

## **Southern Michigan / North-eastern Illinois Outdoor Ornamental Nursery Scenario**

This scenario is one of a suite of scenarios intended to represent outdoor ornamental nursery scenarios in the United States. It should be noted that nurseries are diverse and represent a range of topographic, cultivation, and plant types. Scenarios, when possible have been developed to represent conservative nursery practices that will yield “high-end” runoff, but not unrealistic of actual nurseries in the area. Similarly, selection of curve numbers are based on best available data from TR-55 until further calibration can be performed using regional runoff data, which at the time of scenario development is generally unavailable for nurseries. Figure 1 provides an overview of available curve numbers from TR-55 in order to provide context to the relative magnitude of the curve number used in this scenario. The closest curve number that could be associated with outdoor nurseries is for “farmsteads”, due to similar cover conditions. Curve numbers are generally among the highest available, exceeded primarily by soils in poor condition.

This scenario is parameterized to generally represent outdoor ornamental nursery production in southern Michigan and North-eastern Illinois. The scenario nominally represents outdoor ornamental nurseries in Ottawa County, Michigan since it is the county with the most number of acres in production in the region. In 2002, the state of Michigan ranked 7<sup>th</sup> in the U.S. for total number of ornamental nursery acres in the outdoors (i.e., not under glass), with nearly 26,412 acres in the open (USDA 2002a). In 2002, Illinois ranked 10<sup>th</sup> in the U.S. for outdoor nursery acreage. In Michigan, approximately 23% (5,954 acres) of the total acreage is located in Ottawa County. MLRA 98 dominates southern Michigan and contains the majority of Ottawa County.

Plants cultivated by outdoor nurseries are diverse. For this scenario, crop parameters have been selected when possible to be representative of typical outdoor nursery practices in southern Michigan and north-eastern Illinois. In general, this scenario represents outdoor coniferous evergreen production, including but not limited to Christmas trees. In field production southern Michigan nurseries grow coniferous evergreens, deciduous shade trees, herbaceous perennials and some deciduous shrubs. All of these items are also grown in container operations as well. Based on NASS chemical usage data for 2003, approximately 60% of pesticides applied to nursery crops (by pounds applied) in Michigan are applied to Christmas trees and 12% are applied to other coniferous evergreens (USDA, 2004a). According to the USDA 2003 nursery crops summary (USDA, 2004b), approximately even amounts of coniferous evergreens are container grown in Michigan, approximately 75% of deciduous shade trees are “balled-&-burlapped”. Irrigation may be used for field grown nursery stock in most years as needed during June to August if rainfall is not adequate and is done by overhead travelers, solid set or drip irrigation for some shade trees or pot in pot systems. For this scenario, emergence, maturity, and harvest dates have been set to represent an evergreen crop.

Metfile W14840 is the closest meteorological station to Ottawa County, MI and is within approximately 17 miles of the county centroid. Its data were collected in Muskegon, MI located in the south-western part of the state. The station is located approximately 190 meters above mean sea level (AMSL) which is comparable to Ottawa County which generally ranges from 150 to 250 meters AMSL. Muskegon receives an average rainfall of 33 inches (NOAA, 2006).

Nursery soils used for field production are primarily native soils and are generally not “engineered” soils. Common soil types used for outdoor nursery production include Granby, Augres, Saugatuck, Nestor, Kawkawlin and Belding soil types (Thomas Dudek, personal communication). Exact locations and geographic extent of nurseries in the region are not available; therefore soils were selected based on soil recommendations of local experts, the geographic extent of the listed soils in the area, the drainage group, slope, and erodibility. In developing this scenario, preference was given to selecting a benchmark soil that is in hydrologic group “C” or “D”, and is capable of supporting outdoor nurseries (EPA, 2004). The Granby series was selected for this scenario based on (in order of importance) the recommendation of a local extension agent to support the modeled use, its drainage classification, its status as a benchmark soil, and its large extent in the region. Granby represents the 90<sup>th</sup> percentile of vulnerability in drainage for soils in Ottawa County (the most extensive soil in drainage group D and the most extensive soil overall in the county). Several soil types exceed the Granby series in erodibility (Table 5); however preference was given to the larger geographic extent and greater potential for runoff for Granby soils. Furthermore, Granby soils are also within the typical slope range of 2-3% based on local information (Thomas Dudek, personal communication). Specific soil parameters were selected to parameterize this scenario based on “Granby Loamy Sand” located in Ottawa County, Michigan (Table 4).

The Granby series consists of very deep, poorly drained or very poorly drained soils formed in sandy outwash or sandy glaciolacustrine deposits on outwash plains, lake plains, and glacial drainageways. The series is of large extent and is found in southern Michigan, northern Indiana, northern Ohio, southern Minnesota, southern Wisconsin, northeastern Illinois, Connecticut, and New York (USDA, 2003). Granby is a Hydrologic Group D soil, which represents approximately 13% of the soils in Ottawa County (Table 5). Granby soils have a USLE K factor of that ranges from 0.17-0.2, which is similar to nine other common soils in Ottawa County. Approximately 40% of Ottawa County soils have a pH lower than Granby soils. However, soil pH is not currently a PRZM input parameter and is not expected to often affect chemical fate in the acidic range. Granby soils have an A horizon from 0 to 10 inches (0-25 cm) deep, a B horizon from 10-32 inches (25-81 cm) deep, and a C horizon from 32 to 80 inches (81-1203 cm) deep (USDA, 2003).

| <b>Table 1. PRZM 3.12 Climate and Time Parameters for Southern Michigan / North-eastern Illinois – Ornamental Nurseries.</b> |              |   |
|--|--------------|---|
| <b>Parameter</b>   | <b>Value</b> | <b>Source/Comments</b>                    |
| Starting Date  | Jan. 1, 1961 | Meteorological File Muskegon, MI (W14840) |

|                                      |               |  |
|--------------------------------------|---------------|--|
| Ending Date                          | Dec. 31, 1990 | Meteorological File Muskegon, MI (W14840)  |
| Pan Evaporation Factor (PFAC)        | 0.77          | PRZM Manual Figure 5.1. Value represents most of Southern Michigan / North-eastern Illinois.     |
| Snowmelt Factor (SFAC)               | 0.16          | PRZM Manual Table 5-1. Max of the min range of values for mixed coniferous/deciduous open areas. |
| Minimum Depth of Evaporation (ANETD) | 17.5 cm       | PRZM Manual Figure 5.2 (EPA, 1998)<br>Set to guidance default for free draining soils.           |

**Table 2. PRZM 3.12 Erosion and Landscape Parameters for Ottawa County, Michigan – Ornamental Nurseries.**

| Parameter  | Value    | Source/Comments  |
|--|----------|--|
| Method to Calculate Erosion (ERFLAG)                           | 4 (MUSS) | PRZM Guidance, EPA, 2004   |
| USLE K Factor (USLEK)  | 0.17     | USDA NRCS Soil Data Mart ( <a href="http://soildatamart.nrcs.usda.gov/">http://soildatamart.nrcs.usda.gov/</a> )<br>Value listed for the soil series Granby loamy sand.  |
| USLE LS Factor (USLELS)  | 0.2      | LS equation (Haan and Barfield, 1978)<br>LS value for 1% slope and 400' slope length   |
| USLE P Factor (USLEP)  | 1.0      | Set to 1.0 for orchards as per PRZM Scenario Guidance (EPA, 2004).   |
| Field Area (AFIELD)  | 172 ha   | Area of Shipman Reservoir watershed (PRZM Guidance, EPA, 2004)   |
| NRCS Hyetograph (IREG)   | 3        | PRZM Manual Figure 5.12 (EPA, 1998)  |
| Slope (SLP)  | 1%       | USDA NRCS Soil Data Mart ( <a href="http://soildatamart.nrcs.usda.gov/">http://soildatamart.nrcs.usda.gov/</a> )<br>Mid-point for the soil series Granby loamy sand (0-2%). PRZM Scenario Guidance (EPA, 2004).  |
| Hydraulic Length (HL)  | 600 m    | Shipman Reservoir (PRZM Guidance, EPA, 2004)   |
| Irrigation Flag (IRFLAG)                                       | 2        | Irrigation during cropping period only. Thomas Dudek (MSUE)<br>“Field grown nursery stock may be irrigated in most years as needed during June to August if rainfall is not adequate and is done by overhead travelers”  |
| Irrigation Type (IRTYP)  | 3        | 3 = over canopy sprinkler. Irrigation Guidance for developing PRZM Scenario, Table 3; (June 15, 2005); and Thomas Dudek (MSUE)   |
| Leaching Factor (FLEACH)                                       | 0.1      | Default value. Irrigation Guidance for developing PRZM Scenario, Table 3; (June 15, 2005).   |
| Fraction of Water Capacity when Irrigation is Applied (PCDEPL) | 0.5      | Default value. Irrigation Guidance for developing PRZM Scenario, Table 3; (June 15, 2005), and Tomas Dudek (MSUE) “For field production, available soil moisture in the rooting zone triggers irrigation, usually when it falls below 50% soil moisture capacity.” |
| Maximum Rate at which Irrigation is Applied (RATEAP)           | 0.1      | Default value. Irrigation Guidance for developing PRZM Scenario, Table 1; (June 15, 2005). Set based on cropping curve number.   |

| <b>Table 3. PRZM 3.12 Crop Parameters Ottawa County, Michigan – Ornamental Nurseries (Christmas trees).</b> |               |   |
|---|---------------|---|
| <b>Parameter</b>  | <b>Value</b>  | <b>Source/Comments</b>  |
| Initial Crop (INICRP)   | 1             | Default value   |
| Initial Surface Condition (ISCOND)  | 3             | 3 = residue. Surface consists of mainly gravel or compacted sand. T. Dudek, Cooperative Extension Horticulture and Marketing Agent, Michigan State University.  |
| Number of Different Crops (NDC)   | 1             | Set to number of crops in simulation. Default value.  |
| Number of Cropping Periods (NCPDS)  | 30            | Set to weather data in meteorological file: Muskegon, MI (W14840)   |
| Maximum rainfall interception storage of crop (CINTCP)  | 0.1           | Table 5-4 PRZM manual, light density crops (EPA, 1998).   |
| Maximum Active Root Depth (AMXDR)   | 61 cm         | T. Dudek, Cooperative Extension Horticulture and Marketing Agent, Michigan State University.  |
| Maximum Canopy Coverage (COVMAX)  | 35%           | Trees are spaced 6 feet apart (MSU, 2006). Assumes 4 ft diameter tree canopy. COVMAX similar to Oregon Christmas tree scenario.   |
| Maximum Canopy Height (HTMAX)   | 213 cm (7ft)  | Retail height of Christmas trees range from 6 to 7 feet (NCTA, 2006).   |
| Soil Surface Condition After Harvest (ICNAH)  | 3             | 3 = residue. Surface consists of mainly gravel or compacted sand. T. Dudek, Cooperative Extension Horticulture and Marketing Agent, Michigan State University.  |
| Date of Crop Emergence (EMD, EMM, IYREM)  | 01/01/61      | Values are set to keep E/T and canopy coverage terms working correctly for this evergreen scenario.   |
| Date of Crop Maturity (MAD, MAM, IYRMAT)  | 02/01/61      | Values are set to keep E/T and canopy coverage terms working correctly for this evergreen scenario.   |
| Date of Crop Harvest (HAD, HAM, IYRHAR)   | 31/12/61      | Values are set to keep E/T and canopy coverage terms working correctly for this evergreen scenario.   |
| Maximum Dry Weight (WFMAX)  | 0.0           | Not used in scenario  |
| SCS Curve Number (CN)   | 86, 86, 86    | TR-55, Table 2-2c (USDA 1986). Value for farmsteads, buildings, lanes, driveways, and surrounding lots. Hydrologic Group D.   |
| Manning's N Value (MNGN)  | 0.014         | RUSLE Project; La2OBOBC for Grand Rapids, MI orchards with Conventional Till and no cover (cover code 6). These data were used to approximate values for nurseries Michigan as no data for ornamental nurseries were included in the project.   |
| USLE C Factor (USLEC)   | 0.110 - 0.497 | RUSLE Project; La2OBOBC for Grand Rapids, MI orchards with Conventional Till and no cover (cover code 6). These data were used to approximate values for nurseries Michigan as no data for ornamental nurseries were included in the project. Note: RUSLE dates and C factors from the RUSLE project have been reordered and tied to emergence dates. |

| <b>Table 4. PRZM 3.12 Granby loamy sand Soil Parameters for Ottawa County, Michigan – Ornamental Nurseries</b> |              |  |
|--|--------------|--|
| <b>Parameter</b>   | <b>Value</b> | <b>Source/Comments</b>   |
| Total Soil Depth (CORED)   | 152 cm       | NRCS Soil Data Mart (SDM) ( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> )  |
| Number of Horizons (NHORIZ)  | 4            | NRCS Soil Data Mart (SDM) ( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> ). |

|                               |  |   |
|-------------------------------|--|---|
| Horizon Thickness (THKNS)     | 10 cm (HORIZN = 1)<br>15 cm (HORIZN = 2)<br>56 cm (HORIZN = 3)<br>71 cm (HORIZN = 4)   | NRCS Soil Data Mart (SDM)<br>( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> ).   |
| Bulk Density (BD)             | 1.4 g/cm <sup>3</sup> (HORIZN = 1)<br>1.4 g/cm <sup>3</sup> (HORIZN = 2)<br>1.53 g/cm <sup>3</sup> (HORIZN = 3)<br>1.53 g/cm <sup>3</sup> (HORIZN = 4)   | NRCS Soil Data Mart (SDM)<br>( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> ). Midpoint of the reported range. PRZM Scenario Guidance (EPA, 2004). |
| Initial Water Content (THETO) | 0.232 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =1)<br>0.232 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =2)<br>0.117 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =3)<br>0.103 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =4) | NRCS Soil Data Mart (SDM); values are mean 1/3-bar water contents of Granby loamy sand soils.   |
| Compartment Thickness (DPN)   | 0.1 cm (HORIZN = 1)<br>5.0 cm (HORIZN = 2)<br>4.0 cm (HORIZN = 3)<br>1.0 cm (HORIZN = 4)   | NRCS Soil Data Mart (SDM)<br>( <a href="http://soildatamart.nrcs.usda.gov">http://soildatamart.nrcs.usda.gov</a> ). PRZM Scenario Guidance (EPA, 2004).                                 |
| Field Capacity (THEFC)        | 0.232 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =1)<br>0.232 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =2)<br>0.117 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =3)<br>0.103 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =4) | NRCS Soil Data Mart (SDM); values are mean 1/3-bar water contents of Granby loamy sand soils  |
| Wilting Point (THEWP)         | 0.145 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =1)<br>0.145 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =2)<br>0.05 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =3)<br>0.037 cm <sup>3</sup> /cm <sup>3</sup> (HORIZN =4)  | NRCS Soil Data Mart (SDM); values are mean 15-bar water contents of Granby loamy sand soils.  |
| Organic Carbon Content (OC)   | 4.06 % (HORIZN = 1)<br>4.06 % (HORIZN = 2)<br>0.15 % (HORIZN = 3)<br>0.15 % (HORIZN = 4)   | NRCS SDM; values for horizons 1 to 3 = mean %OM / 1.724. PRZM Scenario Guidance (EPA, 2004).  |

### ***Sensitive Parameter Uncertainties***

#### **Meteorological File**

As characterized above, Metfile W14840 (Muskegon, MI) is the closest metfile to Ottawa County, which was used to represent this scenario. The metfile is located approximately 17 miles from the center of Ottawa County and is generally representative of the area.

#### **Slope**

The scenario USLELS value was calculated with the Haan and Barfield equation (1978) using a 1% slope and an assumed 400-foot slope length, as per PRZM scenario development guidance (EPA, 2004). A slope of 1% was selected because it is midpoint of the range for Granby soils according to USDA (USDA, 2006b). This value is also supported by which indicates information from local experts which indicate the maximum slope on which nurseries are located does not generally exceed 2-3 %. This scenario may underestimate runoff for nurseries located on slopes greater than 1%

#### **USLE C Factor and Manning's N Value**

The RUSLE Project does not include data for ornamental nursery crops. Therefore, USLE C Factor and Manning's N values were selected from data on Michigan orchards with no cover due to the similarities between conditions. This involves some uncertainty since many nurseries will create a surface layer of slag, gravel, or compacted sand. Of the available locations, Grand Rapids Michigan has the most similar meteorological conditions and no cover as this scenario.

### Soil Data

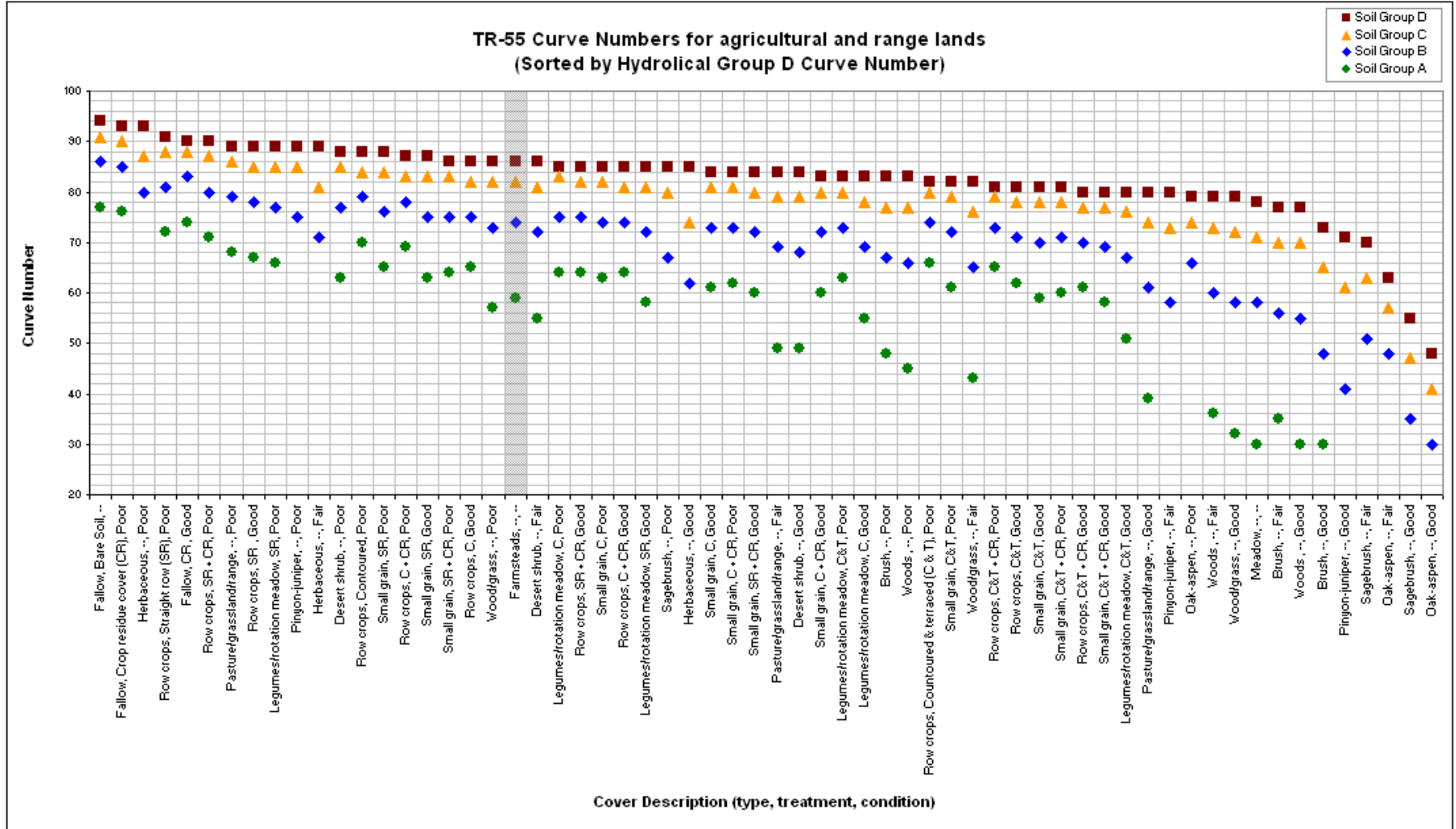
No geospatial data were available to determine the exact locations and geographic extent of nurseries in the region. The USGS GIRAS Landuse/Landcover data for the Conterminous United States includes a nurseries classification; however the data are generally 25 years old at the time of this scenario development and preliminary review of the data indicates that nurseries are not well represented. This is likely due to the resolution of the data (30 m) and age of the data set (based on 1970's and 80's imagery). As a result, soils were selected based on soil recommendations of local experts, the geographic extent of the listed soils in the area, the drainage group, slope, and erodibility. The soil selected is a hydrologic group D soil.

### Crop Parameters

Outdoor ornamental nurseries are highly diverse in the numbers, sizes, and types of plants grown. Ornamental nurseries also vary in the cultivation methods which can range from potted plants (container operations) to field nurseries that may harvest and package plants as bare root or balled and burlapped. This scenario has been parameterized to be representative of the most "typical" nursery plants in the area (see description above). Runoff and erosion may be over or underestimated depending on the type of nursery modeled and a sensitivity analysis has high value in this regard.

### Curve Number

The curve number is the most sensitive parameter in PRZM scenarios. The curve number for this scenario was based on TR-55 (Table 2-2c). Nurseries can be covered in roads, wooded areas, field borders, and buildings. Therefore the curve number closest to this scenario was the value for a hydrologic group D soil representative of farmsteads, buildings, lanes, driveways, and surrounding lots. Runoff and erosion may be under or over-estimated for alternative nursery operations and model validation has high value in this regard. Based on preliminary investigation, no runoff data are available for validating runoff from outdoor nursery operations in this geographic area.



**Figure 1. TR-55 (USDA, 1986) Farmstead curve number used for scenario development relative to other available cover types, soil treatments, and conditions.**

**Table 5. Soils of Ottawa County, California Ranked by Area<sup>a,b</sup>. Includes Soils Comprising Greater than 1% of Total Soil Acres.**

| Soil      | Total Acres | % Area | Hydrologic Group | Erodibility | Slope | pH      | OM     | Sand      | Silt      | Clay      |
|-----------|-------------|--------|------------------|-------------|-------|---------|--------|-----------|-----------|-----------|
| Granby    | 44630       | 13.1%  | A/D              | 0.17-0.2    | 0-2   | 6.5     | 5-7    | 66.9-83   | 9-20.1    | 8-13      |
| Nester    | 34456       | 10.1%  | C                | 0.32-0.37   | 2-40  | 6.5     | 0.75-2 | 34.2-43   | 32.3-38.5 | 18.5-33.5 |
| Rubicon   | 30617       | 9.0%   | A                | 0.15        | 0-45  | 5.8     | 2      | 93.6      | 1.4       | 5         |
| Kawkawlin | 25110       | 7.4%   | C                | 0.32        | 0-6   | 6.5     | 2.5    | 43        | 39.5      | 17.5      |
| Au Gres   | 21314       | 6.3%   | B                | 0.15-0.17   | 0-6   | 5.5-5.9 | 3.5    | 83.8-91.1 | 1.9-9.2   | 7         |
| Croswell  | 17025       | 5.0%   | A                | 0.15        | 0-6   | 5.5     | 1.5    | 92.1      | 1.9       | 6         |
| Blount    | 10409       | 3.1%   | C                | 0.37-0.43   | 0-6   | 5.8     | 2.5    | 38.8      | 36.7      | 24.5      |
| Iosco     | 10064       | 3.0%   | B                | 0.17        | 0-6   | 5.8     | 3      | 83.8      | 9.2       | 7         |
| Chelsea   | 8833        | 2.6%   | A                | 0.17        | 0-12  | 6.5     | 0.75   | 84.3      | 4.2       | 11.5      |
| Montcalm  | 8703        | 2.6%   | A                | 0.17        | 0-40  | 6.2     | 1.75   | 82.5      | 9         | 8.5       |
| Morley    | 8481        | 2.5%   | C                | 0.32-0.37   | 2-45  | 6.2     | 2-2.5  | 34.2-38.8 | 32.3-36.7 | 24.5-33.5 |
| Mancelona | 8470        | 2.5%   | B                | 0.17        | 0-12  | 5.8     | 1.75   | 79.2      | 15.8      | 5         |
| Deer Park | 7704        | 2.3%   | A                | 0.15        | 0-45  | 5.9     | 1.25   | 93.6      | 1.4       | 5         |
| Adrian    | 6080        | 1.8%   | A/D              | -           | 0-2   | -       | 82.5   | -         | -         | -         |
| Richter   | 6043        | 1.8%   | C                | 0.28        | 0-6   | 6.2     | 4.5    | 62.5      | 26        | 11.5      |
| Sloan     | 5988        | 1.8%   | B/D              | 0.28        | 0-2   | 7.2     | 4.5    | 41.6      | 37.4      | 21        |
| Sims      | 4996        | 1.5%   | D                | 0.28        | 0-2   | 6.7     | 2.5    | 41.6      | 37.4      | 21        |
| Allendale | 4718        | 1.4%   | B                | 0.24        | 0-4   | 6.5     | 2      | 67.8      | 23.7      | 8.5       |
| Belding   | 4331        | 1.3%   | B                | 0.2         | 0-6   | 5.8     | 1.5    | 66.6      | 23.4      | 10        |
| Carlisle  | 4313        | 1.3%   | A/D              | -           | 0-2   | -       | 82.5   | -         | -         | -         |
| Bowers    | 4155        | 1.2%   | B                | 0.28        | 0-6   | 6.5     | 2.5    | 44.3      | 40.7      | 15        |
| Boyer     | 3649        | 1.1%   | B                | 0.17        | 0-12  | 6.2     | 1.75   | 79.2      | 15.8      | 5         |
| Gladwin   | 3609        | 1.1%   | B                | 0.2         | 0-6   | 6.2     | 3      | 66.6      | 23.4      | 10        |
| Uby       | 3299        | 1.0%   | B                | 0.24        | 0-12  | 6.2     | 1.5    | 65.3      | 23.2      | 11.5      |

<sup>a</sup> pH, OM, Sand, Silt, and Clay are based on representative values from USDA Soil Data Mart.

<sup>b</sup> Table excludes soils less than 1% of total soil area. Areas such as gravel pits, urban land, sewage lagoons, etc were not included in the % area computations.

“-” = No data.



## Literature Cited

- Dudek, Thomas A. 2006. Personal communication through Nursery Scenario development questionnaire. District Horticulture and Marketing Agent, MSU Extension Ottawa County, Grand Haven, MI 49417, phone number (616) 846-8250, email address [dudek@msu.edu](mailto:dudek@msu.edu).
- EPA. 1998. Carsel, R.F., J.C. Imhoff, P.R. Hummel, J.M. Cheplick, and A.S. Donigian, Jr. PRZM-3, A Model for Predicting Pesticide and Nitrogen Fate in the Crop Root and Unsaturated Soil Zones: Users Manual for Release 3.0. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.
- EPA. 1999. Jones, R.D., J. Breithaupt, J. Carleton, L. Libelo, J. Lin, R. Matzner, and R. Parker. Guidance for Use of the Index Reservoir in Drinking Water Exposure Assessments. Environmental Fate and Effects Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, DC.
- EPA. 2004. Abel, S.A. Procedure for Conducting Quality Assurance and Quality Control of Existing and New PRZM Field and Orchard Crop Standard Scenarios. Environmental Fate and Effects Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, DC. Revised 2004.
- Haan, C.T. and B.J. Barfield. 1978. Hydrology and Sedimentology of Surface Mined Lands. Office of Continuing Education and Extension, College of Engineering, University of Kentucky, Lexington KY 40506. pp 286.
- MSU. 2006. Michigan State University Guide to Growing Christmas Trees in Michigan. Available Online at: <http://www.for.msu.edu/extension/ExtDocs/xmastree.htm>
- NCTA. 2006. National Christmas Tree Association Fact Sheet. Online at: <http://www.christmastree.org/facts.cfm>
- NOAA. 2006. Climate Normals at Major Weather Observing Stations in all 50 States, Puerto Rico, and Pacific Islands. National Oceanic and Atmospheric Administration (NOAA), Environmental Satellite, Data, and Information Service. Online at: <http://www1.ncdc.noaa.gov/pub/data/ccd-data>.
- USDA. 1986. Urban Hydrology for Small Watersheds. United States Department of Agriculture, Natural Resources Conservation Service. Technical Release 55.

- USDA. 2000. Revised Universal Soil Loss Equation (RUSLE) EPA Pesticide Project. U.S. Department of Agriculture, National Resources Conservation Service (NRCS) and Agricultural Research Service (ARS).
- USDA. 2002a. 2002. Census of Agriculture. U.S. Department of Agriculture, National Agricultural Statistics Service (NASS). Online at: <http://www.nass.usda.gov/census/census02/preliminary/2002censusdates.htm>.
- USDA. 2002b Census of Agriculture County Profile for Ottawa County, Michigan. United States Department of Agriculture, Michigan Agricultural Statistics Service. Online at: <http://www.nass.usda.gov/census/census02/profiles/mi/>
- USDA. 2003. Official Series Description – GRANBY Series. U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). October. 2006. Online at: <http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi?-P>.
- USDA. 2004a. Agricultural Chemical Usage 2003 Nursery and Floriculture Summary. United States Department of Agriculture National Agricultural Statistics Service. October. 2006. Online at: <http://usda.mannlib.cornell.edu/usda/current/AgriChemUsNursFlo/AgriChemUsNursFlo-09-15-2004.txt>
- USDA. 2004b. Nursery Crops 2003 Summary. United States Department of Agriculture National Agricultural Statistics Service. October. 2006. Online at: <http://usda.mannlib.cornell.edu/usda/nass/NursProd//2000s/2004/NursProd-07-26-2004.txt>
- USDA. 2006a. Soil Survey Areas of Ottawa County, Michigan. U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), Soil Data Mart. October. 2, 2006. Online at: <http://soildatamart.nrcs.usda.gov>.
- USDA. 2006b. Benchmark Soils of Michigan. U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). October. 2006. Online at: <http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi?-P>.

## **Contacts**

### **Thomas Dudek**

Cooperative Extension  
Horticulture and Marketing Agent

Michigan State University Extension of Ottawa County  
Grand Haven, MI 49417  
Phone: (616) 846-8250  
Email: [dudek@msu.edu](mailto:dudek@msu.edu).