

Wastewater Flow Study
From
Michigan Commercial Establishments
Approved by TAC August 2010



Facilitated by:
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Background:

The most recent version of the Michigan Criteria for Subsurface Sewage Disposal (Michigan Criteria) went into affect in 1989. The Michigan Criteria provides minimum uniform standards of design and construction for subsurface sewage disposal systems in Michigan. Specifically relating to this study, the sewage flows listed in Table 1 of the Michigan Criteria were averages available at the time, and were taken from the “Manual of Septic Tank Practice” (1967-U.S. Public Health Service). The Michigan Criteria recommends modifying the flow averages where experience and/or lifestyle changes indicate a need.

With the proliferation of low-flow water devices (i.e. toilets, showerheads, etc.) and increased water conservation education on one hand and rapid population growth in decidedly rural areas on the other, it became clear that waste flow from certain types of facilities should be reviewed. Specific facility types reviewed were churches, schools, restaurants, and grocery stores with sub-categories in each facility type. The purpose of this study was to analyze current wastewater flows from these types of establishments to determine if there is a need to change flow calculations for septic design purposes.

Procedure:

- The Macomb County Health Department (MCHD) developed surveys to be used as guidance for the study (Appendix A).
- The surveys were sent to all Michigan Environmental Health Directors to use as data collection guides for each LHD when contacting their area facilities.
- Michigan counties participating in this study include Macomb, Monroe, Shiawassee, Oakland, Kalamazoo, Wayne, Ionia, Livingston, Tuscola, Grand Traverse, Genesee, Muskegon, and Lenawee.
- A preliminary letter was sent to all study participant facilities prior to being contacted via phone by the LHD.
- Individual Health Departments surveyed schools, restaurants (fast food and conventional sit-down), churches, and grocery stores in thirteen counties across Michigan. Only facilities utilizing municipal water were surveyed so that actual water use figures could be obtained.

- Following the survey being administered by phone, a minimum of a 12-month period of water use records for each particular establishment were obtained from the appropriate municipal Department of Public Works.
- All data was forwarded by the LHD to the MCHD for analysis
- The actual water use figures from each water facility were then compared to the Michigan Criteria for Subsurface Sewage Disposal sizing criteria.

Analysis:

The data collected (Appendices B, C, D, E) was received in a variety of formats. Some counties conducted their own calculations and provided a predetermined average daily flow while other counties submitted the raw data/water billing information from which an average daily flow was calculated. Peak flows were not utilized for this study due to this variation in data submittal and assumptions that would have to be made in calculating the peak flow. It should also be noted that date ranges for data was also widely varied, with facility data ranging from 12 months to 5 years or more.

The following table (Table 1) is a comparison between the actual water use figures gathered from this study and the Michigan Criteria's suggested peak design flow as well as the range of data for each category and the standard deviation.

TABLE 1

FACILITY TYPE	AVERAGE WATER USAGE (GPD)	DATA RANGE (GPD)	STANDARD DEVIATION	MICHIGAN CRITERIA PEAK DESIGN FLOW (GPD)
CHURCH PER SEAT	1.30	0.06-4.18	1.14	3-7.5*
CHURCH W/SCHOOL PER SEAT	3.08	0.40-6.28	2.04	15-25*
GROCERY PER EMPLOYEE	28.04	4.25-88.22	14.79	35
GROCERY PER SQUARE FOOT	0.10	0.01-1.03	0.04	0.10
ELEMENTARY SCHOOL PER STUDENT	4.45	1.59-9.36	2.26	15-25**
MIDDLE SCHOOL PER STUDENT	2.85	0.26-6.68	1.63	15-25**
HIGH SCHOOL PER STUDENT	5.85	2.12-12.61	3.09	15-25**
TOTAL SCHOOL PER STUDENT	4.56	0.26-12.61	2.68	15-25**
RESTAURANT FAST FOOD PER SEAT	30.17	11.18-56.84	12.07	5-10 gal./seat x daily seat turnover (4.3)***
RESTAURANT FULL SERVICE PER SEAT	19.63	4.07-56.70	11.45	5-10 gal./seat x daily seat turnover (1.3)***

* Range dependent upon extent of kitchen facilities available.

**Range dependent upon extent of cafeteria, gym and shower availability

***Average daily seat turnover based on U.S. data from the National Restaurant Association; 1992.

The standard deviations in Table 1 are large. If one assumes that data are normally distributed, about 2/3 of the values of the data set would fall in the range of the mean minus one standard deviation to the mean plus one standard deviation. So there are still one third of the values outside this range. About 90% of the data values would be within plus or minus two standard deviations of the mean. When one considers the values of the standard deviations for most of the values in Table 1, it is clear that the data are quite variable and we need to be cautious in making decisions from the data. However, some things are clear.

All types of schools and churches with schools use much less water than would be estimated using the values in the Michigan Criteria. The difference is most pronounced in the case of middle schools, but for all schools, the average measured use is in the range of 25 – 35% of the Michigan Criteria estimated value. Because of the high variability, we cannot be certain that the differences are this large, but they are definite.

Conclusion:

The data received from the thirteen counties around Michigan indicates that average water use for these facility types are equal to or less than the Michigan Criteria standards. One exception to this statement is full-service restaurants, in which the data revealed higher flow averages than the Michigan Criteria suggests.

Comparing the data averages and the standard deviation calculations lead to the observation that the daily flow within each facility type is quite variable. Direct use of these average flow numbers to estimate design flow for any of these facility types would be risky. However, these data provide some guidance. At the least, they suggest that the actual flow for any given facility may be quite different than the average flow in the table. With the exception of fast food restaurants, the standard deviations indicate the data spread is more widely varied than ideal for statistical purposes. Fast food restaurants, however, have an average of 30.17 GPD and a standard deviation of 12.07 which indicates the data is reasonably closely grouped within a small range. The fast food average (30.17) also falls closely to the middle of the Michigan Criteria design flow range when the number of turnovers is considered which indicates this design estimate is reasonable. The standard deviation interpretation indicates additional study of the facility type water use should be completed before any change to the Michigan Criteria is considered.

Designers should calculate and propose GPD flows only after looking at all available data. Where available, actual flow numbers from similar facility types should be used. The study indicates this is especially true with churches and schools.

Recommendation for Further Study:

This study was conducted with a limited amount of data. The authors believe each facility type is worthy of its own separate study with flow data collected in a manner that identifies the actual date and time of data collection. This is especially important with data collection for churches. The flow data for churches in this study are average daily flows. It may be more beneficial to collect daily flow data to determine weekly flows versus worship day flows.

Future studies should also maintain stricter control over the format for data submission. The data received for this study was received in various ways (i.e. a pre-calculated GPD number with no additional information, a variety of date ranges, and actual quarterly reports). This required some interpretation of the data by the analyst which may have affected the outcome. Data also did not generally identify if irrigation metering was included in the data or not. Future data collection

should specifically identify such boundary parameters (i.e. all data must be within a 24 month period, data should be all in the same format, data includes irrigation water or not, etc.).

Schools have reported that in school use of showers by students is low which may account for the greatly reduced water usage rate per student compared to the Michigan Criteria. A separate study that looks at student water use patterns in conjunction with overall water use would provide more meaningful data.

Lastly, this study brings to light the need for consistent, accurate data collection. It is recommended that the installation of flow meters (i.e. water meters, pump counters, etc.) be required on all commercial and multi residential facilities.

¹Members of Macomb County Health Department contributing to this report are Scott Hankus, Jennifer Snyder, James Buzonik, and Laura Pobanz.

APPENDIX A

FLOW STUDY INFORMATION SHEET

FACILITY NAME: _____
CONTACT PERSON/TITLE: _____
TELEPHONE: _____
ADDRESS: _____
CITY/TWP: _____
COUNTY: _____
POPULATION DENSITY: _____ (PERSON PER SQUARE MILE)

SCHOOLS:

TYPE: PRESCHOOL ELEMENTARY MIDDLE SCHOOL HIGH SCHOOL
NUMBER OF STUDENTS: _____
SHOWERS: YES NO
SATELITE KITCHEN: YES NO
FULL SERVICE KITCHEN: YES NO

GROCERY/SUPERMARKET:

NUMBER OF EMPLOYEES: _____
SQUARE FOOTAGE OF BUILDING: _____
PUBLIC RESTROOM: YES NO
DELI: YES NO
24 HOUR: YES NO

CHURCH:

NUMBER OF SEATS: _____
PRESCHOOL: YES NO
DAYCARE: YES NO
SCHOOL: YES NO
NUMBER OF STUDENTS AND STAFF: _____
DOMESTIC GRADE KITCHEN: YES NO
COMMERCIAL GRADE KITCHEN: YES NO
HOW MANY TIMES A YEAR IS FOOD SERVED TO THE PUBLIC: _____

RESTAURANT:

NUBER OF SEATS: _____
CONVENTIONAL: YES NO
FAST FOOD: YES NO
DRIVE THRU: YES NO
AVERAGE MEALS PER DAY: _____
24 HOUR: YES NO
DISTANCE TO HIGHWAY: _____ MILE(S)

GALLONS PER DAY: _____

**ATTACH WATER USAGE FOR THE FACILITY*

**APPENDIX B
CHURCH DATA**

FACILITY	COUNTY	PRE SCHOOL	DAY CARE	SCHOOL	# SEATS	GPD	GPD/SEAT
LAKESIDE ASSEMBLY OF GOD	MACOMB				1200	2601	2.17
BROOKSIDE MISSIONARY BAPTIST CHURCH	MACOMB				200	199	1.00
ST. ANNE CATHOLIC CHURCH	MACOMB			X	1200	5635	4.70
ST. CLEMENT CATHOLIC CHURCH	MACOMB				900	3432	3.81
ST. THECLA	MACOMB	X		X	850	3017	3.55
FIRST CONGREGATIONAL CHURCH	MACOMB				125	134	1.07
PEACE LUTHERN CHURCH & SCHOOL	MACOMB	X		X	450	1978	4.40
MT. CARMEL CATHOLIC CHURCH	MONROE				850	1362	1.60
CHURCH OF GOD	MONROE				100	6	0.06
ST. PAULS CATHOLIC CHURCH & SCHOOL	SHIAWASSEE			X	1000	400	0.40
FIRST CHURCH OF GOD	SHIAWASSEE				200	250	1.25
OUR LADY OF THE LAKES	OAKLAND	X		X	800	5022	6.28
HOPE LUTHERN CHURCH	OAKLAND				350	820	2.34
MARIMONT COMM. CHURCH	OAKLAND				600	195	0.33
GULL LAKE UNITED METHODIST CHURCH	KALAMAZOO				380	475	1.25
RICHLAND BIBLE CHURCH	KALAMAZOO				1000	1143	1.14
MT. HERMAN CHURCH	WAYNE				180	54.7	0.30
METRO BAPTIST CHURCH	WAYNE	X	X	X	850	764	0.90
HOWELL CHURCH OF NAZZARENE	LIVINGSTON				400	1671	4.18
FIRST UNITED METHODIST	LIVINGSTON				300	435	1.45
FIRST PRESBYTERIAN	LIVINGSTON			X	350	1507	4.31
OGDEN CHURCH	LENAWEE		X		699	300	0.43
ST PAUL LUTHERN	TUSCOLA	X	X	X	500	1082	2.16
EAST BAY CALVARY CHURCH	GRAND TRAVERSE				850	478	0.56
FIRST BAPTIST	GENESEE				300	357	1.19
FENTON UNITED METHODIST	GENESEE				850	245	0.29
CALVARY BAPTIST CHURCH	MUSKEGON	X		X	800	808	1.01
FAITH LUTHERN CHURCH	MUSKEGON				350	117	0.33

**APPENDIX C
GROCERY DATA**

FACILITY	COUNTY	# EMPLOYEES	SQ. FT.	GPD	GPD/ EMPLOYEE	GPD/ SQ.FT.
FARMER JACK	MACOMB	100	53650	1870	18.70	0.03
FARMER JACK	MACOMB	91	48884	1444	15.87	0.03
FARMER JACK	MACOMB	98	57902	4081	41.64	0.07
KROGER	MACOMB	160	68967	3590	22.44	0.05
KROGER	MACOMB	110	57000	2318	21.07	0.04
KROGER	MACOMB	175	57240	2709	15.48	0.05
NINO SALVAGGIO	MACOMB	130	22414	4355	33.50	0.19
NINO SALVAGGIO	MACOMB	190	52896	7106	37.40	0.13
RANDAZZOS FRESH MARKET	MACOMB	80	44300	340	4.25	0.01
SHOPPERS MARKET	MACOMB	40	18680	673	16.83	0.04
FOODTOWN	MONROE	50	43000	4411	88.22	0.10
KROGER	MONROE	155	35135	4767	30.75	0.07
V.G.'S	SHIAWASSEE	85	37000	3800	44.71	0.10
KROGER	OAKLAND	140	60000	3175	22.68	0.05
MEIJER	OAKLAND	330	212000	8737	26.48	0.04
KROGER	OAKLAND	100	61000	2408	24.08	0.04
HARDINGS FAMILY MARKET	KALAMAZOO	55	26000	403	7.33	0.02
LITTLE TOWN MARKET	WAYNE	5	2140	126	25.20	0.06
SUMMER MEATS	WAYNE	4	2432	324	81.00	0.13
KROGER	LIVINGSTON	100	52000	1869	18.69	0.04
VG'S	LIVINGSTON	130	55000	4113	31.64	0.07
HOWELL VILLAGE MARKET	LIVINGSTON	18	12000	302	16.78	0.03
ORESONS FOOD STORE	GRAND TRAVERSE	75	42000	3876	51.68	0.09
BUECHES FOOD WORLD	GENESEE	100	44000	1767	17.67	0.04
KROGER	GENESEE	100	60000	1100	11.00	0.02
KROGER	GENESEE	135	73000	4000	29.63	0.05
VG'S	GENESEE	161	62000	9033	56.11	0.15
OLIVER T'S	GENESEE	54	18000	230	4.26	0.01
PLUMBS	MUSKEGON	87		1444	16.60	
PLUMBS	MUSKEGON	75		705	9.40	

**APPENDIX D
RESTAURANT DATA**

FACILITY	COUNTY	TYPE	#SEATS	GPD	GPD/ SEAT
MCDONALDS	MACOMB	FAST	60	1928	32.13
MCDONALDS	MACOMB	FAST	95	2227	23.44
ARBYS	MACOMB	FAST	70	1671	23.87
TACO BELL	MACOMB	FAST	50	2842	56.84
TACO BELL	MACOMB	FAST	56	1388	24.79
BIG BOY RESTAURANT	MACOMB	CONV	150	2760	18.40
DENNYS RESTAURANT	MACOMB	CONV	51	1596	31.29
FILIPPAS WINE BARREL	MACOMB	CONV	290	4654	16.05
NATIONAL CONEY ISLAND	MACOMB	CONV	105	2518	23.98
THEOS FAMILY RESTAURANT	MACOMB	CONV	146	2518	17.25
STAWBERRY FIELDS RESTAURANT	MACOMB	CONV	130	3125	24.04
ERIE RESTAURANT	MONROE	CONV	150	611	4.07
MCDONALDS	MONROE	FAST	169	1890	11.18
GREG AND LOU'S	SHIAWASSEE	CONV	140	2000	14.29
CELIA'S	SHIAWASSEE	CONV	32	1000	31.25
ON THE BORDER MEXICAN GRILL	OAKLAND	CONV	322	7552	23.45
APPLEBEES	OAKLAND	CONV	194	3779	19.48
APPLBEES	KALAMAZOO	CONV	147	3963	26.96
PIPERS GRINDERS	KALAMAZOO	CONV	15	321	21.40
ORCHARD GROVE	WAYNE	CONV	61	775	12.70
WOODSIDE MEADOWS	WAYNE	CONV	120	893	7.44
BRIDGE STREET CAFÉ	IONIA	CONV	52	255	4.90
TOMATO BROTHERS	LINVINGSTON	CONV	170	4044	23.79
TW FRIENDS	LINVINGSTON	CONV	180	2943	16.35
MC DONALDS	LINVINGSTON	FAST	40	1709	42.73
DAN'S CLINTON TAVERN	LENAWEE	CONV	88	461	5.24
CULVERS	LENAWEE	FAST	120	4390	36.58
AMERICAN LEGION	LENAWEE	CONV	120	780	6.50
DAIRY QUEEN	TUSCOLA	FAST	75	2333	31.11
RED LOBSTER	GRAND TRAVERSE	CONV	161	9128	56.70
MC DONALDS	GRAND TRAVERSE	FAST	58	1525	26.29
ARBYS	GENESEE	FAST	70	1600	22.86
THE FRENCH LAUNDRY	GENESEE	CONV	130	1650	12.69
BELLACINOS	MUSKEGON	CONV	48	1171	24.40
STEAK AND EGGER	MUSKEGON	CONV	120	3415	28.46