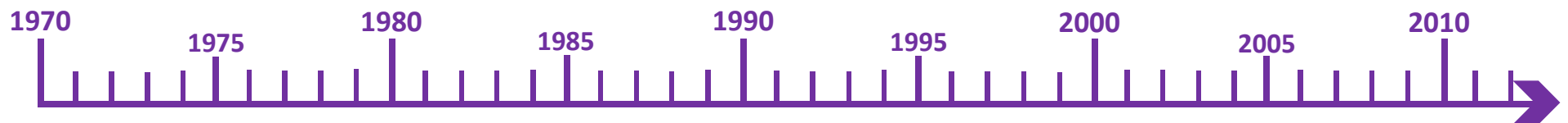




WinSLAMM History and Development

1970 to 2013 and Beyond!



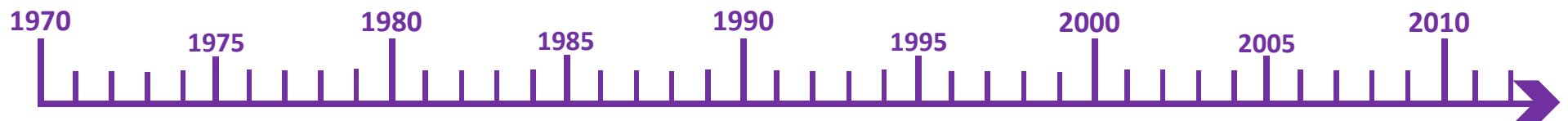
SLAMM

What is SLAMM?

Source Loading and Management Model

It Determines the Runoff Volume and Pollution Load

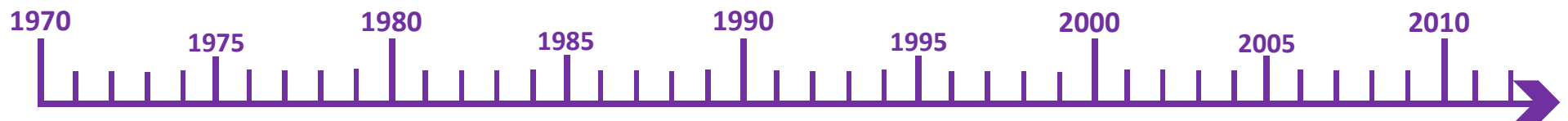
- ☁️ For each Source Area
- ☁️ Within each Land Use
- ☁️ For each Rainfall Event



SLAMM

SLAMM

- ☁️ Performs complete Water Balance for each Rainfall Event
- ☁️ Transfers runoff hydrographs and particle size distributions through the drainage system
- ☁️ Models Stormwater Control Measures in series



SLAMM

Why Source Areas? Because different source areas generate different pollutant loads

Table 23.6 Summary of observed particulate quality for other source areas (means for <125 µm particles) (mg constituent/kg solids).

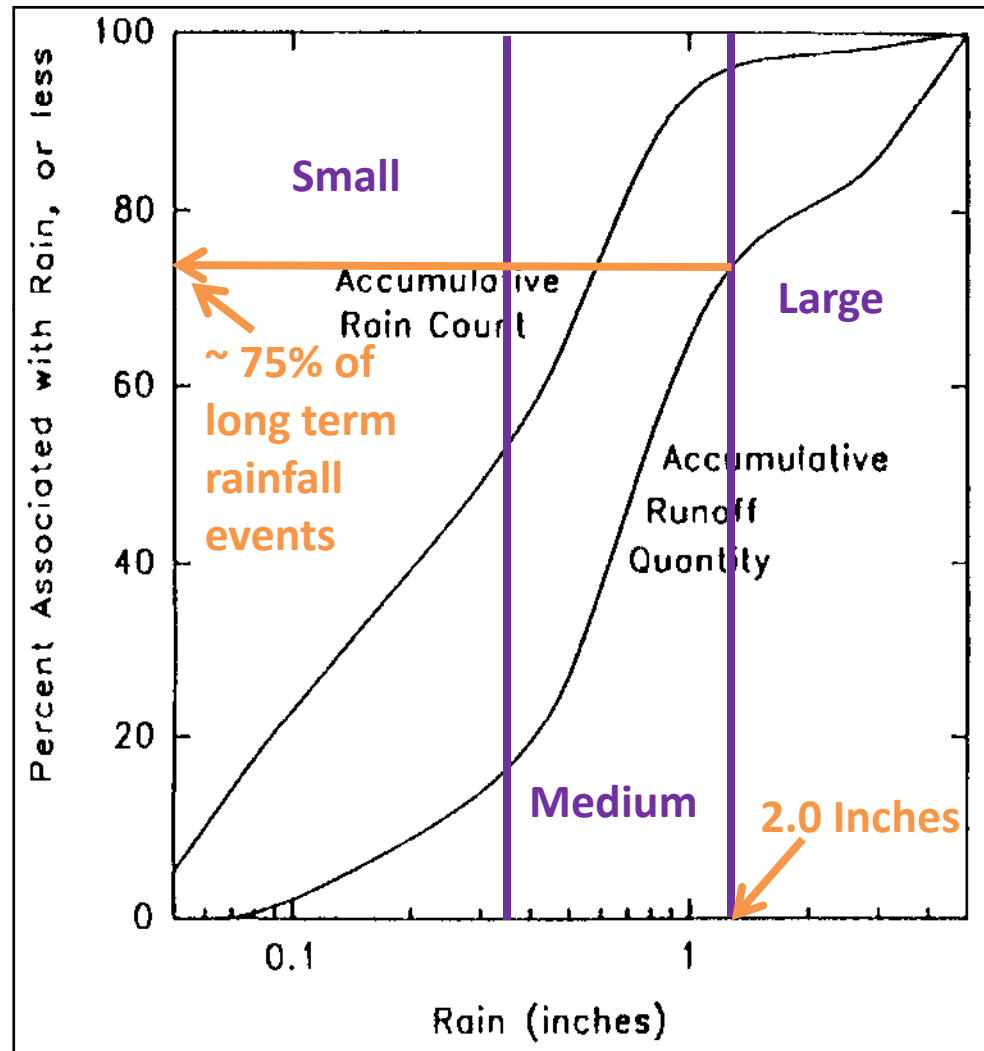
	P	TKN	COD	Cu	Pb	Zn	Cr
Residential/Commercial							
Land Uses							
Roofs	1500	5700	240,000	130	980	1900	77
Paved parking	600	790	78,000	145	630	420	47
Unpaved driveways	400	850	50,000	45	160	170	20
Paved driveways	550	2750	250,000	170	900	800	70
Dirt footpath	360	760	25,000	15	38	50	25
Paved sidewalk	1100	3620	146,000	44	1200	430	32
Garden soil	1300	1950	70,000	30	50	120	35
Road shoulder	870	720	35,000	35	230	120	25
Industrial Land Uses							
Paved parking	770	1060	130,000	1110	650	930	98
Unpaved							
parking/storage	620	700	110,000	1120	2050	1120	62
Paved footpath	890	1900	120,000	280	460	1300	63
Bare ground	700	1700	70,000	91	135	270	38

Source: Pitt and McLean 1986 (Toronto, Ontario)

SLAMM

SLAMM is based on Small Storm Hydrology

Small Storm Hydrology is the concept that the small and medium size rainfall events generate the majority of the runoff volume and pollutants in an urban area because their cumulative volume is larger than the cumulative volume of the large storms.



Milwaukee, WI Long Term Rain Data

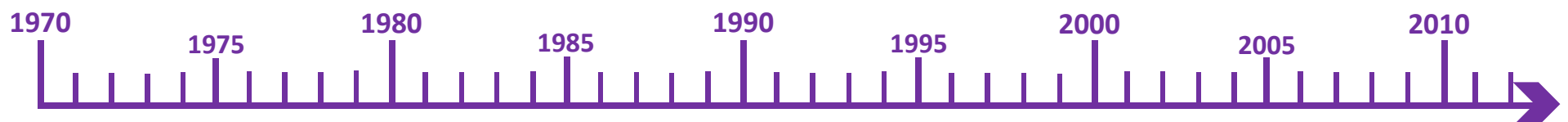
SLAMM

SLAMM was developed because field observations did not match commonly accepted theories. SLAMM uses both:

☁️ State-of-the-art research data and

☁️ Small storm hydrologic theory

And is constantly updated as new research data becomes available*



*Most of the papers referenced in this document can be downloaded through the "History and Development (Research Papers)" link found on the website.



Selection of Large Watersheds Monitored by WI DNR and USGS

Harper Madison WI: Residential 9-22-99



**Marquette Michigan:
Res/Comm. (288 acres)**

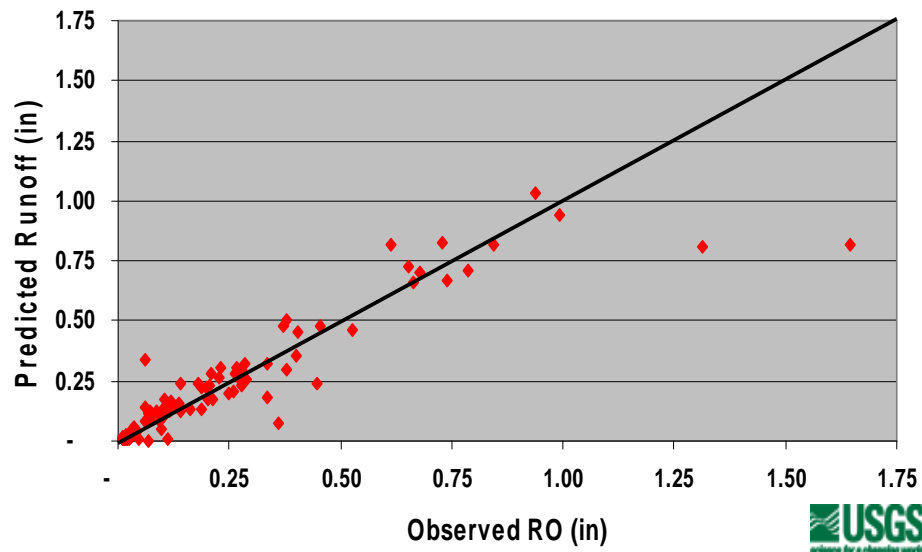


Maintenance Yard Madison WI: 4 acres

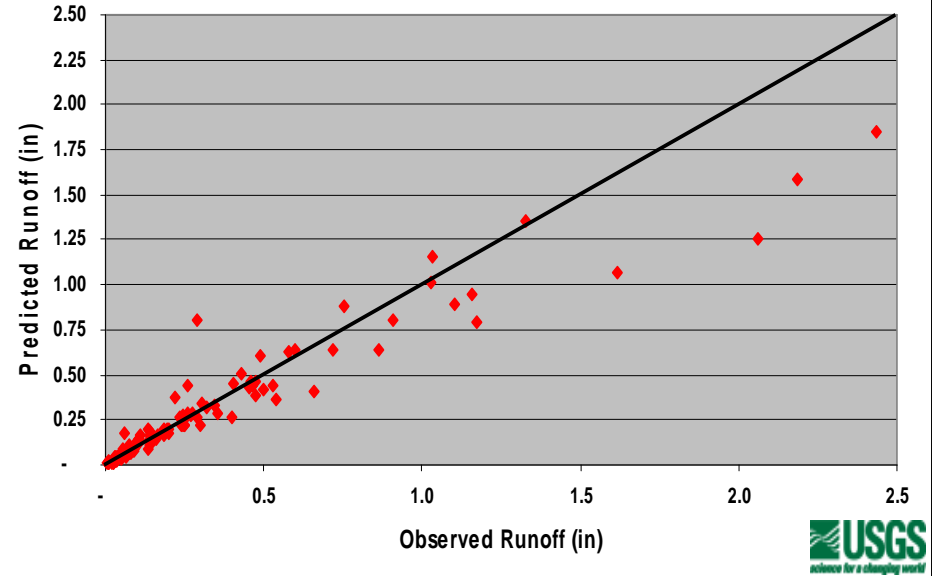


**Syene Industrial Park, Madison WI: 114
acres**

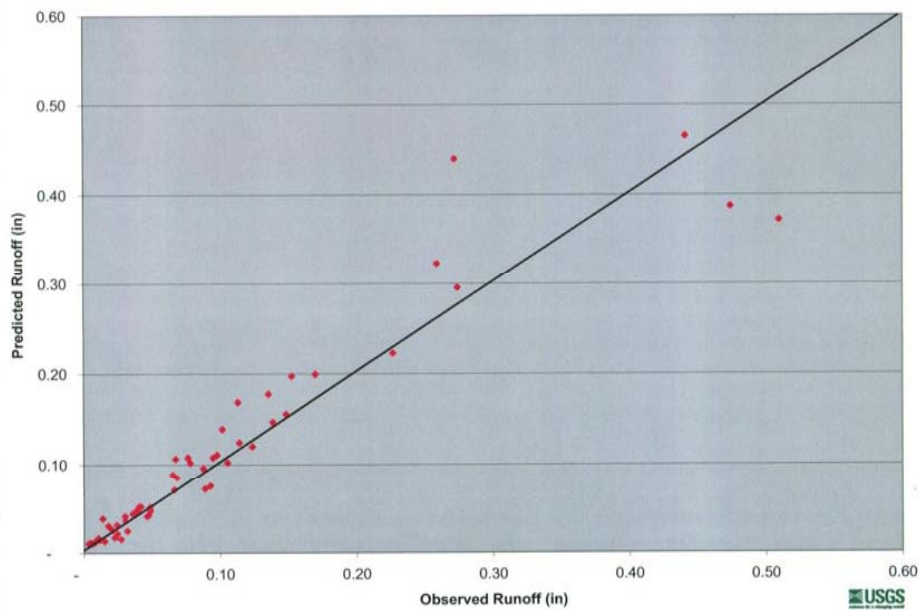
Observed vs. Predicted Runoff Superior Outfall



Observed vs. Predicted Runoff at Syene Outfall

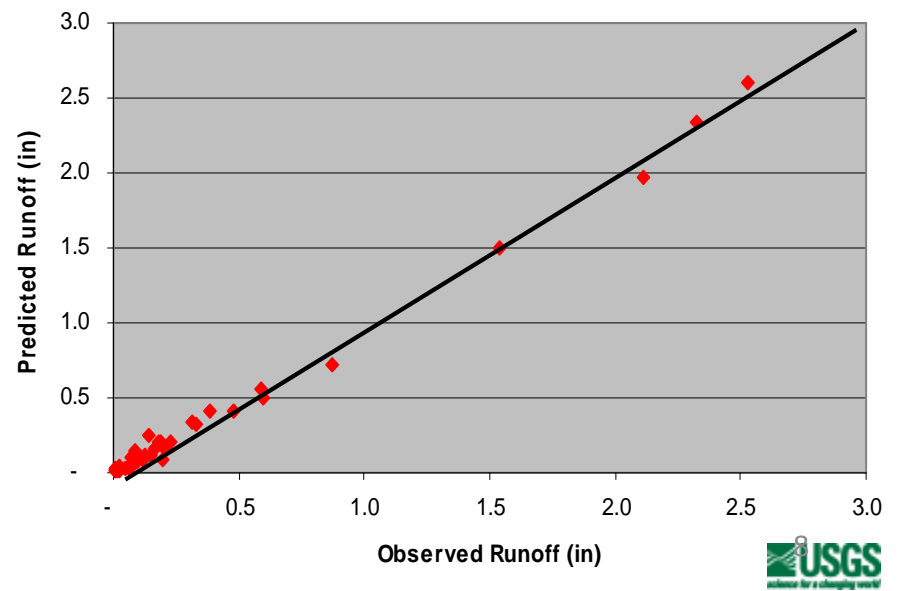


Observed vs. Predicted Runoff at Canterbury Outfall



Draft 5/16/01

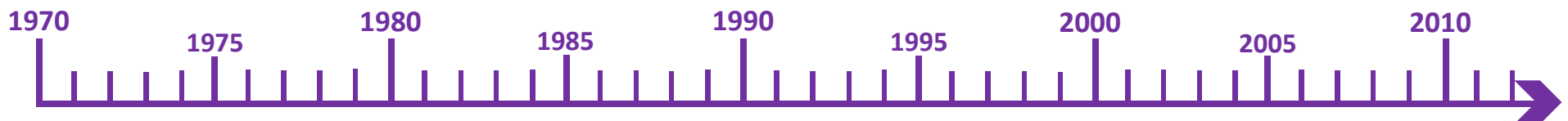
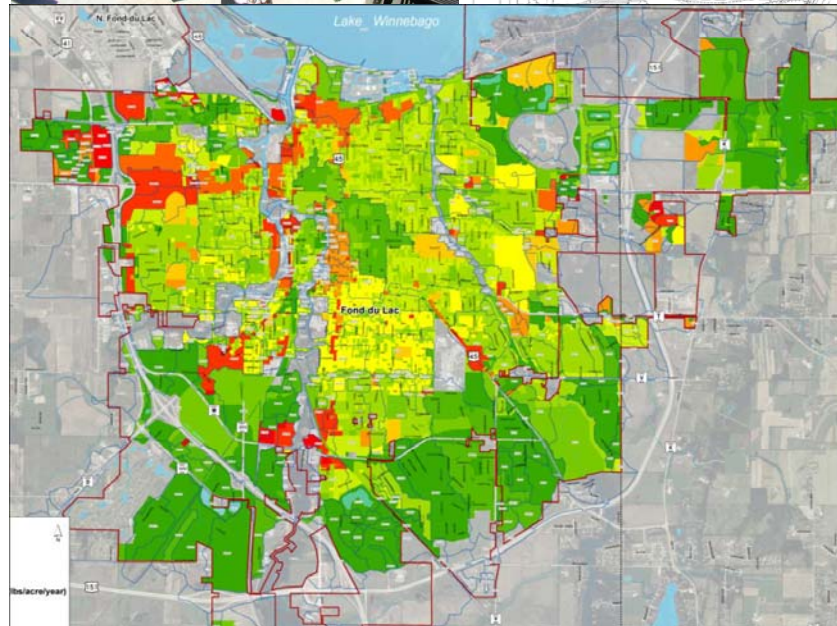
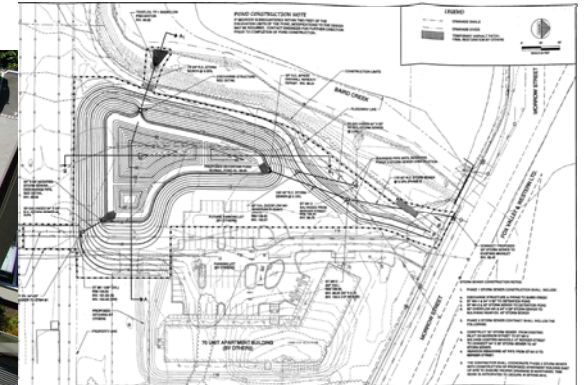
Observed vs. Predicted Runoff at Madison Maintenance Yard Outfall



SLAMM

SLAMM can evaluate:

- ☁️ Single practices
- ☁️ Site development
- ☁️ Large scale, regional projects and watersheds



SLAMM Early Days

Development began in mid-1970s

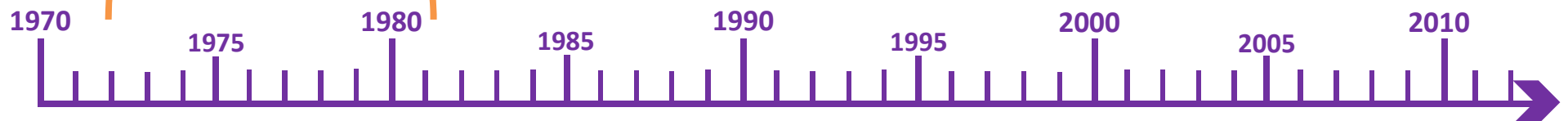


Spreadsheet based



USEPA Studies used for initial development:

- Water Pollution Aspects of Street Surface Contaminants (1972)
- Toxic Materials Analysis of Street Surface Contaminants (1973)
- Contributions of Urban Roadway Usage to Water Pollution (1975)
- Demonstration of Nonpoint Pollution Abatement Through Improved Street Cleaning Practices (1979)
- Demonstration of Nonpoint Pollution Management on Castro Valley Creek (1981)

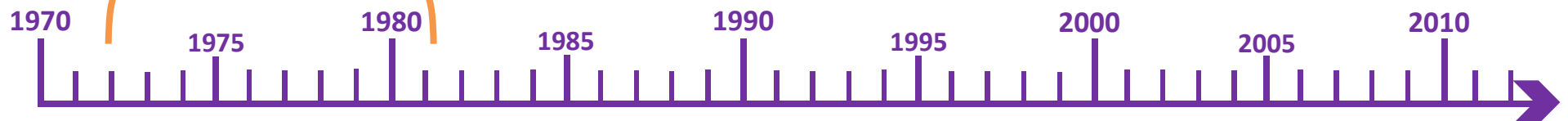


SLAMM Early Days

Development began in mid-1970s

☁️ The program evaluated:

- Runoff volume and pollutant loads from source areas
- Street Cleaning



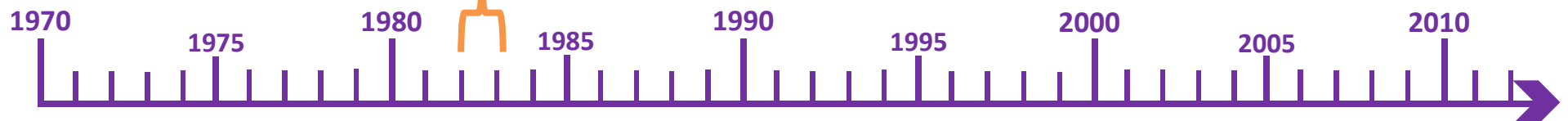
SLAMM in the 1980s

Early 1980s



Other Agencies become involved:

- Urban Bacteria Sources and Control in the Lower Rideau River Watershed, Ottawa, Ontario (Ontario Ministry of the Environment, 1982)
- Washoe County Urban Stormwater Management Program (Washoe Council of Governments, 1982)
- Final Report - NURP Project, Champaign, Illinois: Evaluation of the Effectiveness of Municipal Street Sweeping in the Control of Urban Storm Runoff Pollution (Illinois Dept. of Energy and Natural Resources, 1982)
- Sources of Urban Runoff Pollution and Its Effects on an Urban Creek (USEPA, 1982)



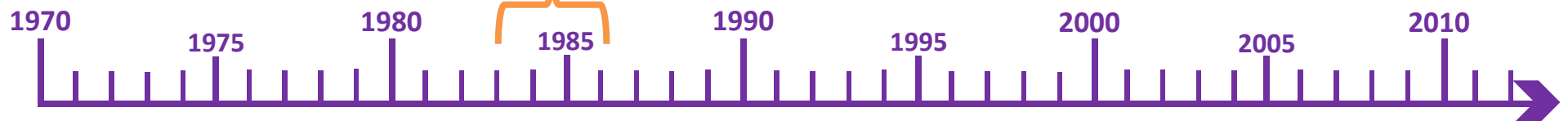
SLAMM in the 1980s

Mid-1980s



Studies continue:

- Evaluation of urban nonpoint sources pollution management in Milwaukee County, Wisconsin (USEPA, 1983)
- Humber River Pilot Watershed Project (Ontario Ministry of the Environment, 1984)
- Characterization, Sources, and Control of Urban Runoff by Street and Sewerage Cleaning (USEPA, 1984)
- Estimation of Pollution from Highway Runoff - Initial Results (Conference on Urban Runoff Quality - Impact and Quality Enhancement Technology, 1986)

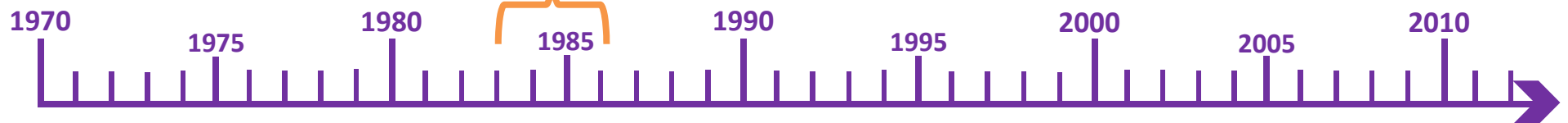


SLAMM in the 1980s

Mid-1980s

☁️ Program evaluates:

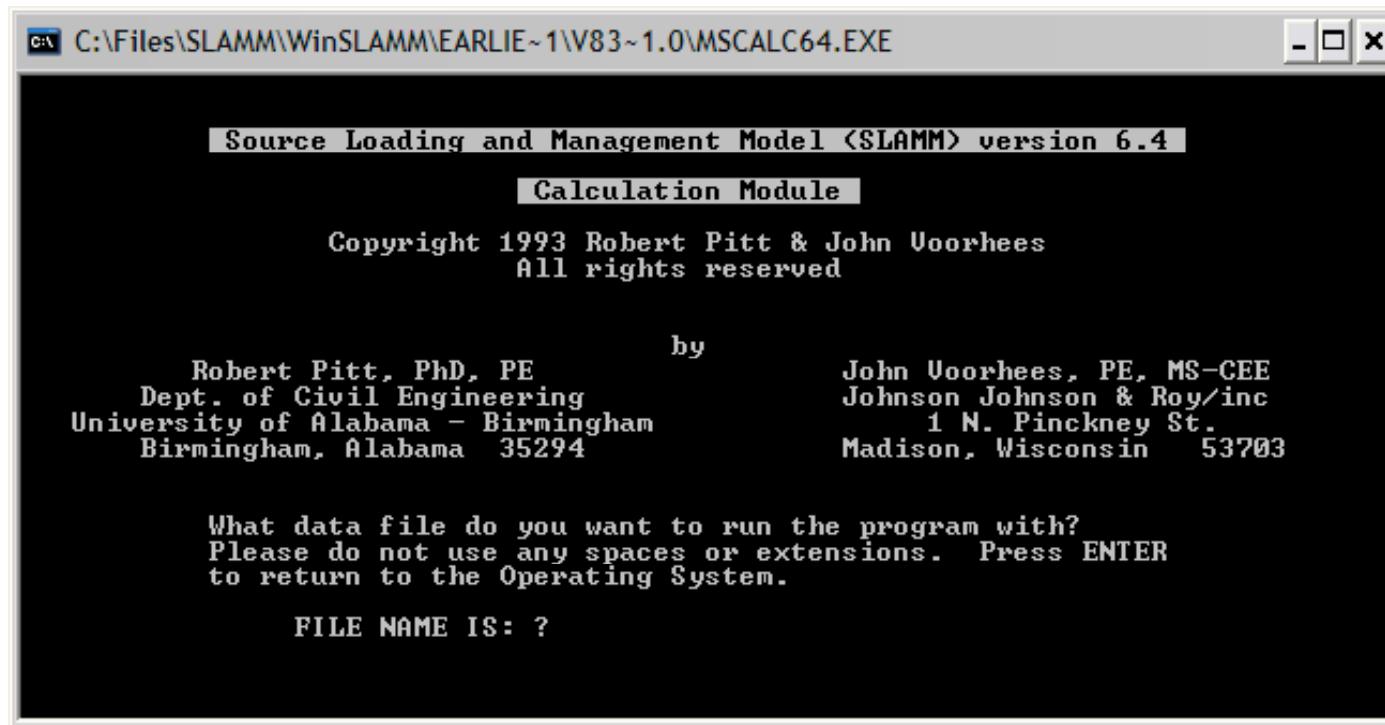
- Runoff volume and pollutant loads from source areas
- Street Cleaning
- Catch Basin Cleaning



SLAMM in the 1980s

1986

☁ First DOS Version Released



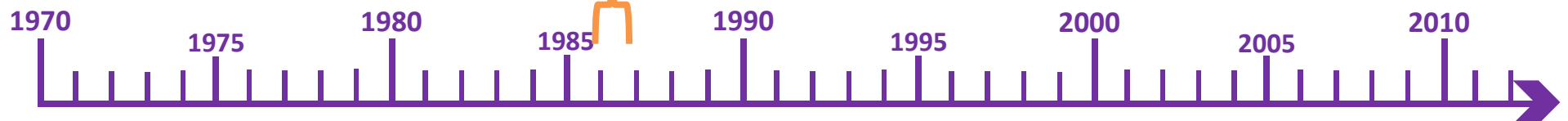
The screenshot shows a DOS window titled "C:\Files\SLAMM\WinSLAMM\EARLIE~1\W83~1.0\MSCALC64.EXE". The window content is as follows:

```
Source Loading and Management Model <SLAMM> version 6.4
Calculation Module
Copyright 1993 Robert Pitt & John Voorhees
All rights reserved

by
Robert Pitt, PhD, PE
Dept. of Civil Engineering
University of Alabama - Birmingham
Birmingham, Alabama 35294
John Voorhees, PE, MS-CEE
Johnson Johnson & Roy/inc
1 N. Pinckney St.
Madison, Wisconsin 53703

What data file do you want to run the program with?
Please do not use any spaces or extensions. Press ENTER
to return to the Operating System.

FILE NAME IS: ?
```



SLAMM in the 1980s

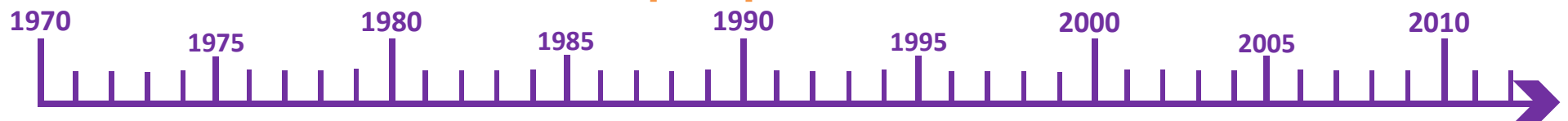
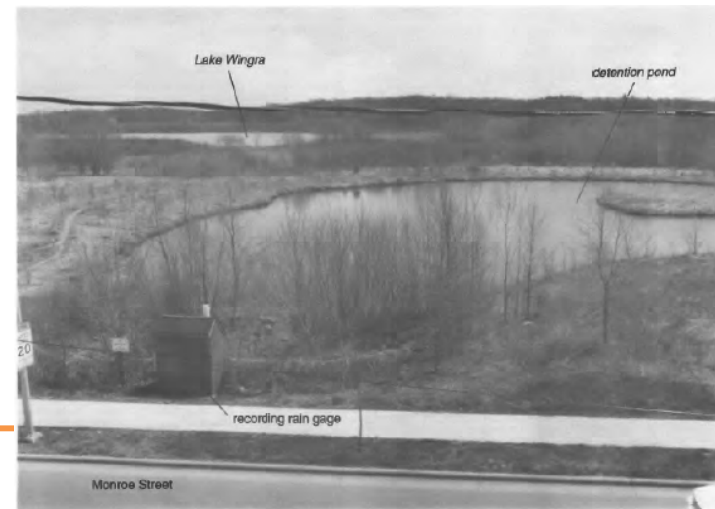
Late 1980s

☔ Studies continue:

☔ Small Storm Urban Flow and Particulate Washoff Contributions to Outfall Discharges (Ph.D. Dissertation, University of Wisconsin, Madison, 1987)

☔ Water quality of an urban wet detention pond in Madison Wisconsin (USGS, 1988)

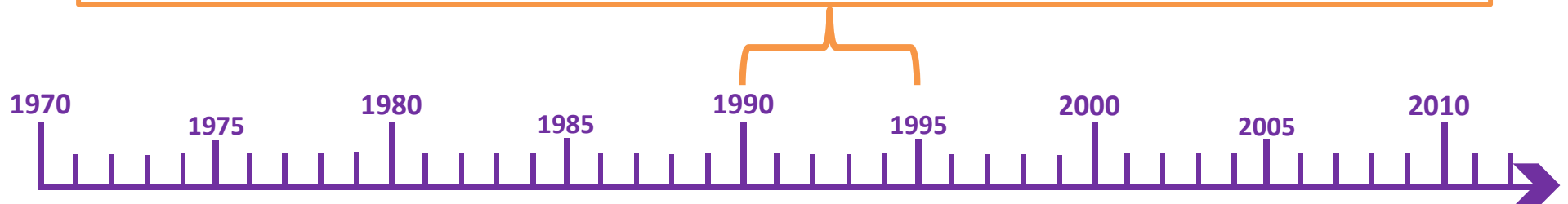
☔ Wet Detention Ponds Added



SLAMM in the 1990s

Early to mid-1990s

- ☔ Studies continue:
 - ☔ SLAMM model calibration and example applications project (USEPA, 1991)
 - ☔ Sources of Pollutants in Wisconsin Stormwater (Water Science Technology, 1993)
 - ☔ Monitoring BMP Effectiveness at Industrial Sites (Engineering Foundation Conference, 1994)
 - ☔ Sources of phosphorus in stormwater and street dirt from two urban residential basins in Madison, Wisconsin (USGS Water Survey, 1995)



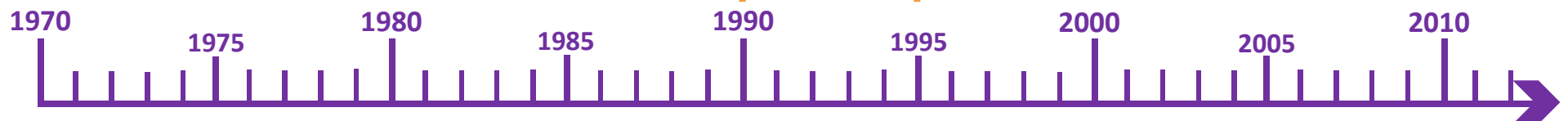
SLAMM in the 1990s

Early to mid-1990s



Program evaluates:

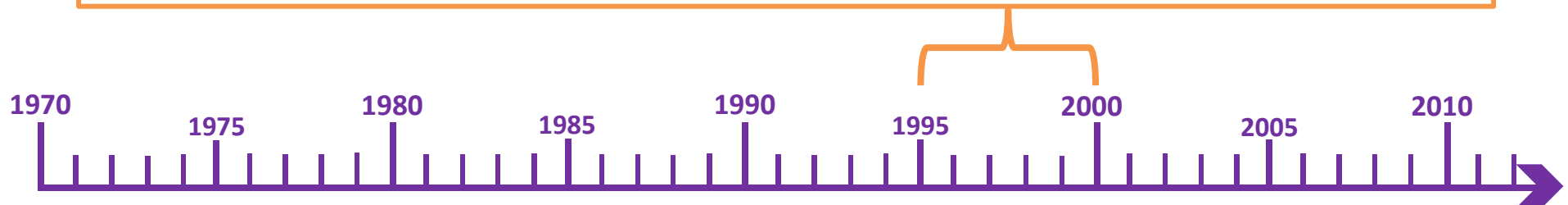
- Runoff volume and pollutant loads from source areas
- Street Cleaning
- Catch Basin Cleaning
- Wet Detention Ponds



SLAMM in the 1990s

Mid to Late 1990s

- ☁ Studies continue:
 - ☁ Contaminant concentration in stormwater from eight Lake Superior basin cities (USGS, 1996)
 - ☁ Influence of particle size on detention pond effectiveness (Water Environment Research, 1997)
 - ☁ Sources of contamination in an urban basin in Marquette, Michigan, and an analysis of concentrations, loads, and data quality (USGS, 1997)
 - ☁ Evaluation of the effectiveness of an urban stormwater treatment unit in Madison, Wisconsin (USGS, 1997)
 - ☁ Evaluation of the multi-chambered treatment train, a retrofit water-quality management practice (USGS, 1999)



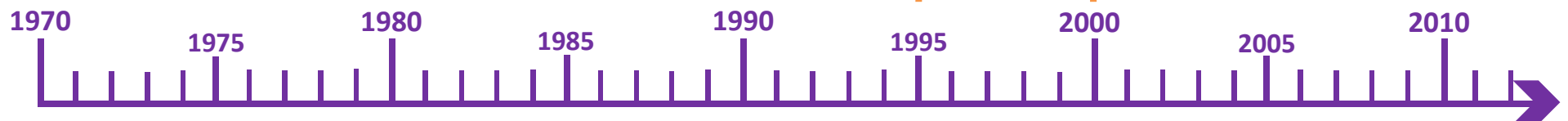
SLAMM in the 1990s

Mid to Late 1990s



Model evaluates:

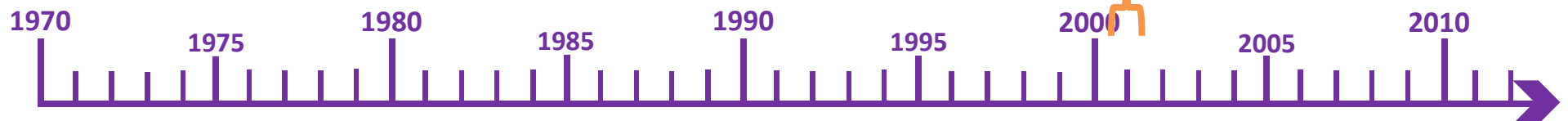
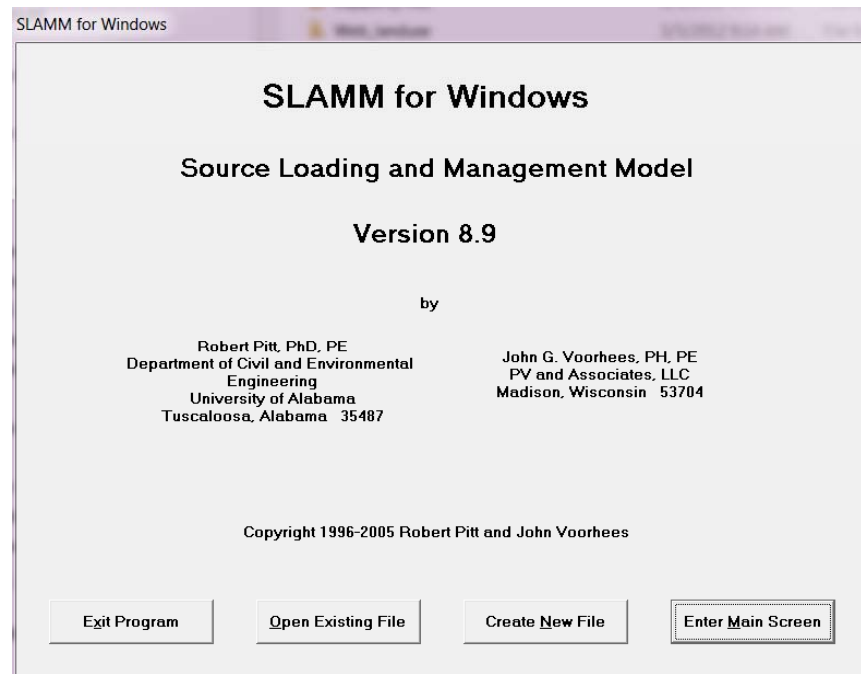
- Runoff volume and pollutant loads from source areas
- Street Cleaning
- Catch Basin Cleaning
- Wet Detention Ponds
- Grass Swales
- Porous Pavement



SLAMM in the 2000s

2001

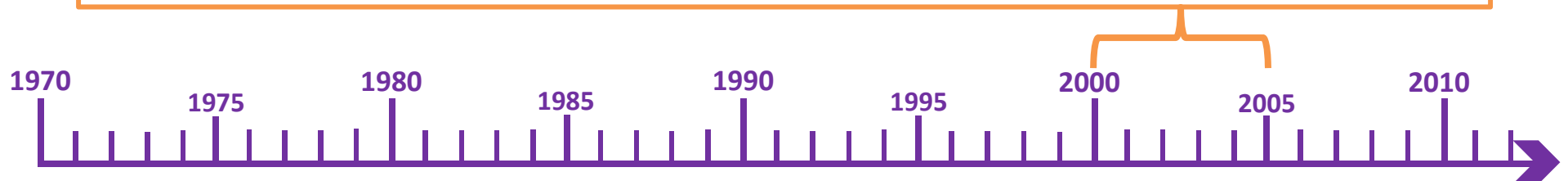
 First Windows Version Released



SLAMM in the 2000s

Early to Mid-2000s

- ☔ Studies continue:
 - ☔ Data and Methods of a 1999-2000 street sweeping study on an urban freeway in Milwaukee County, Wisconsin (USGS, 2003)
 - ☔ Source Area and Regional Storm Water Treatment Practices: Options for Achieving Phase II Retrofit Requirements in Wisconsin (Urban StormWater, 2003)
 - ☔ Effectiveness of a pressurized stormwater filtration system in Green Bay, Wisconsin (USGS, 2004)
 - ☔ Sources of pollutants in urban areas (Part 1) – Older monitoring project (CHI, 2005)
 - ☔ Sources of pollutants in urban areas (Part 2) – Recent sheetflow monitoring results (USGS, 2005)

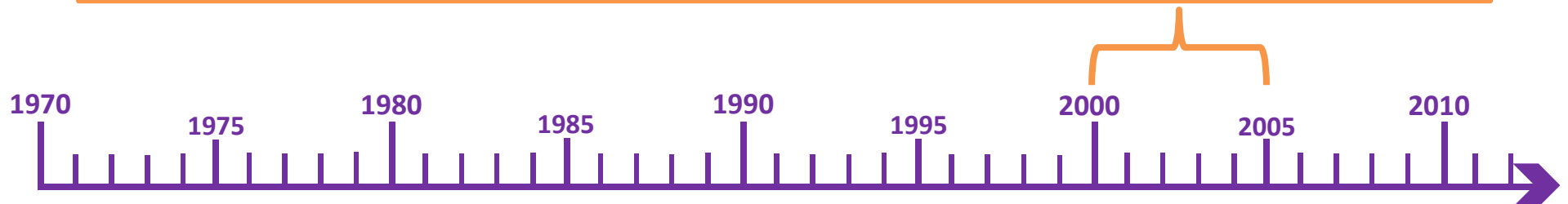


SLAMM in the 2000s

Early to Mid 2000s

☁️ Program evaluates:

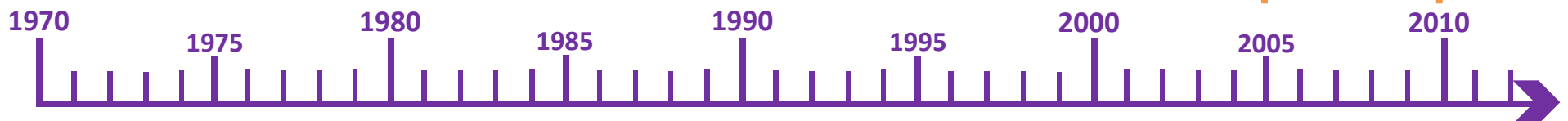
- Runoff volume and pollutant loads from source areas
- Street Cleaning
- Catch Basin Cleaning
- Wet Detention Ponds
- Biofiltration
- Infiltration
- Grass Swales (Infiltration only)



SLAMM in the 2000s

Mid to Late 2000s

- ☁ Studies continue:
 - ☁ Review of historical street dust and dirt accumulation and washoff data (CHI, 2005)
 - ☁ Efficiency of a Hydrodynamic Settling Device in Madison, Wisconsin (USGS, 2006)
 - ☁ Evaluation of street sweeping as a stormwater-quality management tool in three residential basins in Madison, Wisconsin (USGS, 2007)
 - ☁ Comparison of Runoff Quantity and Quality from Two Small Basins Undergoing Implementation of Conventional and Low-Impact-Development (LID) Strategies: Cross Plains, Wisconsin (USGS, 2008)
 - ☁ Parking lot runoff quality and treatment efficiency of a stormwater filtration device, Madison, Wisconsin (USGS, 2009)



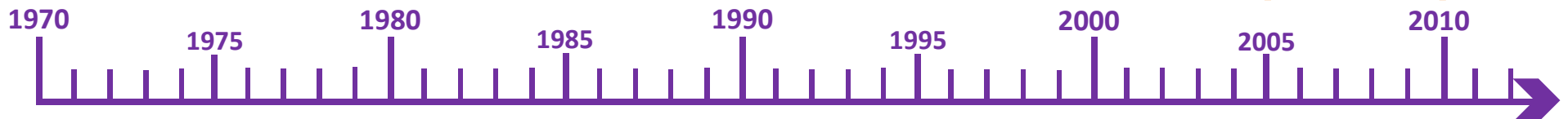
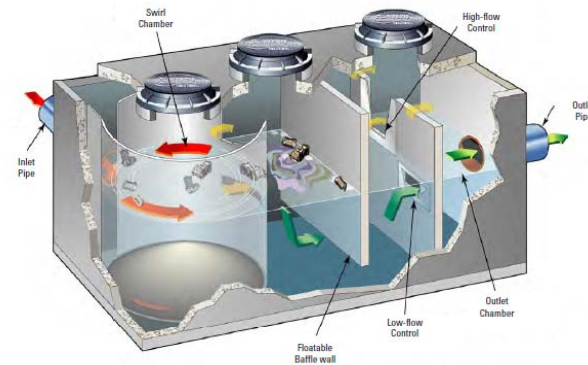
SLAMM in the 2000s

Mid to Late 2000s



Program evaluates:

- Runoff volume and pollutant loads from source areas
- Street Cleaning
- Catch Basin Cleaning
- Wet Detention Ponds
- Biofiltration
- Infiltration
- Grass Swales (Filtration and Infiltration)
- Cisterns
- Hydrodynamic Devices

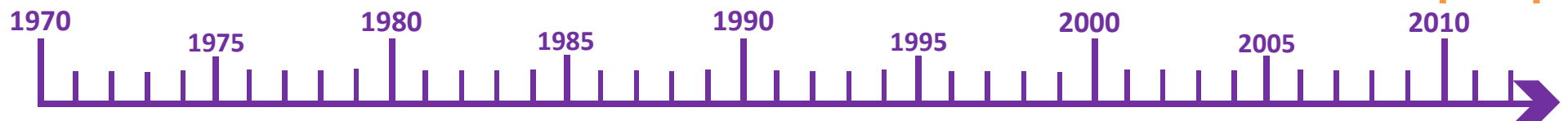


SLAMM in the 2010s

Early to Mid-2010s

☁️ Studies continue:

- ☁️ Highway-Runoff Quality, and Treatment Efficiencies of a Hydrodynamic-Settling Device and a Stormwater-Filtration Device in Milwaukee, Wisconsin (USGS, 2010)
- ☁️ Characterizing the size distribution of particles in urban stormwater by use of fixed-point sample-collection methods (USGS, 2011)
- ☁️ More to be published...



SLAMM in the 2010s

2012

☁️ First “Drag and Drop” Interface Released

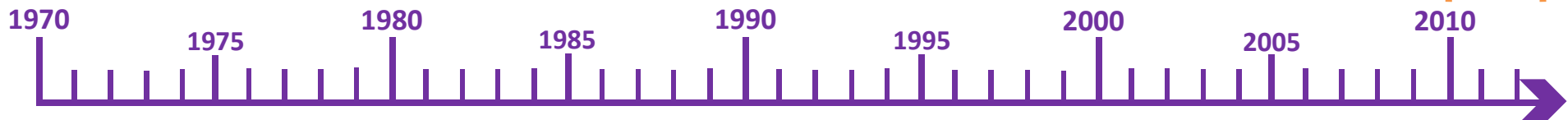
The screenshot displays the WinSLAMM v 10 software interface. The window title is "WinSLAMM v 10 Data File: [C:\Files\SLAMM\WinSLAMM\Test Files\Witch H\VOGC_Existing.mdb] - [Land Use Model]". The interface includes a menu bar (File, Current File Data, Pollutants, Tools, Run, Utilities, Help) and a toolbar with various icons. The main area is divided into two panes. The left pane shows a "Land Use" table with columns for Source Area #, Source Area, Area (acres), Source Area Parameters, First Control Practice, and Second Control Practice. It lists "Roofs" (Source Area 1, Area 1.607) and "Parking" (Source Area 13, Area 4.538). Below this is a "Land Use" table with columns for Land Use #, Land Use Type, Land Use Label, and Land Use Area (acres). The right pane shows a complex network diagram with nodes representing land use types (e.g., Light Industrial, Open Space, Shopping Center, Schools, Hospital, Office Park, Wet Pond, Outfall) and control practices (e.g., Other Device 1-9, OGC-1-9). The diagram illustrates the flow of water from various land use areas through different control practices to a final outfall.

Source Area #	Source Area	Area (acres)	Source Area Parameters	First Control Practice	Second Control Practice
Roofs					
1	Roofs 1	1.607	Entered	--	--
2	Roofs 2				
3	Roofs 3				
4	Roofs 4				
5	Roofs 5				
6	Roofs 6				
7	Roofs 7				
8	Roofs 8				
9	Roofs 9				
10	Roofs 10				
11	Roofs 11				
12	Roofs 12				
Parking					
13	Paved Parking 1	4.538	Entered	--	--
14	Paved Parking 2				
15	Paved Parking 3				
16	Paved Parking 4				
17	Paved Parking 5				

Land Use #	Land Use Type	Land Use Label	Land Use Area (acres)
1	Freeway	Type8: 4 Lane Urban X/S without Media	1.606
2	Residential	Medium Density Res. No Alleys	47.317
3	Other Urban	Open Space	2.039
4	Other Urban	Parks	0.318
5	Freeway	Type8: 4 Lane Urban X/S without Media	3.982
6	Residential	Medium Density Res. No Alleys	1.274
7	Other Urban	Open Space	11.910


CP #	Control Practice Type	Control Practice Name or Location
1	Other Device	DS Other Device # 1
2	Other Device	DS Other Device # 2
3	Other Device	DS Other Device # 3
4	Other Device	DS Other Device # 4
5	Other Device	DS Other Device # 5
6	Other Device	DS Other Device # 6
7	Other Device	DS Other Device # 7

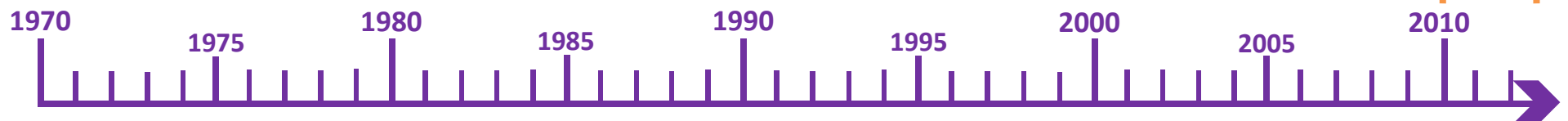
Current File Data Entered | Total Area = 571.831 acres | No Upstream Source Areas | LU# = 21 | Index Number = 21 | Remaining Icons = 222 | Start Date: 01/01/81 | End Date: 12/31/81 | X = 11160 | Y = 10020



SLAMM in the 2010s

Early to Mid-2010s

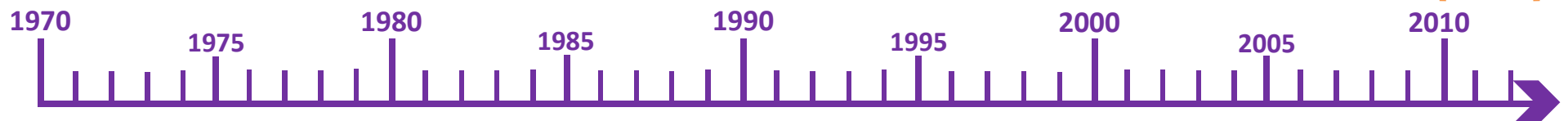
-  Program evaluates:
- Runoff volume and pollutant loads from source areas
 - Routes hydrographs and particle size distributions through network
 - Street Cleaning (high and low traffic areas)
 - Catch Basin Cleaning
 - Wet Detention Ponds
 - Biofiltration
 - Infiltration
 - Cisterns
 - Infiltration
 - Grass Swales (Filtration and Infiltration)
 - Filter Strips (Filtration and Infiltration)
 - Hydrodynamic Devices
 - Evapotranspiration



SLAMM's Future

Future Improvements

- ☁️ Continued refinement of runoff volume, pollutant loads, particle size distributions, and source area concentration data
- ☁️ Direct interaction with GIS
- ☁️ Leaf pick-up program quantification
- ☁️ Incorporation of phosphorus seasonality
- ☁️ Media Filters
- ☁️ Refined Porous Pavement Algorithms





For more Information,
see the Program's Help File
and
www.winslamm.com

