The MEUL method is a simplified version of the LANDRUN Model. LANDRUN is a urban and rural nonpoint source, hydrologic model developed as part of the PLUARG studies on pollution of the Great Lakes from land use and management. For rural areas, LANDRUN uses soil and management factors from the Universal Soil Loss Equation (USLE), infiltration factors, and depression storage factors. The amount of connected impervious surfaces is the key factor in the model for existing urban areas. The MEUL method was developed by using the LANDRUN model to calculate sediment and phosphorus loadings for selected urban and rural land use activities for selected slope and soil groupings. For example, results were calculated for corn grown continuously on very shallow, moderate, and steep slopes in sandy, loamy, clayey, and organic soils. The cropping and management factors of the USLE are used in rural lands to make adjustments from the model simulated results.

The MEUL Method was modified for construction site analysis. The basic assumptions and modifications are as follows:

1. No conservation practices are being used.
2. The soil is bare in the spring and a substantial amount of cover due to weed growth exists in the summer and fall.
3. The overland flow loading multiplier based on slope and the delivery factor used in the MEUL Method cancel.
4. The phosphorus content of the eroded soil is based on a substantial amount of subsoil being eroded. Therefore, half of the phosphorus content used for top soil is assumed for soil from construction sites.

Based on these assumptions, the following values were used:

		Sediment (Tons/acre delivered)	Phosphorus (lbs/acre delivered)
For slopes	0-2%	4	8
	2-6%	12	37
	6-12%	40	119

Phosphorus reaching the streams and eventually Lake Mendota from livestock wastes was estimated using a technique proposed in a Masters thesis by I.C. Moore with a few modifications. The technique is based on a literature review of phosphorus carried in runoff from field plots where manure has been spread, as well as barnyards. In addition, attenuation rates and distances are proposed. That is to say, the closer the field or barnyard is to the stream, the percent of phosphorus reaching the stream will be higher. Moore indicated at a distance of 130 feet on moderate slopes, all the phosphorus would be tied up in the soil. This technique has not been calibrated or verified.

Moore concluded about 4% of the phosphorus generated annually by livestock has the potential to be carried in runoff from barnyards. Also, about 8% of the phosphorus generated during the "winter period" has the potential to be carried in runoff from fields where manure is spread during the winter. The "winter period" is about 40% of the year. Based on these conclusions, one animal unit of dairy cows (a dairy cow equals 1.4 animal units) produces 1.2 lbs. of phosphorus available to be carried off in runoff from barnyards and 1.0 lbs. of phosphorus available to be carried off from fields. These are averages. The amounts of phosphorus for given operations may vary greatly.

The attenuation distances used for the phosphorus estimates for this evaluation were significantly increased. The attenuation rates and distances proposed by Moore are based on non-channel flow. However, field inspections indicate flow from barnyards is commonly channel flow. Therefore, the average attenuation distances should be much greater. The assumptions identified below were used for the analysis.

For barnyard runoff - Any livestock operation farmstead within 250' of the stream network is considered to have little or no attenuation.

Any farmstead between 250' and 660' of the stream network is assumed to have 50% attenuation.

Any farmstead located between 660' and 1,330' of the stream network where the slope between the farmstead and stream is steep (C slope) is assumed to have 50% attenuation.

All others, 0% delivery.

For manure spread on fields in winter - It is assumed most of the manure is spread within a "short" distance of the farmstead. Below are the model assumptions for delivery of manure spread on farm fields.

Any farmstead within 250' of the stream network where the field slopes are 6% or greater is considered to have a 25% attentuation.

Any farmstead between 250' and 1,330' of the stream network where the field slopes are 6% or greater, the attenuation rate is 50%.

If the field slopes are less than 6%, the attentuation rate is considered to be 100%; 0% delivery.

Sediment and phosphorus from streambank erosion was not estimated.

Results - Estimated sediment and phosphorus loadings to Lake Mendota are summarized by subwatershed in Tables 3 and 4.

Croplands and other rural lands contribute an estimated 50% of the sediment and 48% of the phosphorus delivered on an average annual basis to Lake Mendota. For croplands, the majority of the sediment and phosphorus is from steeper slopes (C slopes and greater) planted in corn or tilled up and down the slope. There is also a concern about fields on slopes of 2-6 percent (B slopes) close to streams where corn is grown year after year and tilled up and down the slope.

Livestock operations represent an estimated 8% of the total amount of phosphorus. About 5% is attributable to barnyard runoff and 3% is from manure spread on fields during the winter. Sediment from barnyards was not estimated, however, it can be significant due to the absence of vegetative cover. The values for phosphorus are lower than previous estimates for Lake Mendota even if the rate per animal is doubled. However, much of the manure is spread on loamy soils with shallow slopes which recent research indicates are not significant sources.

Table 3
Estimated Average Annual Sediment Loading to Lake Mendota by Subwatershed and Source Type Based on MEUL Method
(Tons)

Subwatershed	Land Use			
	Urban	Construction	Cropland	Total
Willow Creek	1,387	6	2	1,395
Spring Harbor	1,350	2,476	54	3,880
S.F. Pheasant Br.	470	2,904	856	4,230
N.F. Pheasant Br.	-	800	6,316	7,116
Mid & Lower Ph. Br.	4,358	2,356	1,000	7,714
Direct to Lake	1,306	1,520	95	2,921
Above W. Marsh*	-	-	2,616	2,616
Below W. Marsh	875	2,487	3,474	6,836
Sixmile Creek	-	-	337	337
Spring Creek	-	-	7,182	7,182
Total	9,746	12,549	21,932	44,227
	22%	28%	50%	

* Assumes 75% of sediment retained in Waunakee Marsh

Table 4
Estimated Phosphorus Loading to Lake Mendota
by Subwatershed and Source Type
Based on MEUL and Moore Methods
Phosphorus (LBS)

Subwatershed	Land Use				
	Urban	Construction	Cropland	Livestock	Total
Willow Creek	4,135	14			4,149
Spring Harbor	3,326	8,216			11,542
S.F. Pheasant Br.	972	8,733	2,422		12,127
N.F. Pheasant Br.		2,380	13,637	3,247	19,264
Mid. & Lower Ph. Br.	8,813	6,974	2,761	318	18,866
Direct to Lake	3,272	4,418	281	293	8,264
Above W. Marsh*			13,832	2,502	16,334
Below W. Marsh	1,868	7,666	10,273	1,278	21,085
Sixmile Creek			915		915
Spring Creek			21,639	3,078	24,717
	22,386	38,401	65,760	10,716	137,263
	16%	28%	48%	8%	

*Assumes 25% phosphorus retention by Waunakee marsh.

For existing urban areas, the sediment and phosphorus levels per acre are generally low. Overall, existing urban areas contribute an estimated 22% of the sediment and about 16% of the phosphorus. The efficiency of the City of Madison's street sweeping is generally good, but the leaf collection program is fair due to confused recommendations to homeowners. During 1981, the Willow Creek subwatershed was swept once every 7-10 days with a vacuum sweeper. The sweeping frequency in the Spring Harbor subwatershed was once every 10-14 days and brush sweepers were used. However, if the frequency of sweeping was significantly decreased especially during the spring and fall, the amount of sediment and phosphorus from Madison's streets could double or even triple. A number of large shopping center parking lots are swept very infrequently or not at all. The street sweeping in Shorewood Hills is fair to poor based on the type and frequency of sweeping.

The majority of the phosphorus and sediment estimated from the existing urban areas in the Middle and Lower Pheasant Branch subwatersheds is from the steeply sloped, wooded banks of Pheasant Branch Creek within the City of Middleton. As mentioned in the watershed description, this stream channel is continually eroding. The street sweeping and leaf collection efforts are good in single family residential areas and fair in multi-family areas with large parking lots.

Although construction sites represent a small percent of the land area in the watershed, they contribute an estimated 28% of the sediment and phosphorus.

The three major developing areas are in the South Fork Pheasant Branch subwatershed east of the Beltline Highway within the City of Madison, on the northeast side of the City of Middleton and near Waunakee. Overall, more than 90% of the construction is occurring within incorporated or extraterritorial limits. The remaining construction is scattered throughout the rural (unincorporated) areas of the watershed.

In addition to the sediment and phosphorus being carried from the construction sites, the houses, streets, driveways, and other pervious surfaces being constructed increase the rate and volume of runoff from these developing areas. This is a particular concern for Pheasant Branch Creek. As the South Fork Pheasant Branch subwatershed undergoes development, the rate and volume of flow will increase in the lower portion of Pheasant Branch Creek. This may further aggravate the streambank and bed erosion in this lower section of Pheasant Branch Creek.

Recommended Watershed Actions

The objective of the Sixmile-Pheasant Branch Watershed Project is to substantially reduce sedimentation of the harbors and shallow areas of Lake Mendota and of Waunakee and Pheasant Branch Marshes. The purpose of this section of the plan is to identify actions needed to achieve the project's objectives. The actions may be in the form of structural or non-structural measures termed "best management practices." Examples of best management practices are grassed waterways, contour strip cropping, street sweeping, and stormwater detention basins. The actions may also be in the form of legal or operational procedures such as enactment and enforcement of ordinances to control erosion and stormwater runoff on construction sites. A watershed of this complexity necessitates actions of both types.

It was the desire of all agencies involved in developing this plan to identify the actions needed in sufficient detail to guide local agencies and units of government in implementing this plan. However, in specific cases, the surveys conducted during the preparation of this plan identified additional assessments which should be done within a reasonable time - preferrably during the first year of the implementation effort.

Priority Management Areas - A priority management area is defined as that portion of a watershed where the quantity of pollutants is most significant and where the application of best management practices will be most effective. Since the 1930's, hydrologists, engineers, and scientists have been looking at overland flow as a factor in predicting runoff volumes, flooding and sediment delivery to downstream lakes and streams. It is commonly accepted not all lands within a watershed will produce runoff waters that reach the stream network. Those areas that do produce runoff have been termed "hydrologically active areas." Generally these areas have soils which are saturated or become saturated during rainstorms.

Even though an area may be hydrologically active, not every parcel of land will have the same delivery rate. Generally, the delivery rate will be nearly one (100%) at the streambank and nearly zero at the extreme upslope boundary of the hydrologically active area. The delivery rate is dependent on a number of variables such as distance from a stream, slope, and soil texture. Delivery rates are generally believed to diminish rapidly with increasing distance from the stream. In addition, the velocity and carrying capacity of runoff is generally assumed to be proportional to the slope. Therefore, the greater the slope, the greater the delivery rate.

The priority management area for the Sixmile - Pheasant Branch Watershed is as follows:

For rural areas - all lands draining to the streams and Lake Mendota within 1/8 mile (660') of perennial or intermittent streams, wetlands, or lakes. The width of the priority management area is extended to 1/4 mile (13,200') for steeply sloped lands (6% or greater slopes). Internally drained areas are not included.

For urban areas - all lands draining to the storm sewer network draining to Lake Mendota. Internally drained areas are not included.

Not all lands within the priority management area currently need best management practices. Some have adequate management and some lands have physical conditions such as shallow slopes and thus are not significant nonpoint sources. It is not practical to delete each of these areas from the description of the priority management area. Therefore, the priority management area identifies the overall boundaries. In both urban and rural areas, additional analysis was undertaken to highlight management needs. For example, existing urban and developing areas were ranked based on indicators such as the type and intensity of land use, the percent of impervious surface cover, and soil type. Highlighted urban areas are shown on the map following page 16. Specific site conditions and areas where actions are needed within the priority management area are identified below.

Recommendations for Croplands and other rural lands in the Sixmile-Pheasant Branch Watershed

Best management practices:

- Contour cropping
- Contour Strip cropping
- Minimum Tillage
- Grassed waterways
- Field Diversions
- Terraces
- Crop Rotations
- Livestock Exclusion From Woodlots
- Grade stabilization structures
- Streambank and shoreline protection
- Fencing
- Sloping and Seeding
- Riprapping
- Fertilizer Management
- Pesticide Management