

## SWMM 5 Update History 02/01/2022

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Build 5.2.0 (2/01/22)

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### Engine Updates:

1. Support has been added for modeling street runoff capture by inlet drains:

- A new Street cross-section type, defined in the [STREETS] section of an input file, was added to the set of conduit cross-section shapes.
- A new Inlet object, specified in the [INLETS] section of an input file, was added to select the type and sizing of an inlet structure that captures street runoff.
- A new conduit property, defined in the [INLET\_USAGE] section of an input file, was added to place inlets in a Street conduit and connect them to a sewer system node.
- Inlet capture analysis using the HEC-22 equations or custom capture curves has been interfaced with SWMM's flow routing methods.

- A Street Summary table that displays summary results for each Street conduit and Inlet, including peak flow depth and spread, has been added to the list of Summary Reports.
- 2. A Type 5 variable speed pump that obeys the pump affinity laws relating head and flow to pump speed was added.
- 3. Storage Curve options now include several pre-defined shapes (cylinders, paraboloids, cones and pyramids) whose geometry is based on analytical formulas
- 4. Several new quantities, including past n-hour rainfall, were added to the properties that can appear in control rule condition clauses.
- 5. Control rule condition clauses were expanded to include named variables and math expressions.
- 6. A listing of the nodes with the highest flow routing non-convergence frequency was added to the Status Report.
- 7. Support was added for the latest version of NOAA's Climate Data Online service where GHCN climate files can be retrieved in either US or SI units.
- 8. An additional validation check was added to the user-supplied Initial Deficit value for Green-Ampt infiltration.
- 9. The conversion of runoff flow into an equivalent ponded depth

for Curve Number infiltration was fixed.

10. A new parameter was added to Rain Barrel LIDs indicating whether the rain barrel is covered or not.

11. The effect that the Impervious Surface Fraction parameter for Permeable Pavement LID has on the pavement layer's effective permeability is now accounted for.

12. The values of water depth in a Permeable Pavement LID written to the detailed LID report file are now expressed as inches (or mm) instead of feet.

13. The math expression parser was modified to allow exponents to be expressions instead of just constant numerical values.

14. The way in which average flow is computed was changed for the time-step-average reporting option.

15. The total reporting time value used to compute several statistics in the summary results tables was corrected.

16. Shell sort replaces insertion sort for sorting event periods.

17. The number of open files that SWMM can access was increased to 8192.

18. The command line executable now supports binary output files larger than 2 Gbytes.

19. A number of new functions were added to the SWMM 5 API.

#### GUI Updates:

1. An optional Welcome page has been added to the program.
2. The map-related speed buttons on the main toolbar have been moved into a separate Map toolbar on the Study Area Map window.
3. A set of keyboard shortcuts for common menu commands has been added with a Help menu item that lists them.
4. A subset of results appearing in the Summary Results tables can now be viewed as themes on the Study Area Map.
5. Use of the F1 key to bring up context sensitive Help has been extended to all dialog forms.
6. Support for relative path names for files appearing in an input file has been added making these files more portable.
7. New dialog forms were created for editing the properties of Street cross-sections and Inlet structures.
8. A new Inlet Usage dialog form was created for assigning an Inlet structure to a street conduit and the node that receives its captured flow.

9. A new dialog form has been added for entering a storage unit's shape data.
  
10. A new dialog form has been added that helps a user select a Culvert Code number for conduits based on the culvert's shape and inlet design.
  
11. A Type5 pump type has been added to the choice of pump types in the Pump Curve Editor.
  
12. Void ratios greater than 1 for LID storage layers are now accepted by the LID Control Editor.
  
13. Pump startup and shutoff depths are now included in the properties that can be copied to another pump.
  
14. A problem with the Property Editor not appearing after a session using a multi-monitor setup was fixed.
  
15. The Move Up and Move Down buttons on the Data Browser now work correctly.
  
16. The input file reader now strips off any BOM character it detects at the beginning of the file.
  
17. A warning message is now shown if no data can be read from an opened file, such as when it is not a true SWMM project file.
  
18. Potential problems with determining the map extents from a

SWMM input file were fixed.

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Build 5.1.015 (05/01/20)

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#### Engine Updates:

1. A mix of infiltration methods can now be used within a project.
2. The Status Report now includes a grouped frequency table of the variable routing time steps used during a simulation.
3. An error in the average summary statistics reported for projects with a reporting start date later than the simulation start date was fixed.
4. A pollutant mass balance error occurring when very shallow storage units lost all inflow to flooding was fixed.
5. A fatal error is now issued if a storage node's area curve produces a negative volume when extrapolated to the node's full depth.

#### GUI Updates:

1. The mouse wheel can now be used to zoom in or out of the Study Area Map without having to select a speed button or menu option.
2. The Subcatchment Infiltration Dialog was modified to accept a choice

of infiltration method.

3. The Group Editor dialog was modified to allow a choice of infiltration method and its parameters be assigned to a group of subcatchments.
4. Some problems with the Graph Options dialog for the Statistics Report plots were fixed.
5. Better support for 4K ultra-HD monitors was added.
6. The latter update required that the three toolbars on the main window be combined into one to avoid resizing issues.

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Build 5.1.014 (03/01/20)

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#### Engine Updates:

1. Fixed a refactoring bug that produced incorrect rainfall when the same time series was used by one rain gage assigned to a RDII Unit Hydrograph and, by another gage assigned to a subcatchment.
2. Fixed skipping the first rain gage in a project when checking if two gages have the same station ID but use different data files.
3. Fixed a program crash when running projects with LID units but no subcatchments.

4. Fixed having LID underdrain pollutant loads incorrectly added to the mass balance totals.
5. Fixed the program from hanging when an LID unit sent its outflow back onto the pervious area of its own subcatchment.
6. Fixed a failure to re-initialize layer volumes as each LID unit is evaluated (which could cause incorrect results for certain combinations of LID units).
7. Fixed street sweeping being ignored when the sweeping period began with a higher day of the year than the end of the period.
8. Fixed incorrect adjustments being made for conduit evaporation and seepage losses under dynamic wave flow routing.
9. Fixed having soil moisture deficit recovery be ignored for Green-Ampt exfiltration from storage units.
10. Fixed having node/link ID names be mistaken for option keywords in the [REPORT] section of an input file.
11. Fixed a possible program crash when using the option to report average values within each reporting time interval instead of point values.

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Build 5.1.013 (05/10/18)

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## Engine Updates:

1. A subcatchment's depression storage depth, its pervious surface roughness (Mannings n) and its hydraulic conductivity can now be adjusted on a monthly basis by assigning monthly time patterns to these properties. For conductivity, a subcatchment-specific adjustment pattern will override any project-wide set of climate adjustment factors.
2. LID controls can now treat a designated portion of a subcatchment's pervious area runoff (previously they could only treat impervious area runoff).
3. Permeable pavement LID units subjected to clogging over time can now have their permeability only partly restored at periodic time intervals
4. The following options were added to control flow out of LID units through their underdrains:
  - A storage layer water depth above which a closed drain automatically opens.
  - A storage layer water depth below which an open drain automatically closes.
  - A control curve that specifies how the nominal drain flow rate is adjusted as a function of the head seen by the drain.
5. Pollutant removal percentages can now be assigned to LID processes that have underdrains. The removals apply to flow leaving the unit through the drain and not to any surface overflow from the unit.

6. The Subcatchment Runoff Summary Report now includes both pervious and impervious total runoff volumes (prior to any LID treatment) for each subcatchment.
  
7. A choice of method used to handle surcharging has been added to the list of Dynamic Wave options. The EXTRAN method continues to use the traditional Surge Algorithm to update the head at surcharged nodes. The new SLOT option attaches a Preissmann Slot to closed conduits flowing more than 98.5% full that eliminates the need to switch to the Surge Algorithm for surcharged nodes.
  
8. A closed vessel can now be modeled as a storage unit node that is allowed to pressurize up to a designated Surge Depth value. If this depth is 0 then the unit is modeled as before as an open vessel.
  
9. A weir's discharge coefficient can now be allowed to vary with head across the weir by assigning it a Weir Curve (see Weir Properties). Weir curves tabulate coefficient values at specific head levels.
  
10. When the upstream offset of a regulator link is below the invert of its downstream node it is now automatically raised only for Dynamic Wave flow routing with a warning message issued. For other flow routing choices only the warning message is issued, and no automatic offset adjustment is made.
  
11. Users can now choose to set a periodic time step for control rule evaluation. If this step is 0 then rules are tested as before at every routing time step.
  
12. The option was added to have time series results for a project's nodes and

links be reported as average values computed over a reporting time step instead of being interpolated point values at the end of the reporting time step.

13. The following bugs were fixed:

- Unused rain gages are no longer examined when adjusting the wet runoff time step.
- The surface inflow rate to a permeable pavement LID unit is not allowed to exceed the pavement's permeability.
- The Minimum Nodal Surface Area dynamic wave routing option was being used as surface area always available at a node instead of an amount available only when the surface area of the node's connecting links fell below it.
- The top width of a full closed rectangular cross section shape is now set to 0 since it can no longer supply any surface area.
- The 'C' parameter value for a Mitered Corrugated Metal Arch culvert was corrected.
- An incorrect reporting of flow continuity error for systems with backflow through outfall nodes was fixed.

#### GUI Updates

1. Various property editors and dialog forms were updated to accommodate the newly added engine features (monthly time patterns for subcatchment properties, LID underdrain parameters, LID pollutant removal, choice of surcharge method, storage unit surcharge depth, weir coefficient curve, control rule time step, and reporting of average values).
2. A bug that failed to record the choice of number of barrels for rectangular conduits in the Cross-Section Editor form was fixed.

3. A bug in the GetLinkOutVal function of the Uoutput.pas unit was fixed.

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Build 5.1.012 (03/14/17)

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#### Engine Updates:

1. The direct.h header is now only #included in the swmm5.c file when compiled for Windows. (swmm5.c)
2. Engine Update #7 in Build 5.1.011 (internally aligning the wet time step with the reporting time step) was redacted since it caused problems for certain combinations of time steps. (runoff.c)
3. A subcatchment's bottom elevation is now used instead its parent aquifer's value when saving a water table value to the binary results file. (subcatch.c)
4. A bug that failed to limit surface infiltration into a saturated rain garden LID unit was fixed. (lidproc.c)
5. Calculation of the maximum limit on LID drain flows was modified to produce smoother results at low depths above the drain offset. (lidproc.c)
6. A variable used for reporting detailed LID results is now properly

initialized. (lid.c & lid.h)

7. The occasional writing of duplicate lines to the detailed LID results file was fixed. (lidproc.c)
8. The conversion from conduit seepage rate per unit area to rate per unit of length was changed to use top width instead of wetted perimeter since only vertical seepage is assumed to occur. (link.c)
9. The coefficient of the evaporation/seepage term in the dynamic wave equation for updating conduit flow was corrected (from 1.5 to 2.5). (dwflow.c)
10. The Engels flow equation for side flow weirs was corrected (the original equation used in SWMM 3 & 4 was incorrect). (link.c)
11. Crest length reductions for end contractions are no longer used for trapezoidal weirs. (link.c)
12. The Slope Correction Factor for culverts with mitered inlets was corrected. (culvert.c)
13. An entry in the table of gravel roadway weir coefficients was corrected. (roadway.c)
14. The user supplied minimum slope option is now initialized to 0.0 (meaning none is provided). (project.c)
15. NO/YES are no longer accepted as attributes for the NORMAL\_FLOW\_LIMITED

dynamic wave simulation option (only SLOPE/FROUDE/BOTH are valid).  
(project.c)

16. Changes were made so that the Routing Events and Skip Steady Flow options work correctly together. (routing.c and globals.h)

17. Steady state periods with no flow routing no longer contribute to the routing time step statistics. (stats.c and report.c)

18. When compiling statistics on the frequency of full conduit flow the number of barrels is now accounted for. (stats.c)

19. Under kinematic wave or steady flow routing, the water level in storage nodes that have no outflow links is now updated correctly over time. (flowrout.c)

20. The formula for the depth at maximum width for the Modified Basket Handle cross section was corrected. (xsect.c)

#### GUI Updates:

1. Profile plots now correctly update the main and axis title text when changed via the Profile Plot Options dialog. Also, the downstream offset height of non-conduit links is set to 0 on the plot.

2. The LID Control Editor now sets the Storage Layer Thickness to 0 when a Rain Garden is selected as the type of LID being edited.

3. An OnChange event handler was added to each of the LID Control Editor's data fields to record when a value is changed.

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Build 5.1.011 (08/22/16)

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#### Engine Updates:

1. Detailed flow routing can now be restricted to a set of pre-defined event periods. The event periods are listed in an [EVENTS] section of the SWMM input file, where each line contains a start date, start time, end date and end time for each event.
2. New functions, `swmm_getError()` and `swmm_getWarnings()`, were added to the API used for interfacing SWMM with other applications (see the updated Interfacing Guide for details).
3. The error codes returned by the API functions (`swmm_open`, `swmm_start`, `swmm_step`, etc.) were corrected.
4. The new format for precipitation amounts in rainfall files downloaded from the NCDC's Climate Data Online service are now recognized.
5. Monthly adjustments for hydraulic conductivity are now also applied to the internal Green-Ampt "Lu" parameter which varies with the square root of conductivity.
6. A check was added to insure that subcatchment imperviousness does

not exceed 100 percent.

7. Runoff time steps are now adjusted to stay aligned with the Report time step (making model validation easier).
8. A time step correction was made when computing the outflow volume produced by an outfall that sends its outflow back onto a designated subcatchment.
9. The LID routines were modified so that native soil infiltration is satisfied first when it occurs along with underdrain flow, instead of the other way around.
10. The allowable offset height for an LID underdrain is no longer limited to the top of the storage layer thus allowing upturned drains to be modelled.
11. The detailed LID report file now lists results by both date/time and elapsed hours and reports water level instead of moisture content for permeable pavement.
12. If the offset of the opening of a regulator link is below its downstream node invert it is now raised to the invert level and a warning message is still issued.
13. A weir with an open rectangular shape and non-zero slope parameter will no longer generate an input error message - the slope value is now ignored.



14. An illegal array index bug that could occur when checking the pump curve type for an Ideal Pump in dynamic wave flow routing was fixed.
15. A redundant unit conversion of max. reported depth from the Node Depth Summary table was removed.
16. Node surcharging is now only reported for dynamic wave flow routing and storage nodes are never classified as surcharged.
17. A failure to convert a storage unit's surface area curve from metric to internal units when computing bottom exfiltration was fixed.
18. A bug that caused a link's TIMEOPEN variable (used in control rule conditions) to be re-set to 0 when its setting changed from one partly opened state to another was fixed.
19. The Status Report no longer lists control actions taken by modulated controls since they occur continuously over time and can produce an enormous number of actions.
20. A failure to convert a Roadway Weir's road width that was in metric units was fixed.
21. A bug that caused the saved link settings read from a hot start file to be incorrect in a model containing pollutants was fixed.
22. Rule premises can now include SIMULATION DAYOFYEAR as a condition, where day of year is either in month/day format or a number between 1 and 365.

23. A refactoring bug that affected water quality mass balance results for Steady Flow routing was fixed.

24. The function that decodes the fractional part of a date/time value into hours:minutes:seconds was modified so that rounding doesn't cause the time to exceed 24 hours.

25. Microsoft exception handling statements are now only enabled when the engine is compiled with the Microsoft C compiler.

#### GUI Updates:

1. A new sub-category of simulation options named Events was added along with an Event Editor dialog to allow users to restrict detailed flow routing calculations to specific periods of time. See the Help file topic under Reference | Special Dialog Forms | Events Editor.

2. When a Rain Garden is selected in the LID Control Editor, the Storage layer tab now appears so that a bottom Seepage Rate can be specified. This fixes the problem of having no infiltration out of a Rain Garden.

3. After a simulation has been completed the Run Status dialog box now indicates if any warning messages have been issued.

4. A previously uninitialized variable (elapsed simulation time) passed between the GUI and the engine is now assigned an initial value.

5. The ground surface line on a Profile Plot can now be made visible or

not via the Profile Plot Options dialog, with the default being visible.

6. An option to use thick lines to outline conduits and the ground surface in Profile Plots was added.

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Build 5.1.010 (08/05/15)  
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#### Engine Updates:

1. A modified version of Green-Ampt infiltration (MODIFIED GREEN AMPT) was added that no longer redistributes upper zone moisture deficit during low rainfall events. The original authors of SWMM's Green-Ampt model have endorsed this modified version. It will produce more infiltration for storm events that begin with low rainfall intensities, such as the SCS design storm distributions.
2. A new type of weir, a ROADWAY weir, has been added. It models roadway overtopping using the FHWA HDS-5 method and would typically be used in parallel with a culvert conduit.
3. Rule premises can now test whether a link has been open (or closed) for a specific period of time. See the Help file for more details.
4. Unsaturated hydraulic conductivity ("K") was added to the list of variables that can be used in a user-supplied groundwater flow equation.

5. A bug introduced in update 2 of release 5.1.008 that failed to include infiltration from LID units into the groundwater routine was fixed.
6. A bug that failed to properly initialize the flag indicating that one or more LID controls was initially wet was fixed.
7. Duplicate printing of the first line of an LID detailed report file was corrected.
8. The Hargreaves evaporation formula was modified to use a 7-day running average of daily temperatures, instead of just single day values, as recommended by the formula's authors.
9. Daily potential evapotranspiration (PET) was added as a system output variable.
10. The qualrout.c module was refactored to make it more compact and easier to follow.
11. Storage seepage and evaporation losses are now based on the storage volume at the end, not the start, of the prior time step.
12. The command line used to build the engine included in the "makefile" for the GNU C/C++ compiler was corrected to include the OpenMP libraries.

#### GUI Updates:

1. Potential evapotranspiration (PET) was added as new system-wide variable whose time series can be viewed with a graph or table.

2. A bug in the Number of Threads dropdown list on the Dynamic Wave Options dialog was fixed.
3. Additional bugs in the Cross Section Editor remaining from changes made in release 5.1.008 were fixed.
4. Changes were made to accommodate the new Modified Green-Ampt infiltration option and the new Roadway weir option.
5. The automatic scaling of plots with all y-values the same was improved.
6. The automatic scaling of profile plots was improved and the ground surface line was removed to improve clarity.
7. The function that automatically converts all link depth offsets to elevation offsets now uses the node invert elevation value rather than '\*' for a zero offset.
8. A bug in using the Macro List on the Add-In Tools Properties form to insert a selection into the Working Directory edit box was fixed.

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Build 5.1.009 (04/30/2015)

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General:

1. A missing DLL file used to parallelize SWMM's flow routing routine was added to the installation package.

#### Engine Updates:

1. A re-factoring bug that prevented running simulations longer than 68 years was fixed.
2. An input parsing error that prevented the program from recognizing a comparison between two variables in a control rule premise was fixed.
3. A new warning message was added for when a control rule premise compares two different types of variables.
4. When implementing 5.1.008 update 12, the runoff to a subcatchment fully occupied by LIDs was not being included in the subcatchment's Summary Report.
5. A bug was fixed that allowed LID units to return outflow to a subcatchment's pervious area even though LIDs occupied the entire subcatchment.
6. For quality routing the definition of a dry conduit/storage node was changed to  $\leq 1$  mm of depth to avoid concentrations from blowing up due to evaporation losses.
7. The units label for Total Inflow Volume in the Node Inflow Summary table of a saved report file was corrected.

#### GUI Updates:

1. A bug introduced as a result of 5.1.008 GUI Update 11 that prevented the name of a conduit's Transect or Shape Curve from appearing in the Cross Section Editor was fixed.
2. A nicer default axis scaling routine is now used for time series and scatter plots.
3. The user-supplied custom scaling for the vertical axis of a profile plot is now recognized.

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Build 5.1.008 (04/02/2015)  
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#### Engine Updates:

#### New Features:

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1. Monthly adjustments for hydraulic conductivity used for rainfall infiltration and for exfiltration from storage nodes and conduits were added.
2. LID drains can now send their outflow to a different node

or subcatchment than the parent subcatchment in which they were placed.

3. Conveyance system Outfall nodes now have the option to send their outflow onto a subcatchment, to simulate irrigation or complex LID treatment options.
4. A new LID practice, Rooftop Disconnection, has been added. It allows one to explicitly model roof runoff with an optional limit on the flow capacity of their downspouts. Disconnection is specified by setting the Return To Pervious Area field in the [LID\_USAGE] section to 1.
5. An optional soil layer has been added to Permeable Pavement LIDs so that a sand filter or bedding layer beneath the pavement can be modeled.
6. Several new built-in variable names can now be used in custom groundwater flow equations for porosity, unsaturated hydraulic conductivity, infiltration rate, and percolation rate. See the Help file for more details.
7. A Groundwater Summary table has been added that reports several groundwater statistics for each subcatchment.
8. A new option, the Minimum Variable Time Step, was added that limits the smallest time step that can be computed under variable time stepping for dynamic wave flow routing. In previous releases it was fixed at 0.5 seconds which remains



the default. The smallest value it can now have is 0.001 sec.

9. The dynamic wave routing procedure was parallelized to take advantage of multiple processors, making it run several times faster. A new option, THREADS, sets the number of parallel threads to use, where the default is 1.
  
10. A new column was added to the Node Depth Summary report table that shows the maximum depth recorded at the Reporting Time Step so, it can be compared to the maximum depth attained over all routing time steps also shown in the table.
  
11. Control rule premises can now contain conditions that compare the values of a node or link variable at two different locations (e.g., IF NODE 123 HEAD > NODE 456 HEAD) and node volume was added as a condition clause variable.

Improvements:

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12. When a subcatchment with LID controls receives runoff from another source (e.g., a subcatchment, LID drain or outfall node) the runoff is now distributed only across the non-LID area of the subcatchment instead of the full area. If a single LID takes up the full subcatchment area then the runoff is directed onto the LID.
  
13. Storage node HRT was added to the state variables saved in the Hot Start file.

14. The threshold value for reporting a non-zero runoff result was changed from 0.001 cfs to 0.001 inches/hr.
15. The calculation of overall flow routing mass balance was modified to account for cases where some flow streams, like total external inflow, are negative.
16. The "Surface Runoff" label in the Runoff Continuity Report was replaced with "Total Runoff" since the value reported consists of both surface runoff and LID drain flow.
17. The "Internal Outflow" label in the Flow Routing Continuity Report was replaced with "Flooding Losses" to improve clarity.
18. The pollutant washoff routines were moved to a new code module (surfqual.c) and revised to account for the reduction in pollutant load that results from runoff flow reduction by LID units.
19. Initial flows for Steady Flow routing are now ignored since they are not used in the routing calculation and the initial volume associated with them contributed to system mass balance error.
20. The various types of lateral inflows to conveyance system nodes are now evaluated at the date/time for the start of the routing time step instead of at the end of the time step.
21. The final runoff and routing time steps are adjusted to insure that the simulation's total duration is not exceeded.

22. When evaluating user-supplied math expressions, any NaN (Not a Number) result (caused by an underflow, overflow or divide by zero) is set to 0 so that the NaN doesn't propagate through subsequent calculations.

Bug Fixes:

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23. The evaporation rates read from a time series would only change when a new day was reached (even though values at more frequent intervals were present) and could cause a run to stop prematurely in some rare cases.

24. The runoff read from a Hot Start file should have been assigned to a subcatchment's newRunoff property, not to oldRunoff.

25. An indexing bug that caused Hot Start files with snowmelt parameters to be read incorrectly was fixed.

26. The setting for a non-conduit link read from a Hot Start file was not being used to initialize the link.

27. A bug in adjusting snowmelt for snow covered area derived from an areal depletion curve was fixed.

28. Snowmelt should not have been included in the total precipitation reported for a subcatchment since the snowfall which produced it was already accounted for.

29. When computing a flow rate through the Drainage Mat of a Green Roof LID unit, the mat's void ratio was being applied to the water depth instead of to the mat's area.
30. The state of LID controls was not being considered when choosing to use the wet or dry runoff time step which sometimes lead to excessive LID continuity errors.
31. A re-factoring bug that left reporting time in minutes instead of hours in the detailed LID results file was fixed and results are now written to the file at each runoff time step where the state of the LID unit changes.
32. Failure to initialize groundwater evaporation loss to 0 was causing problems with the reported groundwater mass balance for subcatchments that had no pervious area.
33. Excessive continuity errors for systems having conduits with large seepage rates were fixed.
34. Pollutant loss through seepage in conduits and storage nodes was not being included in the mass balance calculations.
35. Concentrations in conduits and storage nodes were not being increased to account for loss of water volume when evaporation was occurring.
36. Premature exiting of the routine that checks for capacity limited

links whenever a non-conduit link was encountered was fixed.

37. A bug in identifying the percent of time that a conduit has either end full was fixed.

38. A re-factoring bug that prevented surcharged weirs (see Update 5 for 5.1.007) from passing any flow was fixed.

39. A bug in evaluating recursive calls to nodal water quality treatment functions was fixed.

#### GUI Updates:

1. The missing July - December column labels were restored on both the evaporation and wind speed tables in the Climatology Editor.
2. The label "Surface Water Height (Hsw)" in the Groundwater Flow Editor was changed to "Surface Water Depth" to make clear that it is the depth of water at the receiving node and not the height of water above the aquifer bottom (or Hsw as shown in the dialog's diagram).
3. The label "Channel Bottom Height (Hcb)" also in the Groundwater Flow Editor was changed to "Threshold Water Table Elev." to make clear that it is an elevation and not a height above the aquifer bottom (as Hcb is in the dialog's diagram).
4. A Groundwater Summary table was added to the form that displays

summary results tables.

5. Groundwater upper zone soil moisture and node lateral inflow are now included in the abridged Hot Start file that the GUI can produce (using the File | Export | Hot Start File command).
6. The column labels in the various sections of the SWMM input file generated by the GUI were modified to better match the labels used to describe the input file format in Appendix D of the User's Manual.
7. A "Route To" field was added to the Outfall Node property editor to accommodate the new option of allowing outfall nodes to discharge onto a subcatchment.
8. The Dynamic Wave page of the Simulation Options dialog was modified to include the new Minimum Routing Time Step option and the new Number of Threads option.
9. The LID Control Editor was updated to include the new Rooftop Disconnection LID practice and the option to add a soil layer to the Permeable Pavement practice.
10. A Drain Outlet field was added to the LID Usage Editor.
11. The conduit Cross Section Editor dialog was enhanced to display a selectable list of standard size codes and their dimensions for elliptical and arch pipes.
12. Custom changes made to the Map's Legends are now saved with the

rest of a project's settings in its .ini file.

13. Word wrapping was added to the Title/Notes display in the Project Browser to make the contents easier to read.

14. Modal dialog message windows now appear centered over the form that generates them instead of in the middle of the full display screen.

15. The style of all dropdown list boxes was changed to make them more visually appealing.

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Build 5.1.007 (9/15/2014)

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#### Engine Updates:

1. A new feature that provides monthly adjustments for temperature, evaporation rate, and rainfall was added.
2. Support for reading the new GHCN-Daily climate data files available from NCDC's Climate Data Online service was added.
3. In addition to lateral groundwater flow, a custom equation can now also be used for seepage flow to a deeper groundwater aquifer.

4. The [GW\_FLOW] section of the project file was renamed to [GWF] and its format was changed to accommodate both lateral and deep groundwater flow equations.
  
5. A new Weir parameter was added that specifies if the weir can surcharge using an orifice equation or not. Surcharging was the only option in SWMM 5.0 but was switched to no surcharging in earlier 5.1 releases. This new parameter accommodates both closed top weirs that can surcharge and open channel weirs that cannot.
  
6. The formula used to recover infiltration capacity during dry periods for the Modified Horton method was revised.
  
7. The initial cumulative infiltration into the upper soil zone for Green-Ampt infiltration had been incorrectly set to the maximum value instead of zero.
  
8. All of the Green-Ampt infiltration functions were re-factored to make the code easier to follow.
  
9. The calculation of infiltration out of the bottom of a Bio-Retention Cell or Permeable Pavement LID unit with a zero-depth storage layer was corrected.
  
10. Most of the LID simulation routines were modified to provide more accurate results under flooded conditions.
  
11. Results written to the detailed LID results report now



always correspond to a full reporting time step.

12. The name of the variable used to represent the height of the receiving channel bottom in a user-defined groundwater flow equation was corrected to match the name displayed in the GUI's Groundwater Editor dialog (Hcb).
  
13. A problem with the program crashing when a climate file was used to provide evaporation rates for open channels and storage nodes when runoff was not computed (as when there were no subcatchments in the project) was fixed.
  
14. Flow and pollutant routing mass balance accounting was modified to correctly handle negative external inflows.
  
15. The procedure for computing the area available for seepage out of a storage node that has a tabular storage curve was corrected.
  
16. Seepage from storage units can now be modeled using Green-Ampt infiltration, which makes the seepage rate a function of storage level. The constant seepage rate option can still be used by setting the G-A initial moisture deficit to 0.
  
17. The function that finds depth as a function of volume from a storage curve was corrected for the case where the depth falls within a portion of the curve where area is constant with depth (i.e., vertical side walls).

GUI Updates:

1. The Object Toolbar was restored.
2. A new page was added to the Climatology Editor to edit values for monthly adjustments for temperature, evaporation, and rainfall.
3. A field for the new weir surcharge option was added to the Weir Property editor.
4. A problem with the current project being closed without asking if it should be saved first whenever a new style theme was selected from the Program Preferences dialog has been fixed.
5. The default seepage rate from an LID storage layer was changed.
6. The Infiltration Editor was restored for editing Green-Ampt parameters for storage unit seepage loss.
7. The Groundwater Flow Equation Editor was extended to accept equations for deep groundwater flow.

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Build 5.1.006 (5/19/2014)  
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#### Engine Updates:

1. The updating of the next time that detailed LID results should be written to file during a simulation was modified to avoid an off-by-one error.
2. The number of decimal places for hourly evaporation written to a detailed LID report was increased.
3. The amount of soil water available for evaporation in LID units with soil layers was not being limited by the water remaining below the wilting point.
4. The equation that computes the rate of water infiltrating into permeable pavement LIDs had a misplaced parenthesis.
5. There was a unit's conversion error in computing the contribution of a pollutant in direct precipitation to the water quality on a subcatchment.

#### GUI Updates:

1. As a result of the switch to Delphi XE2 some components on the Options and Climatology dialogs were not recording that project data had changed after edits were made.
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Build 5.1.005 (4/23/2014)

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Engine Updates:

1. A problem with reading hydraulic results from a hot start file was fixed.

GUI Updates:

1. The appearance of the Open File Dialog with preview panel was improved.
2. In the property Editor for storage nodes, the Poned Area property was made read-only since storage nodes are not allowed to pond water.
3. Some issues with pop-up topic windows in the Help file being obscured by the main Help window were fixed.

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Build 5.1.004 (4/14/2014)

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Engine Updates:

1. Support for the Ignore RDII analysis option was added to the engine.

GUI Updates:

1. A refactoring bug that ignored any changes to numerical precision made in the Program Preferences dialog was fixed.
2. Another refactoring bug from 5.1.003 that caused projects with groundwater aquifers not to run was fixed.

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Build 5.1.003 (4/8/2014)

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Engine Updates:

1. A new property, the Upper Zone Evap. Pattern, was added to the Aquifer object. It allows one to adjust the aquifer's upper zone evaporation fraction by month of the year.
2. A bug in writing/reading RDII flows to the new binary RDII file was fixed.

GUI Updates:

1. A refactoring bug that prevented SWMM from working correctly for users with non-US Windows regional settings was fixed.
2. A refactoring bug that prevented the Group Delete feature from

working was fixed.

4. Issues with stay-on-top forms obscuring modal dialog forms, with the Browser panel disappearing if its width was made too small and with not being able to browse the Help system when a modal form had focus were fixed (these unforeseen issues were caused by the switch to Delphi XE2 from Delphi 7).
5. The Aquifer Editor form was updated to accept the new upper evaporation pattern property.

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Build 5.1.002 (3/31/2014)

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Engine Updates:

1. A bug that prevented hotstart files with the latest format from being read was fixed.
2. Only non-ponded surface area is saved for use in the dynamic wave surcharge algorithm (when water depth is close to the node's crown elevation).

GUI Updates:

1. Creation of auxiliary forms on startup was moved from the main form's OnActivate event to its OnCreate event, while creation of the map form was moved to the OnShow event.

2. The routines for saving and reading the main form's position and size in the swmm5 .ini file were modified.
3. A memory leak related to copying cells from the grid editor used in various dialogs was fixed.

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Build 5.1.001 (3/24/2014)  
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#### Engine Updates

#### New Features:

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1. SWMM can now read the new file format for precipitation data retrieved online from NOAA-NCDC.
2. A new choice of infiltration method, the Modified Horton method, has been added. This method uses the cumulative infiltration in excess of the minimum rate as its state variable (instead of time along the Horton curve), providing a more accurate infiltration estimate when low rainfall intensities occur.
3. RDII interface files created internally by SWMM are now saved in a binary format to reduce storage space. The ASCII text format for these files is still supported for users that find it desirable to create the files outside of SWMM.

4. Two new categories of LID controls, one for Green Roofs and another for Rain Gardens, have been added so they no longer have to be configured from the Bio-Retention Cell control (although that option still remains). The Green Roof uses a new Drainage Mat layer to store and convey the water that percolates through the soil layer.
  
5. Users can now add their own groundwater outflow equation to a subcatchment, to be used in place of or in addition to the standard equation. Similar to treatment functions, the equation can be any mathematical expression that uses the same groundwater variables that appear in the standard equation.
  
6. Evaporation of water from open channels has been added.
  
7. A new conduit property named Seepage Rate (in/hr or mm/hr) has been added to model uniform seepage along the bottom and sloped sides of a conduit.
  
8. Infiltration from storage units is now referred to as seepage, to be consistent with seepage from conduits. The only required parameter is a seepage rate (in/hr or mm/hr). Previous data files that supply a set of Green-Ampt infiltration parameters will still be recognized.
  
9. Separate accounting and reporting of evaporation and seepage losses in storage units are now made.



10. Open rectangular channels now have a new parameter that specifies if one or both side wall surfaces should be ignored when computing a hydraulic radius (to provide improved support for quasi-2D modeling of wide channels and overland flooding).
11. New Dynamic Wave Analysis options have been added for the maximum number of iterations and head tolerance used at each time step. The percentage of time steps where convergence is not achieved is also now reported.
12. Users can now set the flow tolerances that determine if flow routing calculations can be skipped because steady state conditions hold.
13. Control rules can now use a conduit's OPEN/CLOSED status in both premise conditions and action clauses.
14. The meaning of the link view variable "Capacity" has been changed. For conduits it is now the fraction of the full cross section area filled by the flow, while it is the control setting for all other types of links (the meaning of the control setting varies by link type -- see the Help file or the User's Manual).
15. The link Froude number view variable has been replaced with the link's flow volume, the subcatchment Losses variable has been replaced by two new variables - Evaporation and Infiltration, and upper groundwater zone Soil Moisture has

been added as a new view variable.

16. The Node Inflows Summary table of the Status Report now includes a new column that lists the mass balance error in volume units for each node.

17. A new summary table, Link Pollutant Load, has been added that displays the total mass load of each pollutant that flows through each link.

Improvements:

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18. Using a Drain Delay time of 0 for Rain Barrel LIDs now means that the barrel is allowed to drain continuously, even as it is filling during wet weather periods.

19. The requirement that an impervious surface must be dry (have no more than 0.05 inches of standing water) before it could be subjected to street sweeping has been dropped.

20. After runoff ceases and a land surface goes dry due to evaporation, any remaining mass of pollutant originating from direct deposition or upstream runoff is assumed to be unavailable for future washoff (it shows up as Remaining Buildup in the mass balance report).

21. The way that wet weather washoff inflow loads are interpolated across a flow routing time step was modified to produce a better match between the reported total runoff

load and total quality routing inflow load.

22. The method used to select a time step for processing RDII unit hydrographs was modified to consider the case where K (the ratio of rising limb to falling limb duration) is below 1.0.
23. When the moisture content of the upper groundwater zone reaches saturation, the depth of the lower saturated zone is now set equal to the full aquifer depth (minus a small tolerance).
24. Conduits with negative slopes whose absolute value is below the Minimum Slope option will have their slope changed to the positive minimum value, thus allowing them to be analyzed using the Steady Flow and Kinematic Wave routing options.
25. The Avg. Froude Number and Avg. Flow Change columns in the Flow Classification Summary table have been replaced with the fraction of time steps that flow is limited to normal flow and the fraction of time steps that flow is inlet controlled (for culverts).
26. An error condition now occurs if a pump's startup depth is less than its shutoff depth.
27. Only the upstream node for orifice and weir links is now checked to see if its maximum depth needs to be increased

to meet the top elevation of the orifice or weir opening.

28. Weirs are no longer allowed to operate as an orifice when they surcharge. Instead, any excess flow will flood the upstream node.

29. A warning message is now written to the Status Report if the crest elevation of a regulator link is below its downstream node's invert.

30. When a reporting time falls in between a computational time step during which a pump's on/off status changes, the reported pump flow is the value at either the start or end of the time step depending on which is closer to the reporting time (i.e., no interpolation is used).

31. Control rule conditions can now accept elapsed time or time of day values as decimal hours in addition to hours:minutes:seconds.

32. The test for a control rule condition equaling a specified elapsed time or time of day was modified to more accurately capture its occurrence.

33. If the Water Quality analysis option is disabled then the binary results file no longer contains any pollutant values (of 0) for all time periods.

34. Hot Start files now contain the complete state of the watershed

and conveyance system, so that future simulations can start up correctly where they left off.

35. The following changes to error reporting were made:

- Error 319 was re-numbered to 320 and a new Error 319 was added for a rainfall data file with unknown format.
- Format errors in external time series files are now listed as Error 363 (invalid data) instead of Error 173 (time series out of sequence).

36. Warning messages written to the Status Report are now single spaced instead of double spaced. See report.c.

37. The Link Summary table in the Status Report now lists conduits with negative slopes in their original orientation instead of in their reversed state.

Bug Fixes:

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38. A refactoring bug from 5.0.022 that prevented snowmelt from infiltrating has been fixed.

39. Snowmelt rate during rainfall conditions and the updating of the antecedent temperature index were not being converted from the six-hour time interval used in Anderson's original NWS snowmelt model to the hourly basis used in SWMM.

40. A refactoring bug that failed to set the maximum number of characters high enough for a line read from a user-prepared

rainfall data file has been fixed.

41. The optional Maximum Volume parameter for Horton infiltration was not allowing any recovery of infiltration capacity between storm events.
42. Evaporation from the lower groundwater zone was being computed from the rate remaining after surface and upper zone evaporation was considered instead of from the unadjusted rate (with a reduction afterwards if it exceeds the remaining available rate).
43. An error in applying the Vegetation Volume Fraction parameter to swales was corrected.
44. The time from the last rainfall used to determine when a Rain Barrel should begin to empty wasn't being computed correctly.
45. An erroneous error message for Rain Barrel LIDs with a zero Void Ratio has been fixed (the Void Ratio parameter should be ignored for Rain Barrels).
46. The display of extraneous infiltration results in detailed reports for Rain Barrel LIDs has been eliminated.
47. The check on no street sweeping for a subcatchment during wet periods was checking rainfall over the entire study area instead of just the subcatchment.

48. An erroneous warning message regarding negative offsets for pumps when elevation offsets are used has been eliminated.

49. A possible divide by zero error for trapezoidal channels with zero bottom width has been eliminated.

50. A program crash that occurred when the Ignore Routing option was selected and results were to be saved to a Routing Interface file has been fixed.

51. Projects that had no subcatchments or had the Ignore Runoff switch selected were not able to evaporate water from storage units.

52. Weekday and weekend hourly time patterns for Dry Weather inflows are now correctly applied in a mutually exclusive manner.

53. The Node Flooding Summary table in the Status Report now correctly lists the peak depth of ponded water above the node's maximum depth (i.e., its rim or ground elevation) instead of above its invert elevation.

54. Occasional problems caused by the date/time functions not returning an hour between 0 and 23 (for hourly time patterns) and being off by 1 second (when writing results to outflow interface files) have been fixed.

55. A bug introduced in release 5.0.017 that caused the concentration after first-order decay in a storage node to be ignored has been fixed.

56. A bug in the Total Elapsed Time listed at the end of the Status Report for runs taking longer than 24 hours of computer time was fixed.

57. A correction was made for the slope correction factor used for mitered culvert inlets.

58. The procedure for finding the surface area of a storage unit given its volume was corrected for the case where the storage curve has a section of decreasing area with depth.

59. The procedure for finding a cross-section area given a section factor value was corrected for the case where the section factor table does not have its highest value as the last entry in the table.

60. An error in computing the hydraulic radius of the Rectangular-Triangular conduit shape as a function of flow depth was corrected.

#### GUI Updates

1. The entire GUI code was ported from Delphi 7 into Delphi XE2.

2. Different color themes for the user interface can be



selected from the Program Preferences dialog.

3. The "Data" Browser panel is now named as the "Project" Browser.
4. The Object Toolbar has been eliminated. Visual objects are now added to the map in the same manner as non-visual objects -- by selecting their category from the Project Browser and then clicking the Browser's "+" button (or by selecting Project | Add... on the main menu).
5. The LID Control and LID Usage editors were re-designed to accommodate the new LID control options.
6. Modifications were made to accept the new engine features mentioned above (modified Horton infiltration, seepage rate parameter for conduits, side wall option for rectangular channels, and the additional Dynamic Wave routing options).
7. Modifications were made to accept the updated set of output view variables.
8. The summary results tables that used to appear as part of the Status Report have been moved into a separate Summary Report that makes it easier to view and sort them.
9. The Time Series Plot selection dialog was modified to allow more than one kind of object/variable pair to be plotted.

10. The Graph Options dialog was modified to allow a vertical axis to be inverted (as when plotting an inverted rainfall hyetograph on the same graph as a runoff hydrograph).
  
11. The option to compute evaporation using the Hargreaves equation wasn't being saved along with the rest of a project.
  
12. If pollutants are defined for a project but the Water Quality analysis option is not selected, then after a new analysis is made pollutants will no longer be listed as theme variables in the Map Browser nor will they be available for graphs, tables or statistical reports.
  
13. The columns for the [XSECTIONS] section of a saved project file now includes a heading label for "Culvert Code".

#### SWMM 5.0 Update History

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Build 5.0.022 (04/21/11)

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#### Engine Updates

1. The following fixes and updates were made to the LID module of the code (lid.c):
  - a. The Drain Delay time for a Rain Barrel LID is now

correctly converted internally from hours to seconds.

- b. The meaning of the Conductivity property of a LID's Storage layer has been changed. It is now defined as the saturated hydraulic conductivity of the native soil below the layer instead of the conductivity of the layer itself.
- c. Storage layers are now optional for Bio-Retention Cells and Permeable Pavement LIDs by allowing the layer height to be zero. One should still enter a non-zero conductivity for the layer if infiltration into native soil is allowed.
- d. If the top width of the overland flow surface for an LID is zero then any excess water above the surface storage depth simply spills out instantaneously.
- e. The calculation of infiltration in a Vegetative Swale was corrected so that a swale with vertical sides will produce the same results as a fully pervious subcatchment with the same dimensions, roughness, and slope.
- f. The water initially stored in all LID units is now reported in the Status Report's Runoff Continuity table.
- g. Error messages are now generated if the surface layer vegetation volume fraction is less than 1, if the area of all LIDs in a subcatchment is greater than the total area or if the total capture area of all LIDs is greater than

the subcatchment's total impervious area.

2. Missing values for accumulation periods within an NWS rain file are now processed correctly. See rain.c.
3. A new error message (318) is now generated if a user-prepared rainfall file has its dates out of sequence. See rain.c, err.h, and err.c.
4. Evaporation during wet time periods was including rainfall and run-on as moisture available for evaporation when it should only be the current ponded depth. See subcatch.c.
5. Curve Number infiltration was modified to use only direct precipitation, not including runon or internally routed flow, to compute an infiltration rate. See infil.h, infil.c, subcatch.c and lid.c.
6. A new error message (110) is now generated if the ground elevation of a subcatchment is less than the initial water table elevation of its groundwater aquifer. See gwater.c, err.h, and err.c.
7. A check was added to the tailwater term of the groundwater flow equation to ensure that the term is zero when no tailwater depth exists. See gwater.c.
8. Checks were added to the solution of the governing groundwater mass balance equations to catch conditions where the lower zone

depth is greater than the total depth or when the upper zone moisture content is greater than the porosity. See gwater.c.

9. A divide by zero error no longer occurs when computing the hydraulic radius of an empty Filled Circular pipe whose filled depth is zero. A similar error for the hydraulic radius of an empty trapezoidal channel whose bottom width was zero was also eliminated. See xsect.c.

10. The critical or normal depth adjustment made for a conduit is no longer allowed to set the depth to zero -- some small depth level is always maintained. See dynwave.c.

11. The Pump Summary Report was expanded to include number of start-ups, minimum flow, and time off both the low and high ends of the pump curve. See objects.h, link.c, stats.c, and statsrpt.c.

12. When the setting of an orifice or weir was changed to 0 (to completely block flow) the flow depth in the element wasn't being set to 0. This was only a reporting error and had no effect on the flow routing calculations. See link.c.

13. The Node Surge Summary in the Status Report did not report a ponded node as being surcharged. This was only a reporting error and had no effect on the flow routing calculations. See stats.c.

GUI Updates

1. A new map view variable for subcatchments, the percent of area occupied by LID controls, was added. This view allows one to easily distinguish which subcatchments have been assigned LIDs and which haven't.
2. The LID Control Editor now checks to see that data fields that require fractions (such as vegetative volume, void volumes, soil porosity, etc.) contain valid entries.
3. The LID Group Editor now checks that the total area of all LIDs assigned to a subcatchment does not exceed the area of the subcatchment and that the total percentage of impervious area treated by these LIDs does not exceed 100.
4. Comments applied to Time Patterns are no longer lost when a project is saved and re-opened at a later time.
5. The File | Export | Hostart option now saves the current groundwater state correctly.

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Build 5.0.021 (09/30/10)

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#### Engine Updates

1. A code refactoring error in build 5.0.019 that resulted in no recovery of infiltration capacity during dry periods has been fixed. See subcatch.c.

2. The pervious area adjustment used in 5.0.019 for evaporation and infiltration to a subcatchment's groundwater zone was corrected.  
See gwater.c.
3. The accounting of evaporation loss from just the pervious area of a subcatchment has been corrected. See subcatch.c.
4. The rainfall + runoff used to compute infiltration is no longer pre-adjusted by subtracting any evaporation loss. See subcatch.c.
5. The rate for Green-Ampt infiltration is no longer allowed to be less than the smaller of the saturated hydraulic conductivity and the available surface moisture. See infil.c.
6. The available surface moisture for Green-Ampt infiltration is considered 0 if its value is less than a small tolerance. See infil.c.
7. Evaporation and infiltration losses from Storage nodes under Kinematic Wave and Steady Flow routing are now accounted for properly. See flowrout.c.
8. The Pollutant Loading summary tables in the Status Report now lists results for all pollutants in a single table instead of listing just 5 pollutants per table. See report.c.

## GUI Updates

1. The anchoring of the components on either side of the splitter bar on the Data Browser panel was changed to insure that the main window is displayed correctly when SWMM is first launched.
2. The incorrect display of link slopes on the study area map under the Elevation Offsets option was corrected.

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Build 5.0.020 (08/23/10)

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Engine Updates

1. A refactoring bug that prevented SWMM from reading rainfall data from external rainfall files was fixed. See gage.c.

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Build 5.0.019 (07/30/10)

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Engine Updates

1. The ability to explicitly model five different types of Low Impact Development (LID) practices at the subcatchment level has been added. Consult the LID Controls topic in the Help file for details. See lid.c, lid.h, infil.c, infil.h, input.c, inputrpt.c, project.c, statsrpt.c, and subcatch.c.



2. Pollutant buildup over a given landuse can now be specified by a time series instead of just a buildup function. Consult the Land Uses / Buildup topic in the Help index for more details. See `landuse.c` and `keywords.c`.
  
3. An option was added to allow evaporation of standing water to occur only during periods with no precipitation (the default is the current practice of allowing evaporation in both wet and dry periods). See `climate.c`, `enums.h`, `keywords.c`, `objects.h`, `project.c`, `subcatch.c`, and `text.h`.
  
4. Storage node losses from evaporation and infiltration are now computed directly within the flow routing routines to produce better conservation of mass. See `objects.h`, `routing.c`, `dynwave.c` and `node.c`.
  
5. The check to see if flow in a link should not exceed the normal flow now uses just the upstream Froude number rather than both up and downstream numbers. See `dynwave.c`.
  
6. The maximum trials used when evaluating the flow and head equations at a given time period for dynamic wave routing was increased from 4 to 8. See `dynwave.c`.
  
7. The Ponding calculation for dynamic wave flow routing was changed once again, to obtain better continuity results. The depth in a surcharged node that can pond is not allowed to rise higher than just beyond full depth in any single time step. After that, its change in depth is determined by the node's ponded area. Similarly, the depth of a ponded node is not allowed to drop more than just below full depth in any

single time step. See dynwave.c and node.c.

8. For Kinematic Wave and Steady Flow routing, a node's ponded area is no longer used to infer a ponded depth when a node floods with Ponding turned on. Instead, the water depth is simply set to the node's maximum depth and the ponded area parameter is simply used as an indicator as to whether the node can pond or not. (This differs from dynamic wave routing where the ponded area directly influences ponded depth through the solution of the momentum and flow conservation equations.) See flowrout.c.
9. As a consequence of the preceding update, the Node Flooding Summary table in the Status Report no longer displays the maximum ponded volume in acre-inches (or hectare-mm). Instead, it displays the maximum ponded depth (ft or m) for Dynamic Wave flow routing or the maximum ponded volume (1000 ft<sup>3</sup> or 1000 m<sup>3</sup>) for other forms of routing. See stats.c and statsrpt.c.
10. The groundwater mass balance equations were returned to the form they had in release 5.0.013 since they were not correctly accounting for the water volume transferred between the saturated and unsaturated zones due only to a change in the water table depth. See gwater.c.
11. Controls based on flow rates now properly account for the direction of flow when they are evaluated. This may require users to add an extra condition clause to a rule that only applies for flow in the positive direction (e.g., AND Link XXX FLOW >= 0.0). See controls.c.
12. The Villemonthe correction for downstream submergence is now also used

for partly filled orifices (instead of just for weirs). See link.c and dynwave.c.

13. A missing term in the equation used to check for submerged inlet control for Culvert conduits was fixed. See culvert.c.

14. If a non-conduit link is connected to a storage node, then its contribution to the node's surface area is now ignored. See dynwave.c.

15. The automatic adjustment of the maximum depth of a link's end nodes to be at least as high as the link's crown no longer applies when the link is a bottom orifice. See link.c.

16. A fatal error message is now generated if a conduit's entrance, exit, or average loss coefficient value is negative. See link.c.

17. Requests to do internal routing of runoff between impervious and pervious sub-areas of a subcatchment when only one type of sub-area exists are now ignored. See subcatch.c.

18. The check on the error condition of a node having both incoming and outgoing dummy conduits was modified so as not to get fooled by Outlet-type links. See toposort.c.

19. The Ignore Snowmelt switch is now internally set to true whenever there are no snow pack objects defined, so that precipitation is not mistakenly converted to snow for a project with temperature data. See gage.c and project.c.

20. When reading min/max daily temperatures from a climate file, the values are now swapped if the minimum is greater than the maximum. See climate.c.
21. When the Hargreaves method is used to compute an evaporation rate from daily temperature values, negative rates are no longer allowed. See climate.c.
22. Several bugs that prevented SWMM from detecting and reading Canadian DLY02/04 climate files correctly were fixed. See climate.c.
23. An error message is now generated if a time series used for rainfall is also used for another purpose in a project (since it will cause the two uses to be out of synch). See error.h, error.c, gage.c, climate.c, control.c, and inflow.c.
24. An error message is now generated if two Rain Gages with files as their data source use the same Station IDs but different names for the data file. See rain.c, error.h, and error.c.
25. When zero rainfall values appear in a rain file or time series, they are now skipped over and treated as a dry period, the same as would occur had they not been entered in the first place. See gage.c.
26. A bug that caused the data in an evaporation time series to be out of synch with the simulation time clock has been fixed. This only affected evaporation data supplied from time series and not monthly average data or data from climate files. See climate.c.

27. The water quality mass balance now correctly accounts for any initial mass in the system created by using a hot start file. See massbal.c.

28. For models that only compute runoff and have a reporting time step less than the wet time step, the latter is internally set equal to the former. See swmm5.c.

### GUI Updates

1. The Data Browser was updated to include the newly added Low Impact Development (LID) objects and new dialog forms were added to specify LID design data and their placement within a project's subcatchments.

2. You can now open a project input file by dragging it from Windows Explorer (or the Desktop) and dropping it anywhere in SWMM's main window.

3. A new checkbox was added to the Evaporation page of the Climatology Editor to include the option to evaporate only in dry periods.

4. The choices for Function type on the Buildup page of the Land Use Editor were extended to include an external time series (EXT).

5. SWMM will now continue to use the period (".") as the decimal separator even if the user or the system changes the Windows Regional Settings while the program is running.

6. A new installer program is now used that places the example data sets

in the user's My Documents\EPA SWMM Projects folder.

7. The components below the horizontal splitter bar on the Data Browser panel were placed in their own panel component so that the splitter would work correctly under Windows 7.

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Build 5.0.018 (11/18/09)

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Engine Updates

1. Reporting of the total infiltration + evaporation loss for each Storage Unit (as a percent of total inflow to the unit) was added to the Storage Volume Summary table in the Status Report. See objects.h, node.c, stats.c, and statsrpt.c.
2. Double counting the final stored volume when finding the nodes with the highest mass balance errors has been eliminated. See stats.c.
3. A warning message was added for when a Rain Gage's recording interval is less than the smallest time interval appearing in its associated rainfall time series. (An error message is issued if the recording interval is greater than the smallest time series interval.) See gage.c and text.h.
4. Hot Start interface files now contain the final state of each subcatchment's groundwater zone in addition to the node and link information they have always had. See routing.c.

5. To avoid confusion, the actual conduit slope is now listed in the Link Summary table of the Status Report rather than the adjusted slope that results from any conduit lengthening. See link.c and dynwave.c.
  
6. The Status Report now displays only those summary tables for which results have been obtained (e.g., if the Flow Routing option is turned off, then no node or link tables are displayed). See massbal.c and statsrpt.c.
  
7. Some code re-factoring was done to place rain gage validation and initialization in separate functions. See project.c, gage.c, and funcs.h.
  
8. The engine version number was updated to 50018 (this update had been overlooked since release 5.0.010). See consts.h.

#### GUI Updates

1. A bug that prevented Status Report files from being deleted from a user's TEMP folder when they were no longer in use was corrected. Users should check their TEMP folders (usually in c:\Documents and Settings\\Local Settings\Temp) for old files that begin with "swm". These can safely be deleted.
  
2. The project input file created for use by SWMM's Add-On Tools now contains all project data, including map coordinates and element tags.

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Build 5.0.017 (10/7/09)  
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## Engine Updates

1. The Ponding routine for dynamic wave flow routing was once again modified, this time to account for the special case where a node transitions between surcharged and ponded conditions within a single time step. This should correct the large continuity errors experienced with ponding under release 5.0.016. See `dynwave.c`.
2. Error 112 (a conduit's elevation drop exceeds its length) is now treated as a Warning condition and not a fatal error. In this case the conduit's slope is computed as in earlier versions of SWMM (elevation drop / length) instead of using the more rigorous right-triangle method of HEC-RAS. See `link.c` and `text.h`.
3. Inflow interface files no longer have to contain data for all of the same pollutants defined in the current project (e.g., they can contain just flows or some subset of the pollutants). See `iface.c`.
4. Instead of using the rain gage's recording interval as the time step for processing a set of RDII unit hydrographs, the smaller of the wet runoff time step and the time to peak of the shortest unit hydrograph in the set is now used. As a



result, it is now permissible to use hydrographs whose time to peak is shorter than the rain gage recording interval.

See rdii.c.

5. Under Curve Number infiltration, infiltration now stops when the maximum capacity (initially equal to  $1000/\text{CN} - 10$  inches) is completely used up. See infil.c.
  
6. The small tolerance used to determine how much ponded depth in excess of depression storage is needed to initiate runoff was removed. This produces a smoother runoff response for some data sets. See subcatch.c.
  
7. A default concentration for dry weather flow has been added to the Pollutant object. It can be overridden for any specific node by editing the node's Inflows property. See landuse.c, routing.c, and objects.h.
  
8. For water quality routing, the simplified analytical solution to the CSTR mixing equation was replaced with a more robust finite difference approximation. This seems to avoid numerical problems with high decay rates. See qualrout.c.
  
9. First order decay was not being applied to pollutants transported through conduits under Steady Flow routing. To do this correctly required writing a special water quality routine just for Steady Flow routing. See qualrout.c.

10. A small minimum depth tolerance was introduced for treatment to occur at nodes and to have non-zero concentrations in conduits. See qualrout.c.

11. Large water quality mass balance errors in systems that provide treatment at nodes were eliminated by correctly accounting for both the inflow mass and mass in storage when computing the mass lost to treatment. See treatmnt.c.

#### GUI Updates

1. The property editor for Pollutant objects was modified to accommodate the new default dry weather flow concentration property.

2. The default dry weather runoff time step was reduced from 15 to 5 minutes and the default total duration was changed from 0 to 6 hours.

3. The Ruler tool now displays a small square where the user begins their measurement so that it's easier to create a closed polygon when measuring an area.

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Build 5.0.016 (6/22/09)

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Engine Updates

1. A new option was added to compute daily evaporation from the daily temperature values contained in a climate file using Hargreaves' method. (See `climate.c`, `enums.h`, `keywords.h`, and `text.h`).
2. When the Ponding option is turned on, nodes that can pond are no longer always treated like storage nodes that never surcharge. Now they are only treated this way after ponding occurs. Otherwise they behave like a normal node. (See `dynwave.c`).
3. The small tolerance used to decide when a storage node was full or not has been removed since for very small time steps it could cause a currently full storage unit to remain full even if there was some small net outflow from it. (See `node.c`).
4. Spurious warnings for negative elevation offsets no longer appear when the "\*" entry is used for the offset value or when the offset elevation value is within a small tolerance of the node invert elevation. (See `link.c`).
5. When the water level at a storage node exceeds the highest level supplied in its Storage Curve, an extrapolated surface area from the curve is now used only if the curve is sloping outward (i.e., surface area is increasing with depth at the top of the curve). If instead, it slopes inward then the last surface area entry in the curve is used. (See `table.c`).
6. Comma delimited NCDC rainfall files, both with and without station name, can now be recognized and read correctly by SWMM. (See `rain.c`).

7. Space delimited NCDC rainfall files with empty spaces in the condition code fields can now be read correctly. (See rain.c).
  
8. A bug created in release 5.0.015 that caused incorrect RDII inflows to be computed when the rain gage recording interval was less than the runoff wet time step has been fixed. (See rdii.c).
  
9. A new error check was added to detect if the time base of an RDII unit hydrograph is less than its rain gage recording interval. (See rdii.c).

#### GUI Updates

1. The Evaporation page of the Climate Editor was modified to accommodate the new option for computing evaporation from daily temperatures.
  
2. Evaporation Rate has been added to the list of System variables that can be viewed in time series plots and tables.
  
3. The term "Shape Curve" was replaced by "Storage Curve" in the Storage Unit Property Editor to remove any confusion with the Shape Curve used to define custom closed cross-section shapes.

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Build 5.0.015 (4/10/09)  
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#### Engine Updates

1. Storage unit nodes have a new optional property named Infiltration that can store Green-Ampt infiltration parameters for the unit and thus, allow it to serve as an infiltration basin. The Green-Ampt infiltration model was modified to explicitly include the effect of ponded water depth on infiltration rate. (See `infil.c`, `massbal.c`, `node.c`, and `objects.h`).
2. Different sets of Initial Abstraction parameters (maximum depth, initial depth, and recovery rate) can now be specified for each of the three unit hydrographs (short term, medium term, and long term) that comprise an RDII Unit Hydrograph group (see `keywords.h`, `keywords.c`, `objects.h`, `rdii.c`, and `text.h`).
3. A Meander Modifier was added to a Transect's parameters. It is the ratio of the length of a meandering main channel to the length of the overbank area that surrounds it. This modifier is applied to all conduits that use this particular transect for their cross section. It assumes that the length supplied for these conduits is that of the longer main channel. SWMM will use the shorter overbank length in its calculations while internally increasing the main channel roughness to account for its longer length. (See `dynwave.c`, `flowrout.c`, `link.c`, `objects.h`, and `transect.c`).
4. NWS files in space delimited TD 3240 or 3260 format that include a station name field have been added to the types of rainfall files that are automatically recognized by SWMM (see `rain.c`).
5. The 2 GB binary output file size limit for runs made under the GUI

that was inadvertently added into release 5.0.014 was removed (see output.c).

6. Any backflow that flows into an outfall node due to the head condition at the node is now correctly reported as part of the node's Total Inflow result (see node.c).
7. A fatal error is now generated if the smallest time interval between values in a rainfall time series does not match the recording time interval specified for the associated rain gage object (instead of internally adjusting the gage interval and issuing a warning message) (see error.c, error.h, and gage.c).
8. The normal flow limitation for dynamic wave flow routing based on the Froude number now requires that the latter be greater or equal to 1.0 for both the upstream and downstream flow depths rather just for either of these (see dynwave.c).
9. A reporting error for the overflow rate into the ponded volume for a node that floods under dynamic wave flow routing was corrected (see dynwave.c).
10. The practice of not allowing a computed top surface width to be less than the width at 4% of the full conduit depth for dynamic wave flow routing has been dropped in favor of using the actual width, no matter how small (see dynwave.c).

## GUI Updates

1. Data entry forms were modified to support the new modeling features described in the Engine Updates items (1) - (3).
2. A problem with the way that conduits with elevation offsets were displayed in profile plots drawn prior to a run was corrected.

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Build 5.0.014 (1/21/09)

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Engine Updates

Rain Gages (gage.c, table.c, error.c, error.h, and objects.h)

1. The recording interval for a rain gage is now automatically adjusted to be no greater than the smallest time interval for the gage's time series data (with a warning message written to the Status Report).
2. When two or more rain gages reference the same time series data, a fatal error message is now generated if the Rainfall Formats (intensity, volume, or cumulative volume) for the gages are not all the same.

Infiltration (infil.c)

3. The Green-Ampt infiltration rate was corrected for the case when the surface becomes saturated part way through the current time step.
4. The saturated hydraulic conductivity is no longer needed by the Curve Number method to compute a regeneration rate for infiltration capacity. The latter is now set simply to the reciprocal of the user supplied drying time. Thus, the CN method now requires only two parameters (the CN and the drying time).
5. An optional monthly adjustment pattern can now be used to modify the

recovery rate of infiltration capacity by month of year. The name of this pattern is specified as part of the Evaporation data. See the Help file or the User's Manual for details. (This also affects files climate.c, keywords.c, project.c, enums.h, objects.h, and text.h).

Flow Routing (flowrout.c, node.c, inflow.c, link.c, and objects.h)

6. A new Minimum Slope option has been added. When this option is non-zero a computed conduit slope is not allowed to be below this value. The default is 0. (Note: the slope of a conduit whose elevation difference is below 0.001 ft is first computed using this elevation difference and then is compared to the Minimum Slope value.) (The following files were also changed for this feature: keywords.c, project.c, enums.h, globals.h, text.h).
7. An optional Baseline Time Pattern was added for external inflows at nodes. It can be used to apply a periodic adjustment to the baseline inflow value by month of year, day of week, etc. See the Help file or the User's Manual for more details.
8. Specific conduits can now be designated as Culverts and have Inlet Control flow computed for them under Dynamic Wave flow routing.
9. The rating curve used to determine flow through an Outlet can now be based on either the freeboard depth above the outlet bottom (as before) or on the head difference between the upstream and downstream nodes.
10. The calculation of the maximum outflow that a node can release over a time step should be based on the initial volume, not the final volume, at the node.
11. A problem with the program not accepting an ideal pump when the connecting upstream conduit had an adverse slope was fixed.
12. The formula used to compute conduit slope was modified to match that



used by HEC-RAS.

13. A problem with the program crashing when the No Routing option was selected in combination with the Save Outflows Interface File option was fixed (see output.c).
14. Under Steady Flow and Kinematic Wave routing one can now use a Dummy conduit that connects to a node at higher elevation without having to specify an inlet offset.

Dynamic Wave Flow Routing (dynwave.c, link.c, and node.c)

15. Under-relaxation of flows for pumps between iterations of the governing equations is no longer used since it can produce a solution that does not conform to the pump's operating curve.
16. Instead of the average area, the upstream weighted area that accounts for near-supercritical flow is now used in the  $dQ/dH$  term for conduits.
17. The upstream/downstream Froude numbers used to check for normal flow are now computed using hydraulic depth rather than flow depth.
18. When ponding is allowed, ponded volume is now computed from the computed nodal depth rather than adjusting the depth to accommodate the ponded volume based on the excess of inflow versus outflow. This is a return to the original method that was used up until Release 5.0.010 and makes ponding (which is actually a form of storage) consistent with the way that storage nodes are normally treated.
19. The volume at the inlet node of Type I pumps (where an implicit wet well is assumed to occur) is now determined on the basis of computed depth, just as with storage nodes, rather than computing depth from the change in volume.
20. The possible closing of tide gates on outfalls directly connected to orifice, weir, or outlet links is now correctly accounted for.

#### Conduit Cross-Sections (xsect.c)

21. The modified baskethandle (MODBASKETHANDLE) cross-section shape was extended to allow the circular top to have any desired radius equal or greater than half the section's width. It thus becomes an upside-down version of the Rectangular-Round shape. The section geometry functions for both shapes received extensive revision.

#### Control Rules (controls.c)

22. "SIMULATION MONTH" and "SIMULATION DAY" (meaning month of the year and day of the week, respectively) have been added to the types of time conditions that can be used in a control rule condition clause.

#### Pollutant Buildup/Washoff (subcatch.c, landuse.c, and consts.h)

23. Washoff of a user-specified initial buildup when there is no buildup function specified now works correctly.
24. The way that concentrations in runoff are combined with those from runoff and direct rainfall was modified so as to produce more consistent results, especially when a BMP removal value is applied.

#### Water Quality Routing (qualrout.c, routing.c, treatmnt.c)

25. For storage units, the finite difference form of the mass balance equation was replaced with the analytical CSTR solution.
26. An inflow rate adjustment was added when routing quality through conduits under Dynamic Wave flow routing to help lower the mass continuity error.
27. The formula for updating the hydraulic residence time (HRT) in a storage node was revised.
28. Quality routing under Steady Flow routing is now treated as a

special case where the concentration within a conduit simply equals that of the upstream node.

29. Any reverse flow into the system that occurs at an Outfall node is now treated as an external inflow with respect to water quality and will therefore contain whatever pollutant concentration was specified for external inflows at the node even if no external flow inflow was defined. This feature can be used to model saltwater or contaminant intrusion in tidally influenced channels.

Groundwater (gwater.c):

30. The mass balance equations were re-formulated in a simpler fashion.
31. The flow equation was re-expressed in terms of distances above the aquifer bottom instead of absolute elevations.
32. The equation for computing the maximum infiltration rate that the upper zone can accept was corrected.

Snowmelt (snow.c)

33. Snow removal for a subcatchment now works by removing snow once the "Depth at which removal begins" is reached. The fraction of this amount that remains on the surface is whatever is left over after all of the redistribution options are satisfied.
34. The "Depth at which removal begins" value is now correctly converted to internal units of feet.

RDII (rdii.c)

35. A problem with no RDII being produced when two or more RDII unit hydrographs utilized the same rain gage was fixed.

Time Series (table.c, error.c, error.h, objects.h)

36. Time Series data can now be imported from an external file instead of having to be listed in the project's input file. See the Users Manual or the Help file for details.

#### Simulation Options

37. A user can now choose to ignore any combination of the following process models when running a simulation: Rainfall/Runoff, Snowmelt, Groundwater, Flow Routing and Water Quality (swmm5.c, project.c, runoff.c, subcatch.c, routing.c, keywords.c, keywords.h, text.h, and globals.h).

#### Status Report (statsrpt.c)

38. The heading for the maximum flow column in the Link Flow Summary table was changed to "|Flow|" to show that the flows listed are absolute values.
39. The labels "Mgal" and "Mltrs" were replaced with "10<sup>6</sup> gal" and "10<sup>6</sup> ltr", respectively.
40. The widths for the various types of flow volume fields (e.g., runoff volume, node inflow volume, etc.) were increased in size.

#### Binary Output File (output.c)

41. The Report Start Time written to the binary results is now adjusted to be one reporting period prior to when the first result is reported so that the GUI uses the correct date when it displays results.

#### Output Report (command line version) (report.c)

42. Time series tables for reported subcatchments now report Snow Depth, Groundwater Elevation, and Groundwater Flow (provided that snowmelt

and groundwater processes are included in the simulation).

#### GUI Updates:

1. Support was added for the following new engine features:
  - a. minimum conduit slope option
  - b. culvert designation for specific conduits
  - c. monthly infiltration recovery Pattern
  - d. Baseline Time Pattern for external inflows
  - e. updated Modified Baskethandle cross-section shape
  - f. either depth-based or head-based Outlet rating curves
  - g. options to ignore selected process models
  - h. use of an external file as source of time series data.
  
2. Regarding 1h above, the Time Series Editor dialog was modified to include the external data file option.
  
3. A new category of Simulation Options named Reporting has been added. When this category is selected for editing in the Data Browser, a Reporting Options dialog appears from which one can limit the number of objects whose simulation results are saved and can be reported. The default is to save results for all objects.
  
4. The Group Editing feature was extended to include subcatchment Snow Packs and Groundwater Flow parameters.
  
5. The Help -> Tutorial menu command now works correctly to launch the

newer HTML version of the SWMM5 Tutorial Help file.

6. The File -> Export -> Hotstart File command now converts metric results to internal SWMM US units before saving them to the hotstart file.
7. Commas are no longer recognized as item separators when reading input files since this was causing problems when a comma was used in the ID name of an object (which is allowable).
8. The coordinates of the default natural areal depletion curve for snow packs were changed to correspond to those appearing in the National Weather Service publications on which SWMM's snow melt routines were based.
9. A problem with not loading a specified startup input file when epaswmm5.exe is launched from the command line (or from an Explorer shortcut) was fixed.
10. A problem with the simulation progress meter not displaying the correct number of elapsed days during long-term simulations was fixed.
11. A problem with Profile Plots not being updated correctly when users changed certain display options was corrected.
12. The following updates to the Profile Plot feature were made:
  - i. The selected links are now checked to make sure that they exist and form a connected path.
  - ii. The vertical axis scaling can now be set from the Profile Plot

Options dialog.

iii. The filled-in water level at junctions is now drawn only as high as the maximum junction depth (i.e., the ground surface), even if the HGL is higher.

13. A problem with copying just a single column of a Tabular Report to the clipboard or to a file was corrected.

14. A problem with the selection buttons on the Time Series and Tabular Report Selection dialog becoming stuck in the disabled mode was fixed.

15. If an external file (such as a rainfall climate, or interface file) resides in the same directory as the project file then the directory path portion of the file name is omitted when the file name is saved within the project file. This will make it easier to share project files with other users and computers.

16. The name of the "Rainfall" theme variable was changed to "Precipitation".

17. When the Auto-Backup program preference is selected, a backup file is now created whenever the current project file is saved to disk, not just when the project is first opened.

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Build 5.0.013 (3/11/08)

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Engine Updates:

1. The check on acceptable values for site latitude was corrected (see climate.c).
  
2. The definition and implementation of the PID controller was changed. See the Help File or the User's Manual for details (see controls.c).
  
3. The following changes were made to the dynamic wave flow routing routine in dynwave.c:
  - a. A new method that places more weight on upstream conduit geometry as the Froude number approaches 1 was added.
  - b. A code re-factoring error that crept into the inertial term of the momentum equation was corrected.
  - c. The flow in a fully flowing open channel can no longer be greater than the full normal flow.
  - d. The Normal Flow Limit based on both slope and Froude number was modified to simply implement the two criteria together in the same fashion as they are done individually.
  - e. A check was added that prevents any flow out of a node that is dry.
  - f. The ponding computation was reverted back to that of 5.0.009 (depth is computed from volume rather than volume computed from depth) to better maintain flow continuity.
  - g. Using the maximum allowable change in depth at a node as a criterion for selecting a variable time step was restored.
  
4. The crown elevations of any connecting non-conduit links are now considered when determining a node's crown elevation (see flowrout.c).



5. The possibility that the initial setting of an orifice was not being made correctly was eliminated (see link.c).
6. Error checks were added to test for invalid numbers in a hot start file (see routing.c).

#### GUI Updates:

1. Checks were added to test for erroneous values in an INI file that would prevent a graph from displaying properly.

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Build 5.0.012 (2/4/08)

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#### Engine Updates:

1. The summary results tables written to the Status Report file have been updated and expanded. See the User's Manual for more details. Code changes to support this were made to dynwave.c, flowrout.c, funcs.h, inputrpt.c (a new module), keywords.c, keywords.h, link.c, objects.h, output.c, report.c, stats.c, statsrpt.c (a new module), and text.h.
2. Conduit offsets can now be specified as an absolute elevation or, as before, a relative depth above the node invert. The same is true for the bottom of orifices, weirs, and outlets. The "Link Offsets" setting in the GUI and the

corresponding LINK\_OFFSETS entry in the project's input file determine which option, DEPTH or ELEVATION, is in effect. (see project.c, link.c, keywords.c, keywords.h, globals.h, and text.h).

3. A PID-type controller has been added to the types of modulated control rules that are available. See the Help file or the User's Manual for instructions on how to use this feature (see controls.c and keywords.c).
4. In the simulation results, "flooding" is now considered to occur whenever the water level exceeds the top of a node, whether ponding occurs or not. Before, flooding was only recorded when there was no ponding and node overflow was lost from the system (see dynwave.c, flowrout.c, massbal.c, node.c, stats.c, and statsrpt.c).
5. The point at which the time to drain the upper soil zone for Green-Ampt infiltration is first calculated was moved from time 0 to the time when the first rainfall period occurs. This fixes a problem where different runoff hydrographs were being produced when a project's start date was shifted slightly (see infil.c).
6. The criteria used to determine when steady state flow conditions exist were changed to more closely follow those used in SWMM 4 (see routing.c and the Help File or Users Manual for the Skip Steady Periods option).
7. The optional user-assigned maximum flow limit for conduits was

made operational for all flow routing options, not just Dynamic Wave routing (see link.c).

8. SI unit conversion problems for both a pump's on/off depth settings and its pump curve slope values were fixed (see link.c).
9. The possibility that ponding could occur at the inlet (wet well) node for a Type I pump was added (see dynwave.c).
10. A mistake in the Hazen-Williams head loss formula for force main conduits was corrected (see forcmain.c).
11. The minimum limit of 0.0001 on flow area and hydraulic radius computed from flow depth during dynamic wave routing was removed since flow depth is already limited by this amount (see dynwave.c).
12. The flow direction test added for checking UPSTREAM CRITICAL and DOWNSTREAM CRITICAL flow conditions in dynamic wave flow routing was removed to prevent solutions from becoming stuck (see dynwave.c).
13. The use of a maximum allowable change in depth at a node as a criterion for selecting a variable time step for dynamic wave flow routing was dropped (see dynwave.c).
14. A more refined method for computing the flow across a bottom orifice at low heads was implemented. (see link.c).
15. The head loss calculation caused by flap gates in weirs was

extended to orifices as well (see link.c).

16. The computation of depth as a function of area for a trapezoidal channel was extended to consider the case where the user used 0 for the side slopes (making it a rectangular channel - a holdover from SWMM 4) (see xsect.c).

17. A bug introduced in 5.0.010 that was preventing RDII from being computed for unit hydrographs that used the same rain gage as another unit hydrograph was fixed (see rdii.c and objects.h).

18. Pollutant loading from RDII was corrected to be based on the pollutant's specified RDII quality rather than its rainfall quality (see routing.c).

19. The "Snow Only" option for the buildup of a pollutant was never actually, implemented and has now been added (see subcatch.c).

20. Additional error checking for valid snow melt and snow pack input parameters was added (see snow.c, error.c, and error.h).

21. The same runoff threshold is now used for both pollutant washoff (when above the threshold) and buildup (when below the threshold) to avoid non-zero runoff concentrations from being reported during periods with negligible runoff (see subcatch.c).

22. The values for total system outflow and system flooding that are saved to the binary results file at each reporting time step are now set equal to the same values that are used for computing the

overall flow continuity error, thus avoiding inconsistent system outflow values being generated for some data sets (see output.c).

23. For the command line version of SWMM, the default END\_TIME option was corrected from being 24 days to 0 days (i.e., midnight of the END\_DATE value) (see project.c and swmm5.c).

#### GUI Updates:

1. The Status Bar on the bottom of the main window was given a new look, with drop down buttons added for changing the Link Offsets convention and the project's flow units.
2. A combo-box was added to the Nodes/Links page of the Project Defaults dialog to select the Link Offsets convention (in addition to the button on the Status Bar).
3. The choice of Flow Units was removed from the General Options page of the Simulations Options dialog and placed into a drop-down button on the main window's Status Bar. (As before, one can also set flow units from the Nodes/Links page of the Project Defaults dialog.
4. A Bookmarks panel was added to the Status Report window to make it easier to navigate between different sections within the report.
5. A new Measurement Tool button was added to the Map Toolbar that allows one to measure the distance of a polyline or the area of a polygon drawn directly on the study area map.

6. Storage Units were added to the choice of objects that can be edited using the Group Editor dialog.
7. The length assumed for non-conduit objects displayed on a profile plot was reduced from 100 ft to 10 ft.
8. A "View Conduits Only" option was added to the Profile Plot Options dialog that makes the plot display just the water depth in the conduits along the profile and not show the HGL and ground surface. This allows one to get a better view of how full a conduit is.
9. The Project Data viewer (launched when Project | Details is selected) can now be split into two views by selecting Window | Split from its menu bar (or Window | Remove Split to remove the split view).
10. The number of decimal places set for each computed variable on the Number Formats page of the Program Preferences dialog is now saved between sessions as the other preferences are.
11. Current simulation results are now always saved between sessions (if requested by the user) even if data were modified after the last run was made. In this case, when the project is opened again, the Run Status icon will show that results are available but need updating.
12. If the user changes the display format of a Date/Time axis in the Graph Options dialog and checks the Default box in the dialog, then this format will be used for all future time series plots for the current project.

13. A problem with the Profile Plot dialog not always identifying the path of fewest links between two nodes when asked to do so was corrected.
14. Entries in the [REPORT] section of a project input file that were used to define reporting options for the command line version of SWMM 5 will no longer be lost when the project is run under the GUI version of SWMM. The GUI version simply ignores them but adds them into the project file whenever it is saved.
15. Conduit lengths and areas were always being re-computed after the study area map's dimensions or distance units were changed with the Map Dimensions dialog rather than only when the user selected the re-compute option on the dialog.
16. The backdrop map now pans to the correct position when the Edit | Find Object command is used to locate an object that is currently not in view on the study area map.
17. The problem of having the name of a subcatchment's outlet node or groundwater node be lost whenever that node was converted to another type using the study area map's right-click popup menu was fixed.
18. The Statistics Report analyzer was failing to include the last event in its calculations for some data sets.
19. Additional input validation was added to the Snow Pack editor form.

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Build 5.0.011 (7/16/07  
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Engine Updates:

1. A bug that prevented Weir and Outlet settings from being updated after they were changed by control rules was fixed (see link.c).
2. The control setting for a Weir was not being accounted for when computing an equivalent orifice coefficient for surcharged flow or when computing flow through a V-notch weir (see link.c).
3. The reported depth of flow through a Weir was not taking into account the Weir's control setting (see link.c).
4. An update made in 5.0.010 to how ponded depths and volumes are computed under dynamic wave flow routing was corrected (see dynwave.c).
5. The equations used to mix the quality of runoff, rainfall and ponded water over a subcatchment were revised to prevent numerical instability at very low volumes (see subcatch.c).
6. Missing values in NCDC rainfall files that use the 'M' flag are now added to the total number of missing records reported (see rain.c).



## GUI Updates

1. A bug introduced in release 5.0.010 that neglected to place quotation marks around Map Labels and backdrop file names (which can have spaces in them) when a project was saved to file and which caused problems when the project was re-opened has been fixed.

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Build 5.0.010 (6/19/07)

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## Engine Updates:

1. All "float" variables were re-declared as "doubles" (except for those variables written to binary interface files) and the engine was re-compiled using the Microsoft VC++ 2005 compiler.
2. A new NO ROUTING option was added which allows a run to ignore any flow routing and only compute runoff (see swmm5.c, keywords.c, stats.c, and enums.h).
3. A new type of pump, an Ideal Pump, was added which pumps at a rate equal to the inflow to its inlet node and does not use a pump curve (see enums.h, link.c, and flowrout.c).
4. A new type of conduit shape, a Custom Shape, was added which

allows users to define their own cross-sectional geometry for closed conduits. To implement this feature, a new type of curve, a Shape Curve, was added which records how the width of the cross-section varies with height. (See `keywords.c`, `link.c`, `project.c`, `report.c`, `shape.c`, `xsect.c`, `enums.h`, `funcs.h`, `globals.h`, `objects.h`, and `text.h`).

5. Another new type of conduit shape, a Circular Force Main, was added. It is a circular pipe that uses either the Hazen-Williams or Darcy-Weisbach equations, instead of the Manning equation, for pressurized flow only. The Hazen-Williams C-factor or the Darcy-Weisbach roughness height is one of the shape's parameters. The choice of which equation to use (for Force Mains only) is a new global option. (See `project.c`, `forcmain.c`, `dynwave.c`, `keywords.c`, `link.c`, `xsect.c`, `enums.h`, `globals.h` and `text.h`).
6. Pumps can now have startup and shutoff inlet node depths supplied directly as part of a pump's properties rather than as part of a control rule. (See `link.c`, `routing.c`, `objects.h`, and `funcs.h`).
7. Orifices can now have timed gate openings and closings as in SWMM 4 (i.e., the SWMM 4 ORATE parameter). (See `link.c` and `objects.h`).
8. Unit Hydrographs used for RDII inflows can now have an initial abstraction loss associated with them. Consult the User's Manual or the Help file for details. (See `rdii.c` and `objects.h`).
9. A new criterion was added to determine when a conduit has

supercritical flow and therefore normal flow conditions might apply. It is based on both water surface slope and the Froude number (as opposed to just one or the other). (See `dynwave.c`, `project.c`, `keywords.c`, `enums.h`, and `text.h`).

10. A Flow Instability Index is now computed for each non-pump link.

It counts the number of time steps in which the link's flow is either higher or lower than the flows at the previous and next time steps. The Status Report lists the links with the five highest indexes. (See `objects.h`, `stats.c`, and `report.c`).

11. Node volumes are now initialized to take account of any initial ponding that may be implied by the node depth stored in a hot start file (see `flowrout.c`).

12. The area corrections to the inlet and outlet loss terms under dynamic wave flow routing that were introduced in Build 5.0.008 were removed (see `dynwave.c`).

13. To comply more closely with standard hydraulic practice, the head across an orifice is now computed with respect to the midpoint of its opening, rather than to the bottom. Also, orifices are now treated the same as weirs in terms of not contributing any surface area to their end nodes (see `link.c` and `dynwave.c`).

14. The partly opened setting for an orifice is now interpreted as fraction of the full orifice opening height available rather than as the fraction of the full area available. Also, the

equivalent discharge coefficient for a partly full orifice is now re-computed whenever the setting of the orifice changes (see link.c).

15. In kinematic wave flow routing, when a conduit's inflow is limited to its maximum normal flow, its corresponding inflow area is now correctly normalized to the full flow area (see kinwave.c).

16. For dynamic wave flow routing, the criteria used to check if a node is not full before using its depth to compute a variable time step was corrected to avoid excessively small time steps (see dynwave.c).

17. The width v. depth table for circular shapes was expanded to 51 entries to match that of the other tables for this shape (see xsect.dat).

18. The number of entries in the geometry tables for irregular cross-sections was increased to 51 entries (see objects.h).

19. For Divider nodes, both end nodes of the diversion link are now checked to see if one of them is connected to the divider node (see node.c).

20. Conditions on Outlet links are now correctly recognized in control rule statements and an error message is now generated if more than one rule clause is placed on the same line (see controls.c).

21. When the Ignore Rainfall option is used, a rain gage's rainfall is now properly initialized to 0 to prevent a spurious rainfall value from being reported (see gage.c).
  
22. An explicit check is now made in the engine (which already exists in the GUI) to see if the ID name of the outlet of a subcatchment exists as both a node and a subcatchment. If so, then Error 108 is thrown. (See subcatch.c).
  
23. The column in the Node Depth Summary of the Status Report that previously displayed the total volume of ponded water at each node (but was labelled "Total Flooding") now displays the maximum volume of ponded water at each node and is labelled "Max Vol. Ponded". Also, flow values appearing in the Status Report's tables were expanded to 3 decimal places for MGD and CMS units, and an additional decimal place was added to ponded area and conduit length in the report's Input Summary tables (see stats.c and report.c).
  
24. When a node is ponded under dynamic wave routing, the water depth is now always set equal to the ponded depth rather than the smaller of the ponded and dynamic depths (see dynwave.c).
  
25. A more efficient way of processing the mathematical expressions used in treatment functions has been implemented (see mathexpr.h, mathexpr.c, and objects.h).
  
26. A bug in the Groundwater routine that allowed infiltration to continue even when the entire groundwater table was saturated was fixed as was a metric units conversion error on computed groundwater

flow (see gwater.c).

27. The locations of the left and right overbank stations for an irregular channel transect are now adjusted by the Station Modifier multiplier, in the same way as all of the other station locations across the transect are.
28. An error in computing the flow contribution of the triangular ends of a trapezoidal weir was corrected (see link.c).
29. A roundoff error under kinematic wave and steady flow routing that sometimes caused nodes to be incorrectly reported as ponded was fixed (see flowrout.c).

#### GUI Updates:

1. A "Tools" item was added to SWMM's main menu. The existing menu options to set Program Preferences and Map Display Options were moved there. In addition, it contains a "Configure Tools" option that can be used register add-in tools with SWMM 5. Consult the User's Manual or the Help file for more information regarding add-in tools.
2. A "None" option was added to the choice of routing methods on the General page of the Simulation Options dialog to accommodate the new No Routing analysis option.
3. The Property Editor for Pumps was modified to allow the Pump Curve field to remain blank (or accept a \*) to signify the new Ideal type

pump and to accept startup and shutoff depths.

4. The Property Editor for orifices was modified to include a Time To Close/Open field.
5. The Unit Hydrograph Editor dialog was modified to include the new Initial Abstraction parameters.
6. The Analysis Options dialog was modified to accommodate the new supercritical flow criterion.
7. The Cross-Section Editor and the Curve Editor were modified to accommodate the new Custom cross-section shape feature as well as the new Circular Force Main shape.
8. The File | Export menu has a new option that, once a run has been successfully made, will export the node and link results at the current time period being viewed to a Hotstart file.
9. The popup menu for toggling the map's Auto-Length feature was replaced with a check box on the Status Panel.
10. A check box was added to the Map Dimensions dialog to ask if conduit lengths and subcatchment areas should be recomputed when the Auto-Length setting is on.
11. The Group Delete feature now offers the option of only deleting objects with a specific value for their Tag property.

12. Ponded Area was added to the list of node parameters that can be assigned a default value through the Project >> Defaults menu item.
13. The epaswmm5.ini file that contains a user's program preferences is now saved to the users Application Data folder, in a sub-folder named EPASWMM, rather than to the user's home folder.
14. Conduit slopes are no longer displayed as absolute values, so that negative slopes will show up on a thematic display on the study area map and will also be identified when a map query is made.
15. The bitmap image on the Run speed button was replaced.
16. The automatic identification of a connected path of links between two nodes specified on the Profile Plot dialog now uses the path with the smallest number of links.
17. The Study Area Map's Zoom Out feature no longer uses a zoom out to previous extent. Instead, it zooms out relative to the current center of the map.
18. The Animator toolbar was made a permanent part of the Map Browser panel.
19. The operation of the date and time controls on the Map Browser panel were modified to work correctly with reporting times that are larger than 1 day.
20. The options on the Map Query dialog were extended to allow one to



identify all nodes on the map that have been assigned a particular type of external inflow (Direct, Dry Weather, RDII, or Groundwater).

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Build 5.0.009 (9/19/06)  
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Engine Updates:

1. A climate file in the user-prepared format will no longer be confused with one using the Canadian format (see climate.c).
2. The minimum runoff which can generate pollutant washoff was changed from 0.001 in/hr to 0.001 cfs (see subcatch.c).
3. A new RDII event now begins when the duration of a continuous run of dry weather exceeds the base time of the longest unit hydrograph rather than arbitrarily being set at 12 hours (see rdii.c).
4. Problems with dynamic flow routing through long force mains connected to Type 3 and Type 4 pumps have been corrected (see dynwave.c and link.c).

GUI Updates:

1. A problem in displaying profile plots when all elevations are below zero has been corrected.

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Build 5.0.008 (7/5/06)  
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Engine Updates:

1. The conversion from the Horton infiltration drying time input parameter to an equivalent regeneration curve constant was corrected.
2. Pipe invert elevations at outfalls are now measured relative to the outfall stage elevation rather than the outfall's invert elevation.
3. Entrance/exit minor loss terms for dynamic wave flow routing are now adjusted by the ratio of the mid-point to entrance/exit areas to improve the energy balance.
4. A possible error in computing flow depth from head when checking the normal flow limitation based on the Froude number for dynamic wave flow routing was corrected.
5. A potential problem with converting the units of rainfall read from an external file was corrected.
6. The equivalent length of orifices and weirs was changed from being a minimum of 200 ft to a maximum of 200 ft.
7. Problems in displaying washoff mass balance results for pollutants expressed as Counts/Liter were fixed.
8. The reporting of total system maximum runoff rate in the Status Report's Subcatchment Runoff Summary table has been corrected.
9. The subcatchment pollutant washoff process was reprogrammed to provide more rigorous mass balance results for the case where runoff from one subcatchment is routed over another subcatchment or when there is direct deposition from rainfall.
10. Checks for non-negative conduit offsets and orifice/weir/outlet heights have been added.
11. A constant value and a scaling factor have been added to

Direct External inflows. See the Inflows Editor - Direct Page topic in the Help file for more details.

12. A listing of total washoff loads for each pollutant for each subcatchment has been added to the Status Report.
13. A new summary table of Node Inflows and Flooding has been added to the Status Report.
14. A new summary table of Outfall flows and pollutant loads has been added to the Status Report.
15. The 5.0.006 Engine Update #12 has been revoked.

#### GUI Updates:

1. The Inflows Editor was modified to accommodate the baseline and scaling parameters added to direct external inflows.
2. The .INI file that saves a user's program preferences is now saved to the user's home directory rather than the SWMM installation directory.
3. The Select All command was extended to apply to the Status Report display.
4. A new text file viewer component was used for the Status Report to speed up the display of the report's contents.
5. A formatting error on the Horizontal Axis page of the Graph Options dialog form was corrected. This required making changes to the custom Chart Dialog component that is included with the GUI's source code.
6. Some cosmetic changes were made to the look of Tabular reports.
7. Type 3 pump curves (head v. flow) are now displayed with head on the vertical axis and flow on the horizontal axis when the View option is selected in the Curve Editor dialog.

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Build 5.0.007 (3/10/06)  
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Engine Updates:

1. An "Ignore Rainfall" analysis option was added that causes the program to only consider user-supplied external inflow time series and dry weather flows and ignore any rainfall inputs that would otherwise produce runoff.
2. The hydraulic radius calculations for Rectangular-Closed, Rectangular-Triangular, and Rectangular-Round conduit shapes were modified to account for the increase in wetted perimeter that occurs under full flow due to the top surface.
3. Refinements were made in several places in the code that need to distinguish between Full Flow and Maximum Flow conditions in closed conduits.
4. The code now properly accounts for the case where the depth at which the maximum normal flow occurs through an irregular shaped cross section is less than the full depth.
5. The final volume of any ponded water (caused by node flooding) is now included in the reported flow continuity error.
6. Peak runoff flow was added to the Subcatchment Summary table in the Status Report.
7. Non-conduit links are now included in the Link Flow Summary table of the Status Report.

GUI Updates:

1. The Maximum Depth field in the Property Editor for a conduit with

an irregular shape now shows the correct value for any set of transect elevation values.

2. The "Save Profile to File" button is now enabled when the user manually adds a specified set of links to the Profile Plot dialog.
3. Link Flow Depth and Link Velocity have been added as choices for calibration variables.
4. The way that non-conduit links are displayed on profile plots was changed to avoid problems that occurred for weirs and orifices with crest heights above the node invert.
5. A problem with the way that the Group Editing function was handling the case of irregular shaped cross sections was fixed.

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Build 5.0.006a (10/19/05)

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#### Engine Updates:

1. The formula for snow melt rate during periods with rainfall was corrected to return its value in ft/sec rather than in/hr.
2. A problem with generating routing interface files for systems with just nodes and no links was corrected.

#### GUI Updates:

1. Numerical precision problems in computing centroids for subcatchments with very small distances between vertices were fixed.
2. A problem with no calibration data being shown on a time series graph when some of the data were outside the range of the graph was fixed.

3. A problem with calibration data represented as dates (not elapsed time) being shifted one reporting period over in time series graphs that used elapsed time was fixed.

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Build 5.0.006 (9/5/05)  
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Engine Updates:

1. A new summary table of maximum volumes and outflow rates for each storage unit has been added to the Status Report.
2. The SWMM 4 BC parameter, which specifies a minimum groundwater table elevation for groundwater flow to occur, was added as an optional groundwater flow parameter. If not provided, then as before, the invert of the receiving node defines the minimum groundwater table elevation for flow to begin.
3. A new option was added to the Action clause of a control rule that allows the control setting for pumps, orifices, weirs, and outlets to be defined either by a curve (of setting versus node depth, for example) or by a time series. See the "Modulated Controls" topic in the Help file for more details.
4. The problem with interior nodes being mistaken for outfall nodes (depending on the orientation of the connecting links) under water quality analyses was fixed.
5. Geometry tables for standard size elliptical pipes were added (the standard size code number in the input file was being mistaken for an actual dimension).
6. Storage curves of area versus depth are now linearly extrapolated when a depth exceeds the table limit (as in SWMM 4) rather than just

- keeping the area constant.
7. Evaporation is no longer computed from a storage unit when it becomes dry.
  8. In water quality routing, concentrations in storage units are now adjusted to reflect any evaporation loss over each time step.
  9. It is now permissible to use the same hotstart file to both provide initial values for a run and to save the final values from a run.
  10. The code was modified to be able to read evaporation values from a climate file during runs where no runoff computations are being made (previously any evaporation in such files was being ignored in data sets with no subcatchments).
  11. A problem in the way that water quality was being routed through dummy conduits was fixed.
  12. For pollutant treatment functions that define fractional removal in a storage unit node as a function of concentration, the concentration used is now the inflow concentration into the node (as is done for non-storage nodes), rather than the concentration in the storage unit.
  13. The global first-order decay reaction assigned to specific pollutants is not applied to any storage unit that has a treatment function defined for the pollutant.
  14. The total moisture available for infiltration at each time step of the runoff process now has evaporation subtracted from it before infiltration is computed.
  15. Corrections were made to the way that the water volume in the upper soil zone is depleted during dry periods under Green- Ampt infiltration.
  16. A climate file is now positioned to begin reading at the start of the simulation period (rather than the start of the file) unless the user supplies a specific starting date to begin reading from the file.

17. A fatal error is now generated if the end of a climate file is reached when seeking climate data during a run (rather than just maintaining the same climate values for the remainder of the run).
18. The Node and Conduit flow statistics that appear in the Status Report are now only collected over the reporting period of the simulation, not the entire period (as would be the case when the user specifies a Report Start Date that comes after the Simulation Start Date).
19. The computation of the initial and final groundwater storage volumes used in the Groundwater Continuity table were corrected. This error only affected the continuity numbers and not the computed flows and water table levels.

#### GUI Updates:

1. The File >> Reopen command will now list up to 10 most recently used files.
2. Map coordinates are now displayed with 3 decimal places in the Status Bar.
3. The File >> Preferences dialog now contains a "Prompt to Save Results" option. If left unchecked, simulation results will always be saved when a project file is closed and will be available for viewing the next time the project is opened.
4. A "Report Elapsed Time by Default" option was also added to the File >> Preferences dialog. If checked, then time series graphs and tables will default to using elapsed time, rather than date/time, as the time variable. This choice can always be changed in the dialog box that appears when a graph or table is first created.
5. Additional reporting variables were added to the list of parameters for which Calibration Files can be used (e.g., groundwater elevation, node flooding, etc.).



6. Percent impervious was added to the list of subcatchment themes that can be viewed on the Study Area Map.
7. An Exceedance Frequency plot panel was added to the output produced when a Statistics report is generated.
8. Users can now add, delete, or re-position items in the list of links selected for a Profile Plot in the Profile Plot dialog using a new set of buttons added to the dialog. Links are added to the list by selecting the link either on the Map or from the Data Browser and then clicking the PLUS button on the dialog.
9. Profile Plots can now be generated before any simulation results are available. They include an Update button that allows one to update the plot after editing changes have been made to any nodes or links contained in the plot.
10. The Edit >> Find menu command (and its associated speed button) was split into two sub-commands, one for finding objects on the map (as before) and another for finding text within a Status Report.
11. Problems with the wrong data fields sometimes being updated in the Group Editor were fixed.
12. The Interface File Combine utility was not working at all (the format of the interface file had changed since the original code was written). This has been fixed.
13. The centroids of subcatchment polygons on the map are now computed as true centroids rather than being merely the average of the vertex coordinates.
14. The Maximum Depth property is now preserved when a storage unit is converted to a junction (by right-clicking on it and selecting Convert To from the popup menu).
15. Map and Profile Plot animation is now turned off whenever the Animator Toolbar is closed.

16. More universal support was provided for entering numerical values in scientific notation throughout the GUI's various data entry fields.
17. Display problems with zoom-ins on the preview plots of Transects, Curves, and Time Series in their respective Editor dialogs were fixed.
18. In the GUI source code:
  - a. The custom TOpenTextFileDialog component was renamed to TOpenTxtFileDialog so as not to conflict with a Delphi 2005 component of the same name.
  - b. The custom ChartDlg component was modified to add support for a chart axis that uses Date/Time labels.
  - c. A new unit named Ucalib.pas was added that includes the code for reading data from Calibration Files that was previously contained in the Fgraph.pas unit.
  - d. The Delphi DFM files for the project are now packaged as text files, not binaries, in the source code distribution.

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Build 5.0.005b (6/15/05)  
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Engine Updates:

1. The end node offsets for conduits with the partly filled circular cross-section shape were not being increased to account for the depth of fill.
2. Flow through a weir was not necessarily zero when the water level on the side of the weir at higher head was zero.
3. The "crest height" for a Bottom Orifice is now interpreted as having the orifice lie in a horizontal

plane the specified distance above its upstream node's invert. This allows riser outlet pipes in storage units to be simulated.

GUI Updates:

1. The keyword "WEIR" was not being recognized as a legitimate type of Flow Divider node by the GUI's input data file parser.
2. The Profile Plot could display hydraulic grade lines that dropped below the invert of a conduit.

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Build 5.0.005a (5/25/05)

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Engine Updates:

1. An erroneous error message that appears when a node has multiple outflow links with one of them being an Outlet link has been fixed.

GUI Updates:

1. Corrections were made for the way a Profile Plot is drawn when negative elevation values occur.

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Build 5.0.005 (5/20/05)

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Engine Updates:

1. An error in computing ponded depths at flooded nodes under Dynamic Wave flow routing was corrected.
2. The wrong lookup function was being used to find water elevations at Time Series type outfall nodes.
3. An error in interpolating values stored on a routing interface file was corrected.
4. The rainfall file reader was confusing the standard space-delimited format with other file formats.
5. A reporting error for rainfall time series that had no ending zero value was corrected.
6. A problem with neglecting to compute a snowmelt coefficient for pervious areas was fixed.
7. The keyword for specifying that pollutant buildup be normalized to curb length was modified to accept either CURB or CURBLENGTH.
8. The conversion factor the user supplies for external pollutant mass inflows must now convert time series values into mass concentration units per second (e.g., 5.25 will convert from lbs/day to mg/sec). Flow units are no longer part of the conversion.
9. The ratio of maximum to design flow listed for each conduit in the status report was corrected to account for the number of barrels included in the conduit.
10. The minimum elevation change applied to a flat conduit was changed to 0.001 feet, as used in SWMM 4.
11. The maximum depth of an irregular cross-section transect is now based on the highest elevation of all stations, rather than just the higher of the first and last station, and vertical walls extending up to the highest elevation are added at the first and last station if need be.
12. The nominal width property of an irregular cross-section transect

is now taken as the top width at full depth rather than the maximum width over all depths.

13. At outfalls where the user-specified water elevation is below that of a free outfall, the free outfall elevation is now used.
14. A new property, the maximum allowable flow, was added to the Conduit object. The default value is 0.0, which indicates that no maximum flow is prescribed.
15. Depths at outfall nodes under Steady and Kinematic Wave flow routing are now reported as the depth in the connecting conduit.
16. The calculation of the head over a non-surcharged, submerged weir was corrected to be based on the height of water above the weir crest, rather than the difference in heads on either side of the weir.
17. The equation used to reduce the length of a weir with side contractions was modified to fix a bug in SWMM 4.
18. A new water quality routing algorithm was written that produces more robust results under Dynamic Wave flow routing.
19. The Compatibility Mode option under Dynamic Wave flow routing was removed. Now there is just a single method used which has been designed to be compatible with SWMM 4 yet produce more stable results.
20. A new dynamic wave routing option was added that determines which criterion decides when conduit flow is limited to normal flow (it represents the KSUPER parameter used in SWMM 4).
21. A new flow routing option was added that allows routing calculations to be skipped during periods of steady flow which can greatly reduce the time required for continuous simulations.

## GUI Updates:

1. An error in reading the flapgate parameter for Weirs in an input file was corrected.
2. Having the Property Editor positioned outside the viewable screen area when the user changed the video settings to a lower resolution was corrected.
3. The Convert To option to change nodes from one type of object to another was fixed.
4. The Routing Time Step option is now entered as fractional seconds on the Analysis Options form. The older format of hrs:min:sec will still be imported correctly from previous SWMM5 input files.
5. The ability to include a startup input file on the command line that launches the GUI was added (add /f filename to the command line where filename is the fully qualified name of the input file to start with).
6. Support for output results files greater than 2 gigabytes was added.
7. The display of the hydraulic grade line in Profile Plots, and its intersection with the flow volume in conduits was improved.
8. The summary results tables contained in the Status Report were modified to display more useful information.
9. The graph options selection dialogs were made to behave more consistently.
10. Support was added for copying and printing the graphical views of curves, time series, and transects from within their respective editors.
11. The SWMM 4 flow calibration data file (Extran1.dat) distributed with the example data set Example2.inp was modified to contain the flows actually, produced by SWMM version 4.4h, rather than the original numbers printed in the 1988 Extran manual.

In addition, the SWMM 5.0 User's Manual and Help file were updated to reflect these changes and new additions.

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Build 5.0.004 (11/24/04)  
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Engine Updates:

1. Fixes were made to the routines that identify and read data from the NCDC-formatted external rain files.
2. The sign of reported velocity in links with adverse slope was corrected.
3. Reading of results from previously saved Runoff Interface files was corrected.
4. The calculation of a regeneration rate constant from a soil drying time value for Curve Number infiltration was corrected, and the method was modified to use a constant infiltration capacity during each rain event, rather than a continuously declining capacity.
5. A correction was made to the dynamic wave routing routine for SWMM4 and SWMM3 compatibility modes that improves the match with Extran results from these earlier versions of SWMM.
6. The check for zero-sloped conduits was modified to include any conduit with elevation difference below 0.01 feet.
7. The computation of the ponded depth at flooded nodes under dynamic wave flow routing was corrected.
8. A check was added to make sure that the reporting time step is not longer than the run duration.
9. Surcharged and high Froude number conduits were previously excluded from consideration when computing a variable time step for dynamic

wave routing: they are now included.

10. The code numbers for the concentration units used for each pollutant was added to the binary output file produced from a simulation.

#### GUI Updates:

1. Negative values can now be entered for temperature values that appear on several input forms.
2. The input file reader now checks to make sure that the various time-of-day option values are valid.
3. A problem with copying the correct dates for a Tabular Report that is being copied to the clipboard or to a file was corrected.
4. The Graph Options dialog form was modified to display the Solid option for Style whenever a Size greater than 1 is selected. (Due to a limitation of the Graphics library used in EPA SWMM, only solid lines can be drawn at a thickness greater than 1.)

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Build 5.0.003 (11/10/04)  
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#### Engine Updates:

1. Modifications were made to full depth entries of width tables for closed rounded cross-section shapes to improve the numerical stability for dynamic wave flow routing.
2. Error 405 was added to detect if the size of the binary results file would exceed the 2.1 Gbyte system limit.
3. A unit's problem for RDII inflows under metric flow units was corrected.
4. A problem reading the TEMPDIR option when it contained spaces was



corrected.

5. Support for Canadian DLY02 and DLY04 temperature files was added.
6. Rule-based control of crest height for weirs was corrected (previously the control setting adjusted flow rather than the relative distance between weir crest and crown).

#### GUI Updates:

1. A problem with the Group Editing feature for conduits was corrected (the editor would update the wrong conduit parameter).
2. Execution time for long term simulations on smaller projects was speeded up considerably by only refreshing the progress meter every day rather than every minute.
3. The time to draw time series graphs and perform statistical analyses on large data sets was considerably shortened.

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Build 5.0.002 (11/1/04)

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Engine Updates

1. Modifications made to the Picard method used for dynamic wave flow routing routine.

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Build 5.0.001 (10/29/04)

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First official release of SWMM 5.