Capitol Region Watershed District

Development Impact Analysis

November 23, 2004

Prepared by: EOR

Summary Memorandum

Date: **November 23, 2004**

To: **CRWD Board of Managers and Staff**

From: **Pat Conrad and Sheila Sahu - EOR**

Re: **Development Impact Analysis, Final**

Enc: **Development Impact Analysis Location Map**
Table 1 – Peak Flow Rate Analysis Summary
Table 2 – Volume Control Analysis Summary
Table 4 – Development Impact Analysis Results
Capitol Region Watershed District Development Review Framework
Detailed Model Output

Background

EOR has completed the Development Impact Analysis. As you may recall, this is the second phase of the project, the first phase being the large table evaluating each of the development reviews conducted during 2003. The purpose of the second phase of the project was to perform a more detailed analysis on specific developments within the District and to evaluate the potential impact continued development would have on the District's resources.

Update

At this time, EOR has conducted a detailed analysis of seven representative developments within the District to illustrate their impact. The developments were chosen to represent various land use development scenarios and include Karges-Faulconbridge, Larpenteur and Snelling, Montana Woods, Insurance Auto Auctions, Larpenteur and Adolphus, Gateway Village and Arbor Pointe. (See enclosed map.) A summary of the developments' performance in meeting the District's review criteria is shown in Table 1-3. Table 4 is a compilation of all of the analysis results.

In addition to this development review summary, an impact analysis has been performed. The impact analysis examines the existing land use distribution within the Watershed District and attempts to evaluate the effect of future development. Specifically, the following tasks were performed.

Peak Flow Rate Analysis (see Table 1)

The analysis conducted for rate control was based on the information gathered from past development reviews and is as follows:

Based on the rate control calculations for the 5-yr storm event, the peak discharge rate from a developed 10-acre site would be 0.50 cfs greater than existing conditions, corresponding to an average percent increase of 13.2%. For the 100-yr storm event, the peak discharge rate for a developed 10-acre site would be 4.5 cfs greater than existing conditions, corresponding to an average percent increase of 28.7%.

The following example illustrates the impact of the peak discharge increase:

As was stated above, the peak discharge increase from a 10-acre site for the 100-yr storm event is 4.5 cfs greater than predevelopment conditions. This is the approximate difference in capacity between a 12-inch outlet pipe at 2.5% slope and a 15-inch pipe at 2.5% slope. Therefore, if a 12-inch pipe was currently receiving the peak discharge from a 10-acre site and was at capacity in existing conditions, it would have to be replaced by a 15-inch pipe to accommodate the increase in peak discharge for the 100-yr storm event.

Volume Control Analysis (See Table 2)

The volume control analysis was conducted based on the findings of the development review evaluation and through use of the predicted development patterns generated by the Water Quality Analysis described above.

Based on the calculations for volume control, a future 10-acre site would produce 0.10 ac-ft and 0.20 ac-ft more volume than existing conditions for the 5- and 100-yr storm events, respectively. These volumes correspond to a percent increase from existing conditions of 24.2% and 13.7% for the 5- and 100-yr storm events, respectively.

Water Quality Analysis (see Table 3 below)

1. The first step in the analysis was to predict the amount and type of development that will occur over the next 20 years. To do this, we examined the trends in development we have seen over the past year. We also discussed our assumptions with St. Paul and Met Council planners. These assumptions were then applied to each existing land use classification to develop a "future land use" distribution and are as follows:

   Existing Commercial Land will be redeveloped at a rate of 0.3% per year of which 25% will be converted to High Density Residential. Redeveloped Commercial is assumed to provide 10% reduction in P loads through use of BMPs.

   Existing Industrial Land will be redeveloped at a rate of 0.3% per year of which 25% will be converted to High Density Residential. Redeveloped Industrial is assumed to provide 10% reduction in P loads through use of BMPs.

   Existing Institutional Land will be redeveloped at a rate of 0.3% per year and the redevelopment will provide 25% reduction in P loads.

   Existing Park & Open Space will be redeveloped slightly - no change in acreage but a 5% increase in impervious surface is assumed in the model to account for paths, buildings and parking lots.

   Existing High Density Residential will be redeveloped at a rate of 0.2% per year. Re-developed High Density Residential land is assumed to result in a 25% increase in impervious surface.

Existing Low Density Residential will be redeveloped at a rate of 2% per year of which 15% will be converted to Commercial land use and 35% will be converted to High Density Residential land use. Re-developed Low Density Residential is assumed to result in a 15% increase in impervious surface.

Existing Undeveloped areas will be developed at a rate of 7.5% per year of which 15% will become Commercial, 50% High Density Residential, and 35% Low Density Residential.

Land uses classified as Water or Roadway are assumed to stay constant.

2. A PLoad Watershed Loading Model was constructed to simulate the existing conditions within the Watershed District. The model was calibrated to the output from the District's P8 Water Quality model developed specifically for the Como Lake Subwatershed.

3. The future land use distribution predicted for the District as described above was modeled using the calibrated PLoad Model to predict the change in phosphorus loads. **A 9% overall increase in phosphorus loading is predicted for the Watershed District and a 7% increase in phosphorus loading is predicted for Como Lake.**

4. A WiLMS Lake Model was constructed to evaluate the effect of the increased phosphorus load on the quality of Como Lake. **The model predicts a 4% increase for in-lake phosphorus concentrations.**

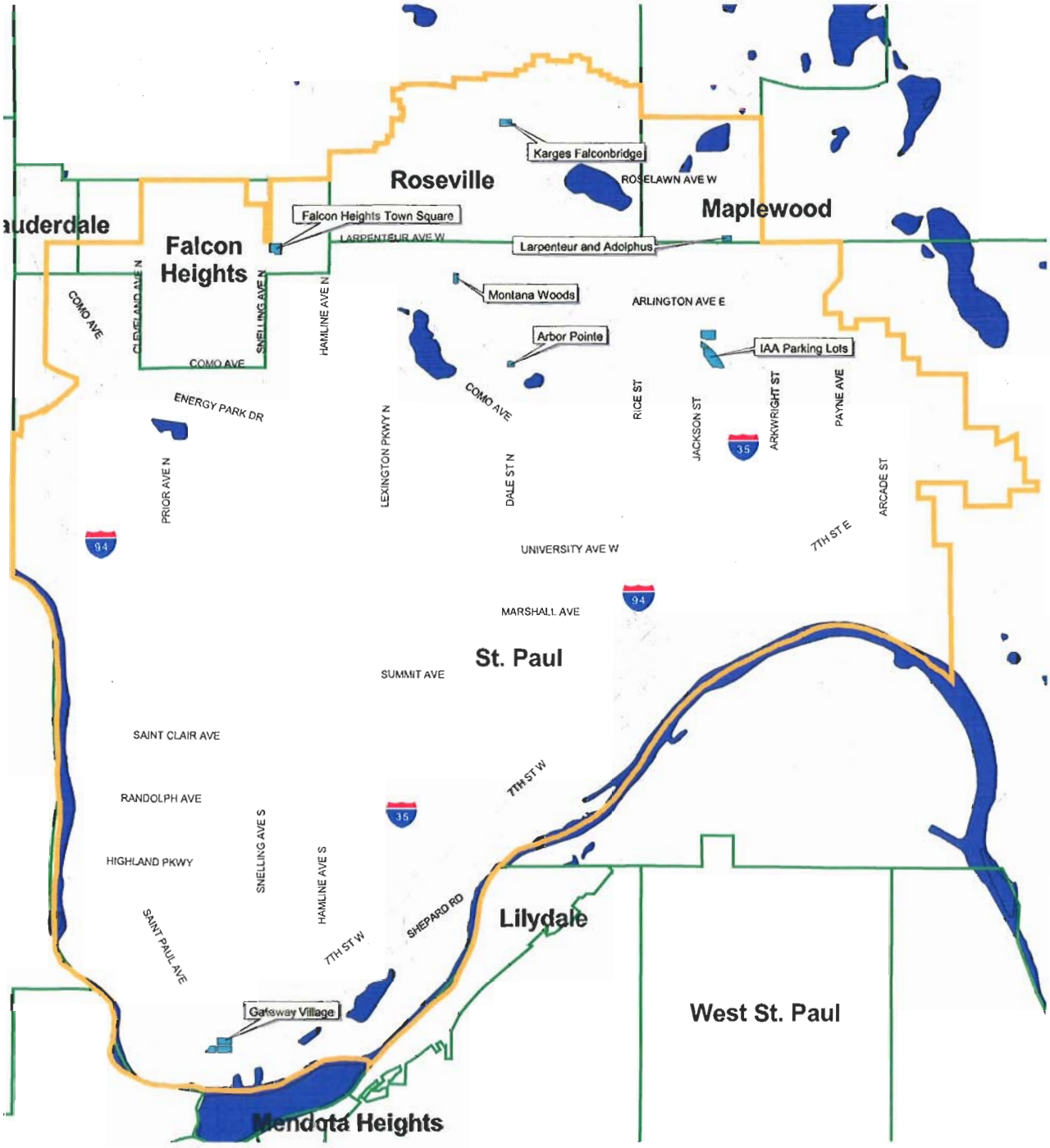
Table 3 Landuse	Existing Acres	Development Rate	Future Acres 20 years	Existing P Load lbs	Future P Load lbs	Net Change
Commercial	1431	0.3%	1673	865	991	15%
Industrial	1268	0.3%	1249	681	668	-2%
Parks & Open Space	5219	0%	5219	1022	1271	24%
Residential High Density	1243	0.2%	2114	621	1161	87%
Residential Low Density	7929	0.2%	8274	3089	3256	5%
Undeveloped	1439	7.5%	0	54	0	-100%
Water	680	0.0%	680	12	12	0%
Roadway	6769	0.0%	6769	4765	4765	0%
Total	25979		25979	**11109**	**12124**	**9%**

Conclusions

This analysis was conducted in order to establish a conservative estimate of the potential impact to District resources from development/redevelopment over the next 20 years.

Future water quality and stormwater management conditions will decline compared to existing conditions with current development scheme that exists within the district. Peak rate and total volume will **increase**, and phosphorus loading with **increase.** The District's goal for improving conditions within the Watershed by requiring a **decrease** in rate and volume, as well as a 60% **reduction** in phosphorus loads to Como Lake is clearly not being met. (See CRWD Development Review Framework)

Capitol Region Watershed District



LEGEND

Impact Analysis Sites

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EOR Emmons & Olivier Resources

Capitol Region Watershed District

Table 1 -- Development Impact Analysis
Peak Flow Rate Analysis Summary

NAME AND TYPE OF DEVELOPMENT	DEVELOPED AREA	RAINFALL EVENT	RATE CONTROL				
	Acres		Existing (cfs)	Developed (cfs)	Net Change (Dev- Ex) (cfs)	Net Change/Area (cfs/ac)	Percent Increase (Net Change/Ex) (%)
Karges- Faulconbridge Redevelopment Renovation of Festival Foods store	3.54	5-yr	6.09	7.04	0.95	0.27	15.6
		100-yr	14.8	21.8	7.00	1.98	47.3
Larpenteur and Snelling (Falcon Heights Town Square) Redevelopment project to include residential and commercial	4.91	5-yr	22.1	17.4	-4.70	-0.96	-21.3
		100-yr	36.4	31.4	-5.00	-1.02	-13.7
Montana Woods 10-lot single-family residential subdivision	1.95	5-yr	2.68	3.21	0.53	0.27	19.8
		100-yr	7.49	8.26	0.77	0.39	10.3
Insurance Auto Auctions Parking lot improvements for two sites- 1336 Jackson Street and 1280 Jackson Street	7.03	5-yr	5.75	7.64	1.89	0.27	32.9
		100-yr	9.89	28.8	18.9	2.69	191.1
Larpenteur and Adolphus Redevelopment project involving converting existing lots into townhomes	1.67	5-yr	1.78	2.99	1.21	0.72	68.0
		100-yr	5.26	7.56	2.30	1.38	43.7
Gateway Village Redevelopment project including 4 condominium/apartment buildings and a clubhouse	15.3	5-yr	28.0	27.7	-0.30	-0.02	-1.1
		100-yr	60.4	52.3	-8.10	-0.53	-13.4
Arbor Pointe Development Senior housing development with parking, and stormwater management facilities	1.45	5-yr	1.50	1.18	-0.32	-0.22	-21.3
		100-yr	3.91	1.40	-2.51	-1.73	-64.2
TOTAL	29.27				**TOTAL 5-yr**	0.34	92.6
					TOTAL 100-yr	3.16	201.1
					AVERAGE 5-yr	0.05	13.22
					AVERAGE 100-yr	0.45	28.7

Note: Earlier versions of this study included a comparison to St. Paul's 1.64 cfs/acre standard. This comparison was removed because it doesn't apply to other cities and the implementation of the standard is not applicable to CRWD's rate control criteria.

Development Table 2 -- Impact Analysis
Volume Control Analysis Summary

NAME AND TYPE OF DEVELOPMENT	DEVELOPED AREA	RAINFALL EVENT	VOLUME CONTROL				
	Acres		Existing (ac-ft)	Developed (ac-ft)	Net Change (Dev- Ex) (ac-ft)	Net Change/Area (ac-ft/ac)	Percent Increase (Net Change/Ex) (%)
Karges- Faulconbridge Redevelopment Renovation of Festival Foods store	3.54	5-yr	0.80	0.54	-0.26	-0.073	-32.5
		100-yr	1.46	1.16	-0.30	-0.085	-20.5
Larpenteur and Snelling (Falcon Heights Town Square) Redevelopment project to include residential and commercial	4.91	5-yr	1.38	1.00	-0.38	-0.077	-27.5
		100-yr	2.32	1.86	-0.46	-0.094	-19.8
Montana Woods 10-lot single-family residential subdivision	1.95	5-yr	0.16	0.17	0.01	0.005	6.3
		100-yr	0.41	0.47	0.06	0.031	14.6
Insurance Auto Auctions Parking lot improvements for two sites- 1336 Jackson Street and 1280 Jackson Street	7.03	5-yr	1.21	1.19	-0.02	-0.003	-1.7
		100-yr	2.50	2.48	-0.02	-0.003	-0.8
Larpenteur and Adolphus Redevelopment project involving converting existing lots into townhomes	1.67	5-yr	0.13	0.16	0.03	0.018	23.1
		100-yr	0.34	0.40	0.06	0.036	17.6
Gateway Village Redevelopment project including 4 condominium/apartment buildings and a clubhouse	15.3	5-yr	2.00	3.18	1.18	0.077	59.0
		100-yr	4.40	5.78	1.38	0.090	31.4
Arbor Pointe Development Senior housing development with parking, and stormwater management facilities	1.45	5-yr	0.10	0.25	0.15	0.101	142.7
		100-yr	0.30	0.52	0.22	0.152	73.3
TOTAL	29.27				**TOTAL 5-yr**	0.05	169.36
					TOTAL 100-yr	0.13	95.80
					AVERAGE 5-yr	0.01	24.2
					AVERAGE 100-yr	0.02	13.7

Table 4 -- Development Impact Analysis, Full Results

REVIEW CRITERIA																
						RATE CONTROL			WATER QUALITY			VOLUME CONTROL				
NAME AND TYPE OF DEVELOPMENT	**PERMIT NUMBER**	**LAND USE**	**SUBWATERSHED**	**DEVELOPED AREA**	**RAINFALL EVENT**	*Peak discharge rates must be at or below existing for 2, 5, 10, and 100-yr, 24-hour storm events.*			*Incorporate non-point source pollution reduction BMP's to achieve 60% annual phosphorus reduction, 90% sediment removal, and 95% heavy*			*Volume of water produced from the site must be equivalent to existing level of impervious or 25% impervious, whichever is less*				**Notes**
				Acres		Existing (cfs)	Developed (cfs)	Net Change (Dev- Pre) (cfs)	Existing (lbs/yr)	Developed (lbs/yr)	Goal to Lake (lbs/yr)	Existing (ac-ft)	Developed (ac-ft)	Net Change (Dev- Ex) (ac-ft)	Meeting Criteria (ac-ft)	
Karges- Faulconbridge Redevelopment Renovation of Festival Foods store	03-RV-002	Commercial	McCarrons Lake	3.54	2-yr (2.8")	5.66	3.52	-2.14	5.96	1.79	2.38	0.58	0.34	-0.24	0.18	Cecilio has observed the raingarden is not being built correctly (soils compacted, no vegetation
					5-yr (3.6")	6.09	7.04	0.95				0.80	0.54	-0.26	0.32	
					10-yr (4.2")	6.43	9.63	3.20				0.98	0.69	-0.29	0.42	
					100-yr (5.9")	14.8	21.8	7.00				1.46	1.16	-0.30	0.80	
Larpenteur and Snelling (Falcon Heights Town Square) Redevelopment project to include residential and commercial development	03-FH-007	Mixed Use	Como Lake	4.91	2-yr (2.8")	17.1	12.7	-4.40	9.72	7.72	3.89	1.05	0.71	-0.34	0.26	
					5-yr (3.6")	22.1	17.4	-4.70				1.38	1.00	-0.38	0.59	
					10-yr (4.2")	25.8	21.0	-4.80				1.62	1.22	-0.40	0.78	
					100-yr (5.9")	36.4	31.4	-5.00				2.32	1.86	-0.46	1.35	
Montana Woods 10-lot single-family residential subdivision	03-SP-009	Single Family Residential	Como Lake	1.95	2-yr (2.8")	1.33	1.48	0.15	0.71	0.74	0.28	0.09	0.10	0.01	0.09	
					5-yr (3.6")	2.68	3.21	0.53				0.16	0.17	0.01	0.16	
					10-yr (4.2")	3.82	4.19	0.37				0.22	0.25	0.03	0.22	
					100-yr (5.9")	7.49	8.26	0.77				0.41	0.47	0.06	0.41	
Insurance Auto Auctions Parking lot improvements for 1280 Jackson Street	03-SP-010	Commercial	Trout Brook	7.03 (2.96 ac disturbed)	2-yr (2.8")	4.83	5.80	0.97	13.7	6.09	5.48	0.86	0.84	-0.02	0.52	Calculations based on 7.03- acre drainage area to pond
					5-yr (3.5")	5.75	7.64	1.89				1.21	1.19	-0.02	0.80	
					10-yr (4.2")	6.60	11.4	4.83				1.58	1.56	-0.02	1.11	
					100-yr (5.9")	9.89	28.8	18.9				2.50	2.48	-0.02	1.93	
Larpenteur and Adolphus Redevelopment project involving converting existing lots into townhomes	03-MW-012	Residential	Trout Brook	1.67	2-yr (2.8")	0.83	1.63	0.80	0.57	0.62	0.23	0.07	0.09	0.02	0.07	
					5-yr (3.6")	1.78	2.99	1.21				0.13	0.16	0.03	0.13	
					10-yr (4.2")	2.61	4.11	1.50				0.18	0.22	0.04	0.18	
					100-yr (5.9")	5.26	7.56	2.30				0.34	0.40	0.06	0.34	
Gateway Village Redevelopment project including 4 condominium/apartment buildings and a clubhouse	03-SP-015	Multi-Family Residential	Mississippi River	15.3	2-yr (2.8")	16.6	17.9	1.30	8.33	8.67	3.33	1.19	2.19	1.00	0.94	Calculations based on full drainage area
					5-yr (3.6")	28.0	27.7	-0.30				2.00	3.18	1.18	1.59	
					10-yr (4.2")	37.6	35.6	-2.00				2.69	3.97	1.28	2.13	
					100-yr (5.9")	60.4	52.3	-8.10				4.40	5.78	1.38	3.83	
Arbor Pointe Development Senior housing development with parking, and stormwater management facilities	03-SP-016	Public	Trout Brook	1.45	2-yr (2.8")	0.73	1.12	0.39	0.02	1.68	0.008	0.06	0.18	0.12	0.06	
					5-yr (3.5")	1.50	1.18	-0.32				0.10	0.25	0.15	0.10	
					10-yr (4.2")	2.31	1.25	-1.06				0.15	0.33	0.18	0.15	
					100-yr (5.9")	3.91	1.40	-2.51				0.30	0.52	0.22	0.30	

Capitol Region Watershed District

"Our mission is to protect, manage and improve the water resources of the Capitol Region Watershed District"

Capitol Region Watershed District Development Review Framework (Adopted 09/05/02)

The following is the framework to be used in reviewing development and redevelopment projects in the District. The framework is organized by general watershed management issues. The Watershed District's policy statement from the Watershed Management Plan is provided as the basis for review. The standard that is provided is an interim standard that will meet the intent of the District's goals, while being rooted in science. These standards give the Watershed District a numerical base for review development and redevelopment plans.

Rate Control

Policy Statements

Reduce runoff rates to levels that allow for stable conveyance of flow throughout the water resources of the District. (WMP page 14)

Require rate control practices on all new development and redevelopment to preserve runoff rates at a level that will not cause the degradation of water resources. (WMP page 14)

Development Review Criteria

Peak discharge rates for developments must be at or below existing rates for the 2, 5, 10, and 100 year storm events.

Volume Control & Infiltration

Policy Statements

Limiting runoff volumes by utilizing site designs that limit impervious or incorporating volume control practices such as infiltration practices is strongly encouraged by the District. (WMP page 150)

Include analysis of infiltration and groundwater recharge potential in all stormwater BMP implementation or retrofitting activities. (WMP page 208)

Minimize connectivity of impervious surfaces to the stormwater system. (WMP page 221)

Development Review Criteria

All land development and redevelopment activities must create stormwater volumes less than or equivalent to the volume of water produced from the site at existing level of impervious or 25% impervious whichever is less. This analysis is to be based on existing soils and geology. Refer to the Met Council Small Site BMP Manual for volume control BMPs such as the use of vegetated swales and redirecting impervious areas onto pervious areas.

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District Staff: Mark Doneux, District Coordinator; Debbie Anderson, Administrative Assistant, Bob Fossum, Water Resource Specialist
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Water Quality

Policy Statements

Interim standard is NURP criteria for ponding or equivalent level of treatment. (WMP page 150)
Require the use of effective nonpoint source pollution reduction BMPs in development projects. (WMP page 12)

Development Review Criteria

Development and redevelopment projects must incorporate effective non-point source pollution reduction BMPs. Effectiveness will be defined as meeting NURP criteria or achieving 60% annual phosphorus reduction, 90% sediment removal and 95% heavy metal removal. Met Council's Small Site BMP Manual can be referred to for selecting and designing alternative BMPs.

Flooding

Policy Statements

Water quantity controls must be provided to ensure no net increase in the impacts or potential for flooding on or off the site and, where possible, address existing flooding problems. (WMP page 150)
Preserve existing flood levels on District water bodies, excluding the Mississippi River, at or below the 100 year flood elevations. (WMP page 13)
Restrict the construction of structures within the 100 year flood elevation of any water body, excluding the Mississippi River, within the District. (WMP page 13)

Development Review Criteria

A proposed pond 100 year high water level can be above adjacent existing structure's lowest floor elevation as long as the structure is at least 100 feet horizontally away from the pond's 100 year flood extent.
A structure's lowest exposed wall elevation must be 2 feet above the 100 year high water level of adjacent ponds and water bodies.

Wetland Management

Policy Statements

Manage wetlands to achieve no-net loss of acreage and values and where possible, strive to enhance the functions and values of existing wetlands within the District. (WMP page 14)
Identify wetland restoration and creation sites to enhance water quality and/or restore natural habitats. (WMP page 220)
Interact with cities in the administration of the Wetland Conservation Act if desired by the cities. (WMP page 224)

Development Review Criteria

In addition to the requirements of the Wetland Conservation Act, development and redevelopment activities within the watershed district shall not result in the net-loss of wetland acreages or functions and values. Proposed wetland alterations must be evaluated using the District's Modified MnRAM methodology and compared to the District's pre-development evaluation to determine the change in wetland functions and values.

Erosion Control

Policy Statements

Require adherence to the Ramsey County Erosion and Sediment Control Handbook for all construction sites within the District. (WMP page 12)

Development Review Criteria

Erosion and Sediment Control plans must be in adherence to the recommendations of the Ramsey County Erosion and Sediment Control Handbook.

Integrated Resource Management

Policy Statements

Apply Integrated Resource Management principles to redevelopment projects. (WMP page 219)

Development Review Criteria

All BMP designs should consider the use of Integrated Resource Management principles including the use of native planting and providing wildlife habitat features. All developments and redevelopments are encouraged to provide open spaces and native plantings in site design.

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District Wide PLoad Model

Landuse	Acres	Developmen Rate	20 Year
Commercial	1431.5	0.3%	85.9
Industrial	1268.1	0.3%	76.1
Institutional		0.3%	0.0
Parks & Oper	5219.1	0.0%	0.0
Residential H	1242.5	0.2%	49.7
Residential Lo	7928.7	0.2%	317.1
Undeveloped	1439.4	7.5%	*1439.0*
Water	680.208	0.0%	0.0
Roadway	6769	0.0%	0.0
Total	**25978.51**		

Existing Conditions

Land Use	acres	% impervious	TP EMC (mg/L)	RVU	Volume (ac-ft)	TP load (lbs)
Commercial	1431.5	85	0.280	0.815	1135.15	865
Industrial	1268.1	75	0.28	0.725	894.53	681
Institutional		25	0.28	0.275	0.00	0
Parks & Open Space	5219.1	15	0.4	0.185	939.47	1022
Residential High Density	1242.5	60	0.32	0.59	713.29	621
Residential Low Density	7928.7	30	0.46	0.32	2468.69	3089
Undeveloped	1439.4	5	0.15	0.095	133.05	54
Water	680.208	100	0.007	0.95	628.75	12
Roadway	6769	100	0.280	0.95	6256.93	4765
			Total Existing Phosphorus Load			**11109**

Future Conditions

	Land Use	acres	% impervious	TP EMC (mg/L)	RVU	Volume (ac-ft)	TP load (lbs)
Un-altered	Commercial	1345.6	85	0.280	0.815	1067.04	813
Un-altered	Industrial	1192.0	75	0.28	0.725	840.86	640
Un-altered	Institutional	0.0	25	0.28	0.275	0.00	0
Improved	Parks & Open Space	5219.1	20	0.4	0.23	1167.99	1271
Un-altered	Residential High Density	1192.8	60	0.32	0.59	684.76	596
Un-altered	Residential Low Density	7611.6	30	0.46	0.32	2369.94	2965
Un-altered	Undeveloped	0.0	0	0	0.05	0.00	0
Un-altered	Water	680.2	100	0.007	0.95	628.75	12
Un-altered	Roadway	6769.0	100	0.280	0.95	6256.93	4765
Redeveloped	Commercial*	327.8	85	0.252	0.815	259.97	178
Redeveloped	Industrial	57.1	75	0.252	0.725	40.25	28
Redeveloped	Institutional	0.0	25	0.3	0.275	0.00	0
Redeveloped	Residential High Density**	920.7	75	0.32	0.725	649.48	565
Redeveloped	Residential Low Density***	662.2	34.5	0.46	0.3605	232.29	291
				Total Future Phosphorus Load			**12124**

* Sum of redeveloped Commercial, 15% of the redeveloped Low Density Residential and 15% of the New Development
** Sum of the Redeveloped High Density Residential, 35% of the Redeveloped Low Density Residential and 50% of the New Development
*** Sum of 50% redeveloped Low Density Residential and 35% developed Undeveloped

Increase in Phosphorus 9%

Change in Model Parameter

Model Equations

RVU = 0.05 + (0.009 X Imperv)
Volume ac-ft = (PXPj X RVU X Acres)/12
P Load = Vol X P emc X 2.72

Precip (in/yr): 28.0
Pj: 0.42

Como Lake Subwatershed PLoad Model

Landuse	Acres	Development Rate	20 Year
Commercial	90.2	0.3%	5.4
Industrial	4.0	0.3%	0.2
Institutional		0.3%	0.0
Parks & Open Space	439.5	0.0%	0.0
Residential High Density	56.6	0.2%	2.3
Residential Low Density	763.5	0.2%	30.5
Undeveloped	42.9	7.5%	*42.9*
Water	71.562	0.0%	0.0
Roadway	300	0.0%	0.0
Total	**1768.332**		

Existing Conditions

Land Use	acres	% impervious	TP EMC (mg/L)	RVU	Volume (ac-ft)	TP load (lbs)
Commercial	90.2	85	0.280	0.815	71.56	55
Industrial	4.0	75	0.28	0.725	2.84	2
Institutional		25	0.28	0.275	0.00	0
Parks & Open Space	439.5	15	0.4	0.185	79.12	86
Residential High Density	56.6	60	0.32	0.59	32.46	28
Residential Low Density	763.5	30	0.46	0.32	237.73	297
Undeveloped	42.9	5	0.15	0.095	3.97	2
Water	71.562	100	0.007	0.95	66.15	1
Roadway	300	100	0.280	0.95	277.31	211
				Total Existing Phosphorus Load		**683**

Future Conditions

	Land Use	acres	% impervious	TP EMC (mg/L)	RVU	Volume (ac-ft)	TP load (lbs)
Un-altered	Commercial	84.8	85	0.280	0.815	67.27	51
Un-altered	Industrial	3.8	75	0.28	0.725	2.67	2
Un-altered	Institutional	0.0	25	0.28	0.275	0.00	0
Improved	Parks & Open Space	439.5	20	0.4	0.23	98.36	107
Un-altered	Residential High Density	54.3	60	0.32	0.59	31.17	27
Un-altered	Residential Low Density	733.0	30	0.46	0.32	228.22	286
Un-altered	Undeveloped	0.0	0	0	0.05	0.00	0
Un-altered	Water	71.6	100	0.007	0.95	66.15	1
Un-altered	Roadway	300.0	100	0.280	0.95	277.31	211
Redeveloped	Commercial*	15.1	85	0.252	0.815	11.96	8
Redeveloped	Industrial	0.2	75	0.252	0.725	0.13	0
Redeveloped	Institutional	0.0	25	0.3	0.275	0.00	0
Redeveloped	Residential High Density**	35.8	75	0.32	0.725	25.26	22
Redeveloped	Residential Low Density***	30.3	34.5	0.46	0.3605	10.62	13
				Total Future Phosphorus Load			**729**

* Sum of redeveloped Commercial, 15% of the redeveloped Low Density Residential and 15% of the New Development
** Sum of the Redeveloped High Density Residential, 35% of the Redeveloped Low Density Residential and 50% of the New Development
*** Sum of 50% redeveloped Low Density Residential and 35% developed Undeveloped

Increase in Phosphorus 7%

Change in Model Parameter

Model Equations

RVU = 0.05 + (0.009 X Imperv)
Volume ac-ft = (PXPj X RVU X Acres)/12
P Load = Vol X P emc X 2.72

Precip (in/yr): 28.0
Pj: 0.42