

# 24B PERMEABLE PAVER BMP MONITORING

## BACKGROUND

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Best management practices (BMPs) include procedures and structures designed to help reduce water pollution. Permeable pavers are a BMP designed to increase infiltration. In 2005 and 2006, the MPRB monitored the permeable paver lot located at the City of Minneapolis' Animal Shelter located at 212 17<sup>th</sup> Avenue North, Minneapolis. Permeable pavers were used as part of an innovative building design project to help reduce runoff flow volumes. The project was designed to reduce stormwater and pollutant runoff by more than 50 percent.

The drainage area was measured to be 5,777 square feet which included the section of the Animal Shelter roof and the section of the paver lot that drained to the monitored manhole. The diameter of the stormwater pipe was 12 inches. The inlet manhole cover was an open drain.

The site is located in a commercial/industrial land use area and is approximately 1 block east of Interstate 94 and 3 blocks south of Broadway Avenue. The watershed drains to the Mississippi River.

## METHODS

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The MPRB monitored a storm drain located at Minneapolis' Animal Shelter from June to October 2005 and May to October 2006. One of two storm drains was monitored at the permeable paver lot. The storm drain monitored was located within the gated parking lot of the Animal Shelter. The equipment in 2005 included a level/pressure transducer with ISCO 4120 datalogger and was installed on 5/27/05. The equipment in 2006 included a area/velocity transducer with ISCO 4150 datalogger and was installed on 5/3/05. Data were downloaded approximately every two weeks.

A tipping bucket rain gage was installed on the Animal Shelter building roof from 8/31/05 – 11/2/05 and 5/3/06 – 11/9/06. The rain gage was used to calculate theoretical flow data. Rain data from the Bassett's Creek Watershed Outlet Monitoring Program (WOMP) station was used prior to installation in 2005 and in 2006 (from 6/16/06 – 8/6/06) to augment missing data. The WOMP rain gauge is located near the Minneapolis Vehicle Impound Lot approximately 2.1 miles away. More information on the Bassett's Creek WOMP station can be found in Section 21.

The total drainage area of the storm drain was measured in the field using a tape measure. Theoretical flow volumes were calculated by multiplying the total drainage area by the total amount of daily rainfall. Measured flow volumes were recorded using the datalogger.

## RESULTS & DISCUSSION

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Storm data are presented in Table 24G including the dates of storm events, rainfall, intensity, peak levels, flow volumes, and percent infiltrated. In 2005 a total of 28 storm events were

recorded and in 2006 a total of 26 storm events were recorded. A storm event is defined as having 0.10 inches of rainfall or greater separated by eight hours. Some events occurred in 2005 with no record of rainfall and are not included in Table 24G. This may be due to the washing of trucks at the shelter which can overflow to the drain pipe and cannot be used in the calculations because the water volume and therefore infiltration is unknown.

Several large rain events occurred in 2005 and 2006 resulting in pipe surcharges. In 2005 six events surcharged resulting in inaccurate flow recordings, Table 24G. The 2005 surcharge flow calculations were inaccurate due to the level probe used. In 2006 five events surcharged. The 2006 surcharges were less of a problem to calculate, because an area velocity probe was used. Recorded peak levels for surcharge events were greater than 18 inches. Overflow problems generally occurred during high flow, high intensity events.

**Table 24G. Storm event data for the permeable paver lot in 2005 – 2006. cf = cubic feet.**

Date	Rainfall (in)	Intensity (in/hr)	Peak Level (in)	Theoretical Flow Volume (cf)	Measured Flow Volume (cf)	Percent Infiltrated %	Notes:
6/4/05	0.23	0.05	0.76	111	120	-8	
6/8/05	0.82	0.12	2.04	395	385	3	
6/10/05	0.55	0.06	5.80	265	943	-256	
6/13/05	0.47	0.03	1.25	226	310	-37	
6/20/05	1.06	0.85	28.64	510	5,032	-887	SURCHARGED
6/27/05	1.43	0.09	2.50	688	744	-8	
6/29/05	0.19	0.02	0.86	91	17	81	
7/3/05	0.40	0.27	1.98	193	181	6	
7/20/05	0.47	0.24	1.73	226	101	55	
7/23/05	0.63	0.28	18.83	303	1,448	-378	SURCHARGED
7/25/05	1.14	0.35	30.64	549	5,558	-912	SURCHARGED
8/4/05	0.18	0.05	0.13	87	11	87	
8/8/05	0.22	0.08	0.26	106	5	95	
8/11/05	0.12	0.07	0.48	58	18	69	
8/16/05	0.13	0.26	2.17	63	121	-92	
8/18/05	0.14	0.02	0.06	67	2	97	
8/19/05	0.26	1.04	1.16	125	20	84	
8/26/05	1.83	0.61	31.25	881	5,114	-480	SURCHARGED
9/3/05	0.77	0.14	1.38	371	250	33	
9/4/05	2.17	0.34	1.54	1,045	678	35	
9/5-9/6/05	0.77	0.17	2.03	371	478	-29	
9/12-9/13/05	0.77	0.04	2.09	371	537	-45	
9/19/05	0.51	0.34	2.07	246	375	-52	
9/21/05	2.09	0.52	24.57	1,006	4,525	-350	SURCHARGED
9/24-9/25/05	1.04	0.05	1.00	501	406	19	
9/28/05	0.27	0.07	0.76	130	366	-182	
10/4-10/5/05	5.71	0.21	28.34	2,749	21,218	-672	SURCHARGED
10/12/05	0.22	0.26	0.20	106	33	69	
<b>2006</b>							
5/8-9/06	1.27	0.05	2.50	611	106	83	
5/12-13/06	0.67	0.03	5.00	323	313	3	
5/24-25/06	0.38	0.01	1.25	183	21.8	88	
6/1/06	0.10	0.10	0.25	48	0.00	100	
6/5/06	0.73	1.83	18.0	351	112	68	SURCHARGED
6/16-17/06	2.99	0.43	30.0	1439	1395	3	SURCHARGED
6/17/06	0.14	0.06	0.10	67	2.80	96	
6/24-26/06	0.59	0.03	1.00	284	48.0	83	
7/1/06	0.16	0.64	1.25	77	0.00	100	
7/11/06	0.27	0.36	0.50	130	0.10	100	
7/13-16/06	0.46	0.04	0.06	221	0.00	100	
7/19/06	0.37	0.07	3.00	178	1.80	99	
7/24/06	1.40	0.51	32.0	674	47.4	93	SURCHARGED
7/25/06	0.12	0.24	0.06	58	0.10	100	
8/1-2/06	3.85	0.64	33.0	1853	1020	45	SURCHARGED
8/6/06	0.37	0.49	0.60	178	0.40	100	
8/13/06	0.42	0.07	0.50	202	0.00	100	
8/23/06	0.78	0.35	2.00	376	23.4	94	
8/24/06	1.54	0.08	38.0	741	480	35	SURCHARGED
9/2-3/06	0.97	0.04	0.20	467	0.00	100	
9/16/06	0.27	0.07	0.10	130	0.50	100	
9/17/06	0.15	0.15	0.10	72	0.70	99	
9/21-22/06	0.82	0.10	0.30	395	31.0	92	
9/23/06	0.26	0.07	0.20	125	8.70	93	
10/11/06	0.21	0.05	0.25	101	7.50	93	
10/16/06	0.29	0.03	0.40	140	6.60	95	
<b>2005 Total</b>				<b>11,839</b>	<b>48,996</b>	<b>-314</b>	
<b>2005 Total (Without Surcharges)</b>				<b>5,841</b>	<b>6,101</b>	<b>-4</b>	
<b>2006 Total</b>				<b>9,426</b>	<b>3,627</b>	<b>62</b>	
<b>2005 - 2006 Total Combined</b>				<b>21,265</b>	<b>52,623</b>	<b>-147</b>	

In 2005 a total of 13 events showed positive treatment percentages. Nine events had negative treatment percentages (not including surcharged events). Many events showed larger volumes than possible for the calculated drainage area. This generally occurred for large rain events. It is possible that the drainage area could have different sizes for different events. The known contributing drainage area was measured by MPRB staff, however there is an adjacent building west of the paver lot which has rain leaders pointed toward the lot. The leaders are approximately 25 feet west with a buffer of tall vegetation. It is not currently known if these leaders contribute to the paver lot around certain sized rain events. Careful monitoring of the adjacent building's drainage would be necessary to determine if it is contributing to the total flow of the pipe. It is possible that the pipe could backup from downstream. Additionally trash is often found within the pipe which may influence level readings. Further monitoring is necessary to investigate these possibilities.

In 2006 all events showed positive treatment percentages. The 2006 data show an overall 62% infiltration. An area/velocity meter used in 2006 was useful in determining pipe backups and calculating surcharge event flow volumes. From a qualitative perspective, the permeable pavers appear to be functioning well with little or no ponding visible during rain events.