44.29	44.29	80.60	80.60
		2915	15.54	15.49	27.93	27.93	51.24	51.24
		2920	1.82	1.82	4.58	4.58	10.02	10.02
		2930	9.72	9.70	15.19	15.19	25.74	25.74
		2935	25.36	25.31	38.78	38.78	64.80	64.80
		2960	3.87	3.87	6.05	6.05	10.28	10.28
		2965	7.34	7.32	13.11	13.11	24.20	24.20
		2980	1.65	1.65	5.30	5.30	12.57	12.57
		3085	228.33	228.23	255.54	255.38	301.09	301.91
		3160	73.04	73.00	81.99	82.02	95.43	95.59
		3200	0.80	0.80	0.92	0.92	1.19	1.19
		3300	1.48	1.48	1.99	1.99	3.06	3.06
		3408	4.68	4.68	5.59	5.59	7.49	7.49
		3409	11.66	11.66	14.20	14.20	19.51	19.51
		3411	76.44	76.20	150.29	150.29	290.81	290.81
		3454	1.83	1.82	4.66	4.66	10.15	10.15
		3455	4.51	4.50	9.54	9.54	19.39	19.39
		3465	5.71	5.70	11.72	11.72	23.41	23.41
		3470	9.90	9.88	15.77	15.77	27.32	27.32
		3474	0.65	0.65	1.99	1.99	4.60	4.60

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	INFLOW	3480	7.77	7.75	15.44	15.44	29.95	29.95
		3500	1.47	1.46	3.25	3.25	6.59	6.59
		3505	0.46	0.46	1.20	1.20	2.65	2.65
		3511	1.83	1.82	3.41	3.41	6.47	6.47
		3514	0.22	0.22	0.93	0.93	2.29	2.29
		3515	2.52	2.51	5.68	5.68	11.82	11.82
		3516	0.25	0.25	1.05	1.05	2.59	2.59
		3520	0.30	0.30	0.61	0.61	1.23	1.23
		3521	1.52	1.51	2.06	2.06	3.10	3.10
		3524	1.87	1.87	4.09	4.09	8.39	8.39
		3525	4.81	4.80	11.09	11.09	23.47	23.47
		3526	0.12	0.12	0.49	0.49	1.22	1.22
		3529	0.09	0.09	0.40	0.40	0.99	0.99
		3532	0.13	0.13	0.54	0.54	1.33	1.33
		3533	0.49	0.49	2.05	2.05	5.07	5.07
		3535	6.50	6.48	14.39	14.39	29.87	29.87
		3537	0.09	0.09	0.39	0.39	0.95	0.95
		3540	4.21	4.20	9.41	9.41	19.70	19.70
		3541	0.22	0.22	0.93	0.93	2.29	2.29
		3544	1.64	1.63	3.55	3.55	7.28	7.28
		3546	0.24	0.24	1.00	1.00	2.48	2.48
		3548	1.53	1.52	2.62	2.62	4.71	4.71
		3550	9.68	9.65	21.31	21.32	44.04	44.04
		3553	1.19	1.19	1.77	1.77	2.88	2.88
		3565	7.23	7.21	14.64	14.64	29.13	29.13
		3569	0.23	0.22	0.58	0.58	1.29	1.29
		3570	9.31	9.28	20.22	20.22	41.61	41.61
		3580	7.46	7.46	8.46	8.46	10.56	10.56
		3600	0.02	0.02	0.04	0.04	0.08	0.08
		3620	1.66	1.66	3.11	3.11	5.93	5.93
		3625	2.40	2.39	4.86	4.86	9.52	9.52
		3635	6.53	6.50	12.94	12.94	25.20	25.20
		3640	9.92	9.90	19.60	19.60	37.86	37.86
		3645	8.76	8.73	17.06	17.06	32.77	32.77
		3655	2.23	2.21	7.15	7.15	16.52	16.52
		3656	3.18	3.18	3.18	3.18	3.18	3.18
		3660	6.62	6.60	12.30	12.30	23.35	23.35
		3662	1.57	1.56	6.18	6.18	15.10	15.10
		3664	3.83	3.83	3.83	3.83	3.83	3.83
		3665	2.59	2.57	8.17	8.17	18.75	18.75
		3668	4.28	4.28	4.28	4.28	4.28	4.28
		3670	22.88	22.83	47.67	47.67	95.77	95.77
		3710	5.42	5.40	11.95	11.95	24.67	24.67
		3720	8.87	8.84	18.36	18.36	36.74	36.74
		3725	2.71	2.70	5.94	5.94	12.18	12.18
		3730	3.85	3.83	8.07	8.07	16.08	16.08
		3735	5.47	5.45	10.74	10.74	20.89	20.89
		3740	2.97	2.96	6.34	6.34	12.86	12.86
		3745	2.56	2.55	4.93	4.93	9.35	9.35

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	INFLOW	3750	7.21	7.18	14.91	14.91	29.82	29.82
		3755	6.54	6.52	13.49	13.49	27.01	27.01
		3760	7.64	7.62	15.73	15.73	31.31	31.31
		3763	5.35	5.33	10.98	10.98	21.92	21.92
		3764	3.67	3.66	7.59	7.59	15.15	15.15
		3765	0.81	0.81	1.65	1.65	3.26	3.26
		3770	7.31	7.28	15.07	15.07	30.14	30.14
		3775	4.96	4.95	9.78	9.78	19.05	19.05
		3780	7.53	7.50	15.43	15.43	30.82	30.82
		3895	3.29	3.28	5.93	5.93	10.77	10.76
		5030	5.05	5.02	10.34	10.34	20.04	20.04
		5040	8.66	8.63	17.09	17.09	33.36	33.36
		5105	3.80	3.78	7.16	7.16	13.54	13.54
		5108	1.60	1.59	3.01	3.01	5.70	5.70
		5110	3.56	3.55	6.62	6.62	12.55	12.55
		5115	6.79	6.78	12.20	12.20	22.72	22.72
		5250	9.45	9.43	14.77	14.77	25.04	25.04
		5255	6.66	6.62	25.43	25.43	61.72	61.72
		5415	1.25	1.24	1.94	1.94	3.25	3.25
		5420	4.89	4.88	8.33	8.33	15.00	15.00
		5510	15.21	15.18	24.34	24.34	42.00	42.00
		5530	16.02	15.99	25.65	25.65	44.26	44.26
		5555	27.95	27.94	31.15	31.15	37.36	37.36
		5615	12.42	12.39	21.01	21.01	37.55	37.55
		5710	10.76	10.73	17.07	17.07	29.26	29.26
		5729	28.94	28.88	52.68	52.68	98.71	98.71
		5802	5.27	5.26	8.95	8.95	16.08	16.08
		5879	4.21	4.20	8.11	8.11	15.68	15.68
		7003	5.14	5.10	14.16	14.16	31.40	31.40
		7004	5.60	5.56	13.00	13.00	27.15	27.15
		7011	1.85	1.85	2.54	2.54	4.00	4.00
		7031	35.78	35.64	81.58	81.58	168.90	168.90
		7035	2.54	2.54	3.10	3.10	4.28	4.28
		7040	4.67	4.67	5.93	5.93	8.58	8.58
		7041	41.37	41.24	84.96	84.96	168.09	168.09
		7045	2.32	2.32	3.07	3.07	4.64	4.64
		7046	42.09	42.04	57.26	57.26	87.04	87.04
		7050	1.52	1.52	1.98	1.98	2.92	2.92
		7060	2.86	2.86	3.81	3.81	5.80	5.80
		10321		0.00				
		10322	0.00	0.00				
		12201						0.06
		16866	5.54	5.54	5.54	5.54	5.54	5.54
		17786	0.00		0.00		0.00	
		20111	3.96	3.94	10.41	10.41	22.45	22.45
		35215	0.45	0.45	1.88	1.88	4.65	4.65
		36300	4.52	4.50	8.63	8.63	16.31	16.31
	INFLOW Total		2,825.32	2,823.16	4,260.60	4,261.31	6,907.44	6,908.42
	OUTFLOW	100	1,438.88	1,436.04	1,732.04	1,727.18	1,836.24	1,834.15

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	OUTFLOW	200	1,255.08	1,253.21	1,446.43	1,429.90	1,498.12	1,499.77
		370			42.08	41.01	427.78	429.49
		600						0.04
		621					0.00	0.01
		680						0.00
		690					0.05	0.07
		1004					0.09	0.09
		1008	0.66	0.64	9.82	9.81	26.46	26.45
		1012	0.00	0.00	0.25	0.26	1.20	1.22
		1020			2.82	2.84	10.16	10.08
		1026					33.37	32.33
		1032	0.00	0.00	2.48	2.47	7.29	7.24
		1036					16.04	16.14
		1040			0.02	0.03	3.23	3.25
		1052			0.81	0.81	3.52	3.54
		1056			1.31	1.31	4.03	4.02
		1060			0.49	0.50	1.51	1.51
		1064			0.39	0.39	1.63	1.46
		1068			2.40	2.26	6.78	6.82
		1072			1.05	1.05	4.75	4.80
		1074						0.01
		1076			2.02	2.03	5.98	5.95
		1082	0.78	0.77	5.20	5.19	12.27	12.27
		1086	0.05	0.05	1.76	1.76	4.34	4.34
		1090			2.28	2.27	5.72	5.71
		1094			0.33	0.35	1.09	1.11
		1100					0.13	0.13
		1225					0.00	0.00
		1340						0.00
		1400			0.00	0.01		
		1415			0.00	0.00	0.22	0.27
		1420					0.13	0.01
		1425					0.16	0.25
		1435			0.05	0.05		
		1440			0.01	0.02		0.02
		1560					0.44	
		1602			5.76	5.76	13.92	13.89
		1610			3.46	3.53	9.96	10.08
		1614			27.99	28.20	73.86	74.29
		1618			0.79	0.80	4.57	4.62
		1622			2.80	2.85	9.36	9.52
		1628			2.87	2.87	7.00	7.01
		1632			3.47	3.48	8.29	8.32
		1636			0.56	0.57	1.96	1.94
		1640			0.40	0.40	1.24	1.17
		1648			2.02	1.84	6.14	5.95
		1656	1.57	1.54	8.79	8.80	20.31	20.27
		1664			5.24	5.27	9.96	10.00
		1670					0.02	

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	OUTFLOW	1674					0.01	0.01
		1676	0.03	0.03	3.18	3.18	9.57	9.58
		1678					0.01	0.01
		1682			1.03	1.05	4.29	4.29
		1684					0.00	
		1686				0.00	0.02	0.01
		1688			3.04	3.05	7.32	7.13
		1740						0.00
		1745					0.07	0.17
		1766			35.34	35.34	103.30	103.30
		1778	0.00	0.00	0.00	0.00	0.00	0.00
		1790						0.01
		1792			51.32	51.36	170.75	171.27
		1793			51.32	51.36	170.75	171.27
		1797	7.54	7.49	26.88	26.88	61.93	61.93
		1835			0.04	0.04	0.07	0.03
		1837					0.00	0.01
		1838						0.02
		1875					0.00	0.02
		1935					0.00	
		2005			0.00	0.00	0.04	0.02
		2006			10.93	10.96	31.68	31.49
		2007			0.01	0.00	0.32	0.23
		2008			10.93	10.96	31.68	31.49
		2009			10.93	10.96	31.68	31.49
		2040					0.01	0.01
		2045						0.00
		2050					0.00	0.00
		2065				0.01		0.01
		2070			0.00	0.06	0.01	0.09
		2105			13.02	13.12	64.58	65.24
		2106			13.02	13.12	64.58	65.24
		2320					0.00	0.02
		2325						0.00
		2360					0.00	
		2370					0.00	
		2375					0.00	
		2380					0.01	0.03
		2385					0.05	0.05
		2425					0.03	
		2430			0.01	0.00	0.03	0.03
		2435					0.01	0.01
		2510					0.00	0.00
		2525					0.03	0.01
		2565						0.02
		2570						3.31
		2575						0.15
		2585						0.03
		2590					0.00	0.00

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	OUTFLOW	2595						0.00
		2600					0.03	
		2700			11.38	11.63	48.92	49.94
		2705			11.38	11.63	48.92	49.94
		2730						0.01
		2735						0.06
		2740						3.51
		2745						9.77
		2755						14.01
		2810						0.02
		2830			3.02	3.22	9.52	9.69
		2835			3.02	3.22	9.52	9.69
		2840			3.02	3.22	9.52	9.69
		2845			3.02	3.22	9.52	9.69
		2908			106.74	141.28	690.85	700.71
		3005						0.01
		3006						0.00
		3010						0.00
		3027					0.00	0.00
		3035					0.00	0.00
		3344					0.01	0.00
		3350					0.01	0.00
		3356						0.00
		3358					0.00	0.00
		3365				0.00	0.00	0.00
		3366			0.01	0.00	0.03	0.03
		3367						0.00
		3368					0.00	0.00
		3369					0.01	0.01
		3370						0.01
		3376				0.00	0.02	0.01
		3377			0.00	0.00	0.01	0.01
		3378				0.00	0.01	0.01
		3379					0.00	0.00
		3406						0.19
		3407					0.00	0.01
		3410					0.00	
		3412					0.00	
		3414			46.14	46.31	188.95	189.15
		3430					0.00	0.01
		3521					0.01	0.01
		3534						0.00
		3536					0.00	0.00
		3538			1.95	1.95	16.80	16.96
		3543			2.74	2.74	13.76	13.77
		3546					0.00	0.00
		3602	2.26	2.15	22.99	22.31	45.15	45.70
		3800						0.01
		3815					0.00	

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	OUTFLOW	3819					0.10	0.07
		3845					0.05	0.06
		3860						0.03
		3885					0.07	0.07
		3920						0.00
		3940					0.02	
		3945						0.00
		3948					0.01	0.01
		3949			0.00	0.00	0.01	0.01
		3950					0.01	0.00
		3976			0.01	0.01	0.05	0.03
		3977						0.01
		3980					0.02	
		3990			0.01	0.01	0.02	0.03
		3992						0.00
		3993						0.00
		5006						0.00
		5216						0.04
		5217			0.04			
		5218			0.04	0.04		0.04
		5219				0.02	0.04	0.02
		5545					0.00	0.01
		5550					0.05	0.05
		5555					0.00	0.00
		5560					0.00	0.00
		5645					0.01	0.01
		7002			6.73	6.89	23.40	23.60
		7012	0.03	0.03	0.40	0.40	1.18	1.18
		7032			39.00	39.00	126.10	126.10
		7042	22.33	30.51	59.94	59.93	141.90	141.90
		7047	0.26	0.38	13.53	13.89	41.67	41.93
		10041					0.53	0.54
		10205			3.22	3.21	9.59	9.56
		10321	0.00		2.52	2.51	7.47	7.44
		10322			2.59	2.59	7.83	7.86
		10401			0.02	0.03	3.23	3.25
		10402			0.02	0.03	3.23	3.25
		10403			0.02	0.03	3.23	3.25
		10522			0.81	0.81	3.52	3.54
		10562			1.31	1.31	4.03	4.02
		10681			2.40	2.26	6.78	6.82
		10761			2.02	2.03	5.98	5.95
		10821	0.78	0.77	5.20	5.19	12.27	12.27
		10861	0.05	0.05	1.76	1.76	4.34	4.34
		10901			2.28	2.27	5.72	5.71
		12201			0.01	0.03	0.00	
		12301					0.20	0.58
		12304					0.12	0.26
		16021			5.76	5.76	13.92	13.89

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	OUTFLOW	16181			0.79	0.80	4.57	4.62
		16182			0.79	0.80	4.57	4.62
		16361			0.56	0.57	1.96	1.94
		16401	0.10	0.12	3.57	3.58	8.89	8.96
		16445			3.48	3.66	8.40	8.53
		16446			3.48	3.66	8.40	8.53
		16481			2.02	1.84	6.14	5.95
		16482			2.02	1.84	6.14	5.95
		16513						0.00
		16561	1.57	1.54	8.79	8.80	20.31	20.27
		16562	1.57	1.54	8.79	8.80	20.31	20.27
		16761	0.03	0.03	3.18	3.18	9.57	9.58
		16762	0.03	0.03	3.18	3.18	9.57	9.58
		16821			1.03	1.05	4.29	4.29
		16822			1.03	1.05	4.29	4.29
		16823			1.03	1.05	4.29	4.29
		16824			1.03	1.05	4.29	4.29
		16825			1.03	1.05	4.29	4.29
		16881			3.82	3.85	8.19	8.40
		16882	0.01	0.02	2.93	2.87	7.38	7.21
		16883	0.01	0.02	3.34	3.39	8.09	8.30
		16900					0.01	0.00
		17786		0.00		0.00		0.00
		25250					0.03	0.04
		25251					0.09	0.19
		25701						0.73
		33332					0.01	0.01
		33333					0.00	0.01
		33334					0.01	0.01
		33335					0.02	0.01
		33336					0.02	0.02
		33337					0.04	0.04
		33338					0.30	0.33
		33339					0.01	0.01
		33442					0.01	0.01
		33462						0.04
		33463					0.04	0.01
		33464					0.00	0.01
		33465					0.02	
		33561						0.00
		33562					0.01	0.01
		33571					0.01	0.01
		33572					0.01	0.00
		33743						0.00
		35013					0.01	0.01
		35014					0.01	0.01
		35015					0.01	0.01
		35016					0.00	
		35022					0.01	0.01

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	OUTFLOW	35023					0.00	
		35024					0.00	
		35441					0.01	0.00
		36021	2.26	2.15	22.99	22.31	45.15	45.70
		36022	2.26	2.15	22.99	22.31	45.15	45.70
		36023	2.26	2.15	22.99	22.31	45.15	45.70
		36551					0.00	0.01
		36552					0.88	0.91
		36553					0.78	0.85
		36554					0.00	
		36561					0.00	0.00
		36562					0.00	0.00
		36563						0.02
		36564					0.01	0.00
		36703					0.06	0.08
		36705					9.03	8.58
		37008					0.00	0.00
		37772					0.01	0.01
		37773					0.00	0.03
		37774					0.04	0.01
		37776					0.05	0.04
		37777					0.07	0.09
		38001						0.01
		38601					0.02	
		38604						0.02
		38605					0.02	0.02
		38606					0.02	0.02
		38880					0.01	0.01
		38889					0.01	0.01
		38910						0.01
		38911					0.06	0.15
		38912						0.00
		38913					0.06	
		38914					0.05	0.05
		38915					0.05	0.06
		38953					0.06	
		39153						0.07
		39157					0.05	0.05
		39159					0.04	0.08
		39501						0.00
		39502					0.01	0.00
		39522				0.00	0.01	0.03
		39523					0.00	0.01
		39524			0.00	0.00	0.02	0.02
		39525				0.02	0.02	0.04
		39526			0.02	0.00	0.10	0.07
		39667						0.01
		39791						0.00
		39801					0.00	0.00

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
GD	OUTFLOW	39802						0.01
		350082						0.00
		377013					0.00	0.00
	OUTFLOW Total		2,740.40	2,743.38	4,039.23	4,051.17	6,652.07	6,702.15
GD Total			5,565.72	5,566.54	8,299.83	8,312.48	13,559.51	13,610.57
SO	INFLOW	8015	32.39	32.39	34.90	34.90	40.14	40.14
		8075	66.41	66.41	69.76	69.76	76.77	76.77
		8205	296.37	295.82	580.93	580.93	1,144.97	1,144.97
	INFLOW Total		395.17	394.61	685.59	685.59	1,261.88	1,261.88
	OUTFLOW	2780	399.03	398.93	445.73	444.82	459.95	458.88
		8100			0.01		0.01	0.01
		8207			243.30	243.87	805.43	806.77
	OUTFLOW Total		399.03	398.93	689.04	688.69	1,265.39	1,265.66
SO Total			794.20	793.54	1,374.63	1,374.28	2,527.26	2,527.53
WW	INFLOW	3086	0.29	0.29	0.36	0.36	0.51	0.51
		4046	0.41	0.40	1.28	1.28	3.01	3.01
		4050	0.86	0.86	0.91	0.91	1.01	1.01
		4086	0.23	0.23	0.63	0.63	1.40	1.40
		4105	0.03	0.03	0.04	0.04	0.04	0.04
		4106	2.64	2.64	4.06	4.06	6.88	6.88
		4130	0.03	0.03	0.03	0.03	0.03	0.03
		4131	6.07	6.06	11.14	11.14	21.07	21.07
		4145	12.01	12.01	12.72	12.72	14.21	14.21
		4170	4.61	4.61	5.18	5.18	6.39	6.39
		4175	0.04	0.04	0.04	0.04	0.05	0.05
		4220	0.77	0.77	0.86	0.86	1.04	1.04
		4270	28.70	28.70	30.80	30.80	35.15	35.15
		4271	30.92	30.92	32.01	32.01	34.28	34.28
		4319	0.97	0.96	2.02	2.02	4.01	4.01
		4322	0.45	0.45	0.53	0.53	0.68	0.68
		4326	0.65	0.65	0.77	0.77	1.03	1.03
		4327	24.04	23.98	43.18	43.18	79.50	79.50
		4331	0.06	0.06	0.08	0.08	0.13	0.13
		4332	0.71	0.71	0.86	0.86	1.17	1.17
		4333	0.20	0.20	0.25	0.25	0.36	0.36
		4341	0.97	0.97	2.32	2.32	4.96	4.96
		4361	10.59	10.56	18.39	18.39	33.51	33.51
		4363	0.29	0.29	0.75	0.75	1.64	1.64
		4365	0.17	0.17	0.21	0.21	0.28	0.28
		4371	4.96	4.94	10.44	10.44	21.21	21.21
		4374	3.13	3.13	4.20	4.20	6.34	6.34
		4386	4.30	4.29	9.68	9.68	20.11	20.11
		4389	1.17	1.17	1.48	1.48	2.11	2.11
		4411	0.15	0.15	0.47	0.47	1.08	1.08
		4421	0.26	0.26	0.79	0.79	1.84	1.84
		4423	0.71	0.71	0.77	0.77	0.89	0.89
		4431	1.50	1.49	3.23	3.23	6.61	6.61
		4435	0.50	0.50	0.54	0.54	0.60	0.60
		4436	2.15	2.15	2.25	2.25	2.45	2.45

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
WW	INFLOW	4437	0.47	0.47	0.79	0.79	1.40	1.40
		4450	4.54	4.54	5.04	5.04	6.08	6.08
		4451	0.14	0.14	0.17	0.17	0.24	0.24
		4461	7.65	7.65	9.07	9.07	12.01	12.01
		4470	0.20	0.20	0.22	0.22	0.28	0.28
		4473	0.50	0.50	0.67	0.67	1.02	1.02
		4476	2.52	2.52	2.86	2.86	3.58	3.58
		4480	0.75	0.75	0.84	0.84	1.03	1.03
		4501	11.97	11.97	13.11	13.11	15.50	15.50
		4506	1.53	1.52	2.97	2.97	5.73	5.73
		4508	0.63	0.63	1.51	1.51	3.19	3.19
		4511	0.83	0.82	1.87	1.87	3.86	3.86
		4513	0.70	0.70	1.67	1.67	3.53	3.53
		4521	0.83	0.82	2.06	2.06	4.47	4.47
		4526	0.34	0.34	0.71	0.71	1.41	1.41
		4530	0.90	0.90	1.06	1.06	1.39	1.39
		4531	1.93	1.93	4.02	4.02	8.03	8.03
		4535	1.16	1.16	1.35	1.35	1.74	1.74
		4541	0.29	0.29	0.75	0.75	1.64	1.64
		4545	5.24	5.24	5.96	5.96	7.45	7.45
		4560	2.20	2.20	2.42	2.42	2.87	2.87
		4565	1.50	1.50	1.61	1.61	1.83	1.83
		4568	8.21	8.21	10.00	10.00	13.73	13.73
		4575	0.19	0.19	0.20	0.20	0.24	0.24
		4576	15.51	15.51	18.07	18.07	23.43	23.43
		4580	1.25	1.25	1.35	1.35	1.55	1.55
		4585	2.26	2.26	2.47	2.47	2.91	2.91
		4600	21.18	21.18	21.96	21.96	23.58	23.58
		4601	12.45	12.45	14.60	14.60	19.09	19.09
		4616	7.00	7.00	8.26	8.26	10.89	10.89
		4618	3.51	3.51	3.98	3.98	4.97	4.97
		4620	0.23	0.23	0.25	0.25	0.29	0.29
		4631	8.96	8.96	10.35	10.35	13.26	13.26
		4650	0.08	0.08	0.11	0.11	0.19	0.19
		4672	1.25	1.25	1.43	1.43	1.81	1.81
		4676	0.22	0.22	0.24	0.24	0.27	0.27
		4680	0.11	0.11	0.15	0.15	0.22	0.22
		4685	0.29	0.29	0.34	0.34	0.44	0.44
		4695	2.98	2.98	3.62	3.62	4.96	4.96
		4700	0.04	0.04	0.05	0.05	0.07	0.07
		4706	0.12	0.12	0.14	0.14	0.17	0.17
		4708	0.14	0.14	0.15	0.15	0.17	0.17
		4710	7.33	7.33	7.90	7.90	9.09	9.09
		4711	0.19	0.19	0.20	0.20	0.24	0.24
		4713	0.38	0.38	0.44	0.44	0.58	0.58
		4715	0.46	0.46	0.54	0.54	0.71	0.71
		4717	0.05	0.05	0.06	0.06	0.09	0.09
		4755	0.50	0.50	0.55	0.55	0.65	0.65
		4775	2.27	2.27	2.41	2.41	2.70	2.70

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
WW	INFLOW	4820	0.21	0.21	0.25	0.25	0.33	0.33
		4857	1.66	1.66	1.84	1.84	2.23	2.23
		4955	0.11	0.11	0.12	0.12	0.13	0.13
		4975	0.59	0.59	0.61	0.61	0.65	0.65
		4985	7.41	7.41	7.69	7.69	8.26	8.26
		4990	12.18	12.18	12.41	12.41	12.90	12.90
		4991	19.90	19.90	20.99	20.99	23.26	23.26
		7760	0.95	0.95	1.01	1.01	1.14	1.14
		7765	2.05	2.05	2.31	2.31	2.85	2.85
		7800	44.69	44.69	45.96	45.96	48.62	48.62
		7955	17.12	17.12	18.19	18.19	20.43	20.43
		9012	2.60	2.60	3.88	3.88	6.56	6.56
		9020	19.81	19.81	22.38	22.38	27.75	27.75
		9040	25.12	25.12	26.58	26.58	29.64	29.64
		9045	1.12	1.12	1.46	1.46	2.17	2.17
		9080	19.80	19.80	21.74	21.74	25.78	25.78
		9205	0.31	0.31	0.38	0.38	0.51	0.51
		9206	2.47	2.46	5.03	5.03	10.07	10.07
		9210	0.37	0.37	0.44	0.44	0.56	0.56
		9225	1.64	1.64	1.94	1.94	2.57	2.57
		9230	0.47	0.47	0.56	0.56	0.74	0.74
		9235	0.22	0.22	0.26	0.26	0.35	0.35
		9236	1.22	1.22	2.24	2.24	4.29	4.29
		9241	15.95	15.94	23.88	23.88	39.76	39.76
		9245	1.25	1.25	1.54	1.54	2.14	2.14
		9325	0.04	0.04	0.05	0.05	0.07	0.07
		9341	0.35	0.35	0.94	0.94	2.07	2.07
	INFLOW Total		489.16	488.95	598.49	598.49	816.04	816.04
	OUTFLOW	3085	339.29	339.20	366.45	366.30	413.19	414.02
		3160	108.15	108.10	117.29	117.32	131.88	132.04
		4047	0.03	0.02	0.89	0.89	2.61	2.61
		4099			4.15	3.70	23.44	28.00
		4132	0.23	0.23	3.60	3.60	8.05	7.97
		4273	24.04	24.04	24.04	24.04	24.04	24.04
		4318	0.41	0.40	1.47	1.23	3.86	3.45
		4328	8.56	8.53	27.41	27.42	62.21	62.73
		4342	0.22	0.22	1.31	1.61	2.23	4.36
		4364	2.81	2.79	9.26	9.22	20.04	20.71
		4366	0.01	0.01	1.21	1.24	5.30	4.78
		4372	0.48	0.51	5.69	5.69	16.37	16.42
		4386						0.29
		4411					0.17	0.18
		4412			0.29	0.29	0.72	0.71
		4421					0.25	0.25
		4422	0.01	0.01	0.53	0.53	1.31	1.32
		4432	0.33	0.33	2.10	2.10	4.25	5.08
		4438	0.00	0.00	0.32	0.25	0.60	0.62
		4452					0.01	0.02
		4462	0.39	0.39	1.21	1.21	3.27	3.32

Sum of Vol_MG			Event SWMM					
			01MD		01YH		10YH	
Model	In/Out	Nodes	44GU	RPO	44GU	RPO	44GU	RPO
WW	OUTFLOW	4474	0.00	0.00	0.08	0.09	0.29	0.30
		4478			0.02	0.02	0.31	0.31
		4509	0.23	0.23	0.83	1.25	1.07	2.95
		4514	0.14	0.15	1.16	1.16	2.96	2.97
		4532	0.59	0.58	2.73	2.73	6.74	6.74
		4541						0.02
		4542	0.05	0.05	0.53	0.54	1.41	1.40
		4569	0.05	0.05	0.92	0.94	3.23	3.37
		4577	0.36	0.36	1.73	1.75	5.36	5.44
		4602	1.20	1.20	3.05	3.05	7.43	7.44
		4617			0.05	0.05	0.92	0.89
		4619	0.70	0.70	1.87	1.88	4.43	4.47
		4632	0.51	0.51	1.38	1.38	4.25	4.23
		4716					0.06	0.06
		7499			3.17	3.30	7.48	9.25
		7660						0.25
		7720						0.04
		9207	0.31	0.31	2.82	2.82	8.11	5.23
		9234			8.00	8.17	25.14	25.91
		41322			1.31	1.31	6.20	6.28
	OUTFLOW Total		489.10	488.92	596.85	597.09	809.22	820.48
WW Total			978.26	977.86	1,195.34	1,195.58	1,625.26	1,636.52

Appendix C Comparison of EXTRAN Results

Appendix D Contents of Computer Compact Disc (CD)

Folder	Description of content
GD313(RPO)	GDRSS/WWMP Event Model 2001 Update (version 3.13), input and output files
GD313(44G)	GDRSS/WWMP Event Model 2001 Update (version 3.13-44), input and output files
SWMM	Copy of the SWMM 4.4GU executable file and associated documentation