WWHM2012
LID Training Workshop

Sponsored by the Washington State Department of Ecology

Instructor: Doug Beyerlein, P.E., P.H., D.WRE

Clear Creek Solutions, Inc.

Mill Creek, Washington

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WWHM2012 LID Training Agenda

0:00 – 0:15 Introduction (Ecology staff)
0:15 – 0:30 Overview of changes from WWHM3
0:30 – 0:45 Revised flow duration analysis
0:45 – 1:00 New LID reporting features
1:00 – 1:15 Infiltration facilities sizing
1:15 – 1:30 Green/vegetated/eco-roofs
1:30 – 1:45 Permeable/porous pavement

1:45 – 2:00 Break

2:00 – 2:30 Bioretention
2:30 – 2:45 CAVFS
2:45 – 3:00 Wetland protection
3:00 – 3:45 Multiple LID facilities
3:45 – 4:00 Questions and Answers

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WWHM2012 LID Training Disclaimer

In addition to this WWHM2012 LID training all interested parties should:

- read 2012 *Stormwater Management Manual for Western Washington*
- attend Ecology's Western Washington Stormwater Manual training
- attend AGC's WWHM2012 basic and/or advanced computer workshops (if no previous experience with WWHM)

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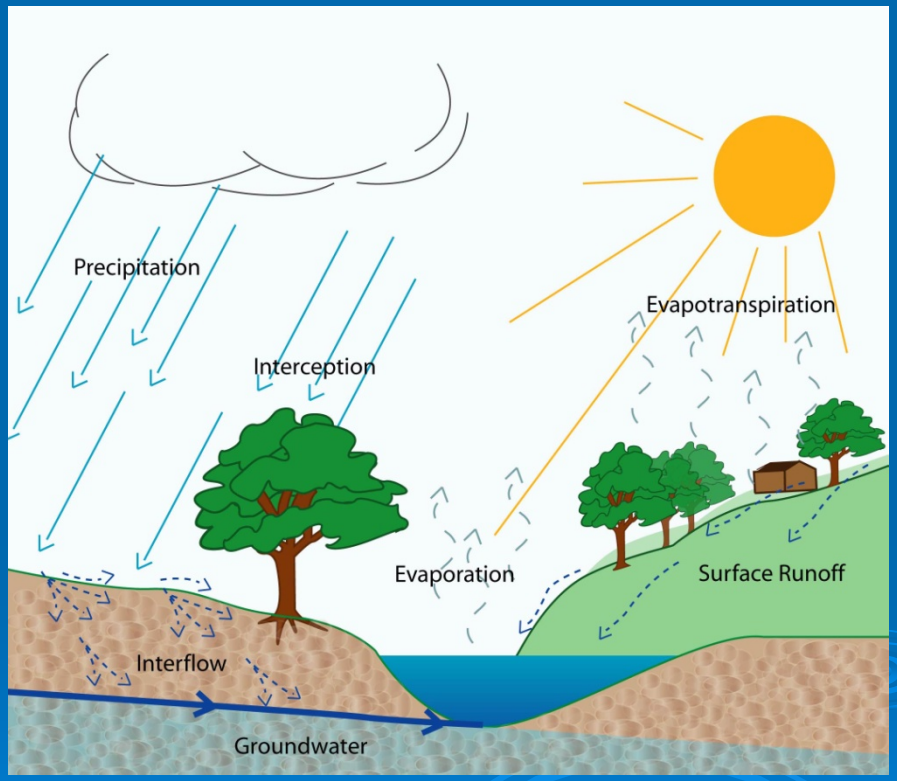
Stormwater LID Modeling

- HSPF continuous simulation hydrology in WWHM2012.
- Multiple-year 15-minute historic rainfall used to generate multiple-year 15-minute runoff data.



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How LID Works

- Uses long-term on-site infiltration and evapotranspiration to reduce stormwater runoff.
- What happens between storm events is more important than what happens during storm events.

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Overview of changes from WWHM3

Specific changes and additions in WWHM2012 include:

- Runs on Microsoft Windows 7 operating systems.
- Updated precipitation data through water year 2009 (September 2009).
- 15-minute model time step instead of an hourly time step.
- 15-minute precipitation data in place of hourly data.
- Updated water quality design flow calculations.
- Improved AutoPond capabilities.
- Added SSD Table element options.
- *Revised flow duration analysis with two duration standards:*
- *(1) Stream Protection Duration and (2) LID Duration.*
- *New LID reporting features.*
- *Automated sizing options for infiltration facilities.*
- *New green roof element.*
- *New permeable pavement element.*
- *New bioretention element.*
- *New CAVFS (compost amended vegetated filter strips) element.*
- *Revised wetland input volume criteria calculations.*

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Revised Flow Duration

Specific changes and additions in WWHM2012 include:

- *Revised flow duration analysis with two duration standards: (1) Stream Protection Duration and (2) LID Duration.*

Stream Protection Duration:
Minimum Requirement #7 Flow Control Standard:
0.50Q2 to Q50

LID Duration:
Minimum Requirement #5 Low Impact Development Performance Standard:
0.08Q2 to 0.50Q2

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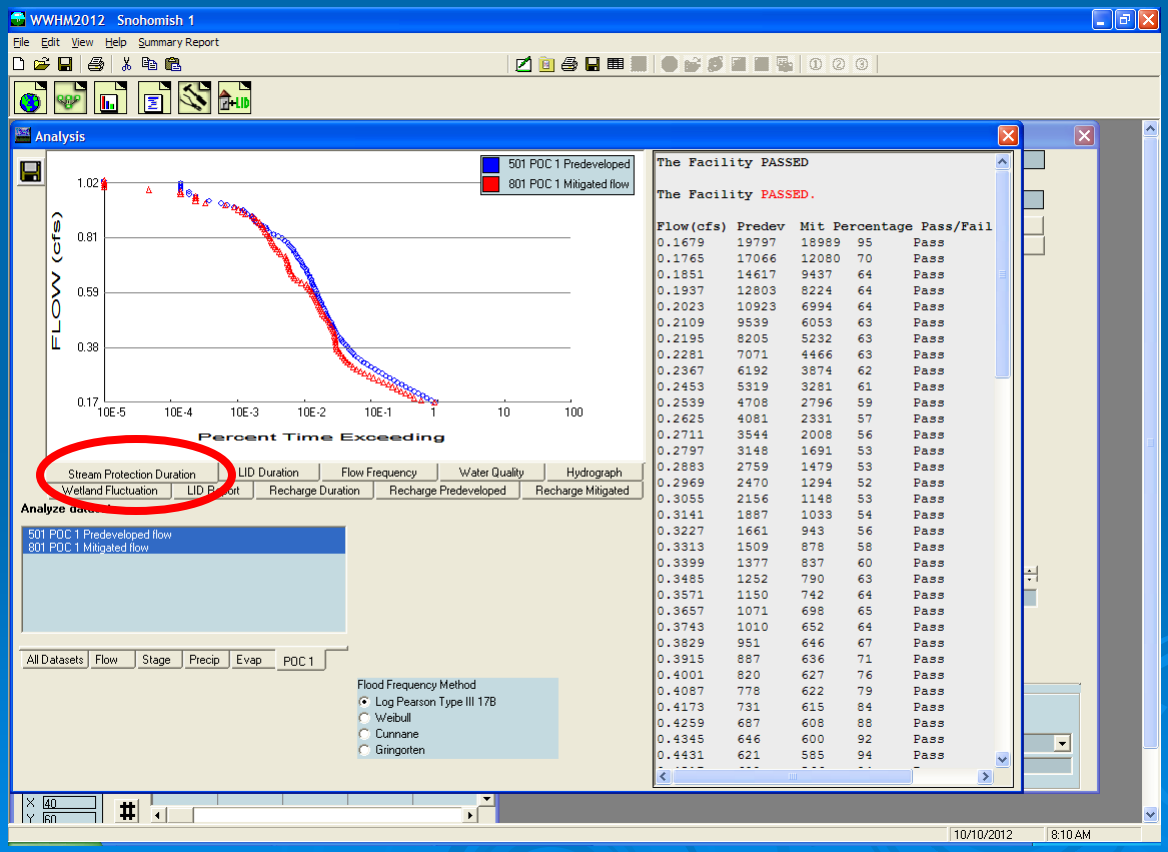
Revised Flow Duration

Stream Protection Duration:
Minimum Requirement #7 Flow Control Standard:
0.50Q2 to Q50



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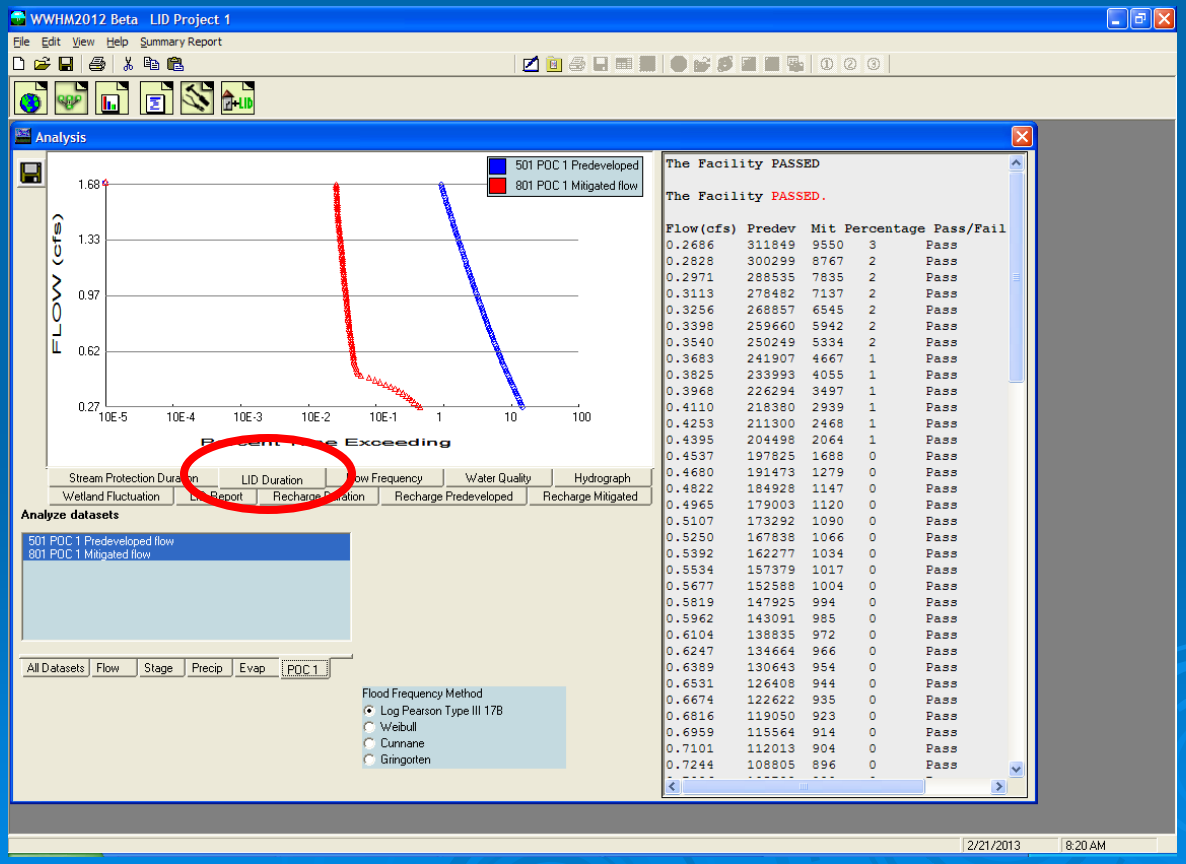
Revised Flow Duration

LID Duration:
Minimum Requirement #5 Low Impact Development Performance Standard:
0.08Q2 to 0.50Q2



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New LID Reporting Features

Ecology SWMMWW (Vol I, Section 2.3) Definitions:

- ***Hard Surface – An impervious surface, a permeable pavement, or a vegetated roof.***

- ***Pollution-generating hard surface (PGHS)*** *–Those hard surfaces considered to be a significant source of pollutants in stormwater runoff. See the listing of surfaces under pollution-generating impervious surface.*

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New LID Reporting Features

Ecology SWMMWW (Vol I, Section 2.3) Definitions:

- ***Pollution-generating impervious surface (PGIS)*** - Those impervious surfaces considered to be a significant source of pollutants in stormwater runoff. Such surfaces include those which are subject to: vehicular use; industrial activities (as further defined in the glossary); storage of erodible or leachable materials, wastes, or chemicals, and which receive direct rainfall or the run-on or blow-in of rainfall; metal roofs unless they are coated with an inert, non-leachable material (e.g., baked-on enamel coating); or roofs that are subject to venting significant amounts of dusts, mists, or fumes from manufacturing, commercial, or other indoor activities.

- ***Pollution-generating pervious surfaces (PGPS)*** - Any non-impervious surface subject to vehicular use, industrial activities (as further defined in the glossary); or storage of erodible or leachable materials, wastes, or chemicals, and that receive direct rainfall or run-on or blow-in of rainfall, use of pesticides and fertilizers or loss of soil. Typical PGPS include permeable pavement subject to vehicular use, lawns and landscaped areas including: golf courses, parks, cemeteries, and sports fields (natural and artificial turf).

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New LID Reporting Features

Pollution Generating	Non-Pollution Generating
Lawn, Pasture	Forest
Metal roofs, green roofs	Non-metal roofs
Permeable road pavement	Non-vehicle permeable pavement (sidewalks, etc.)
Vehicle pavement	Non-vehicle pavement

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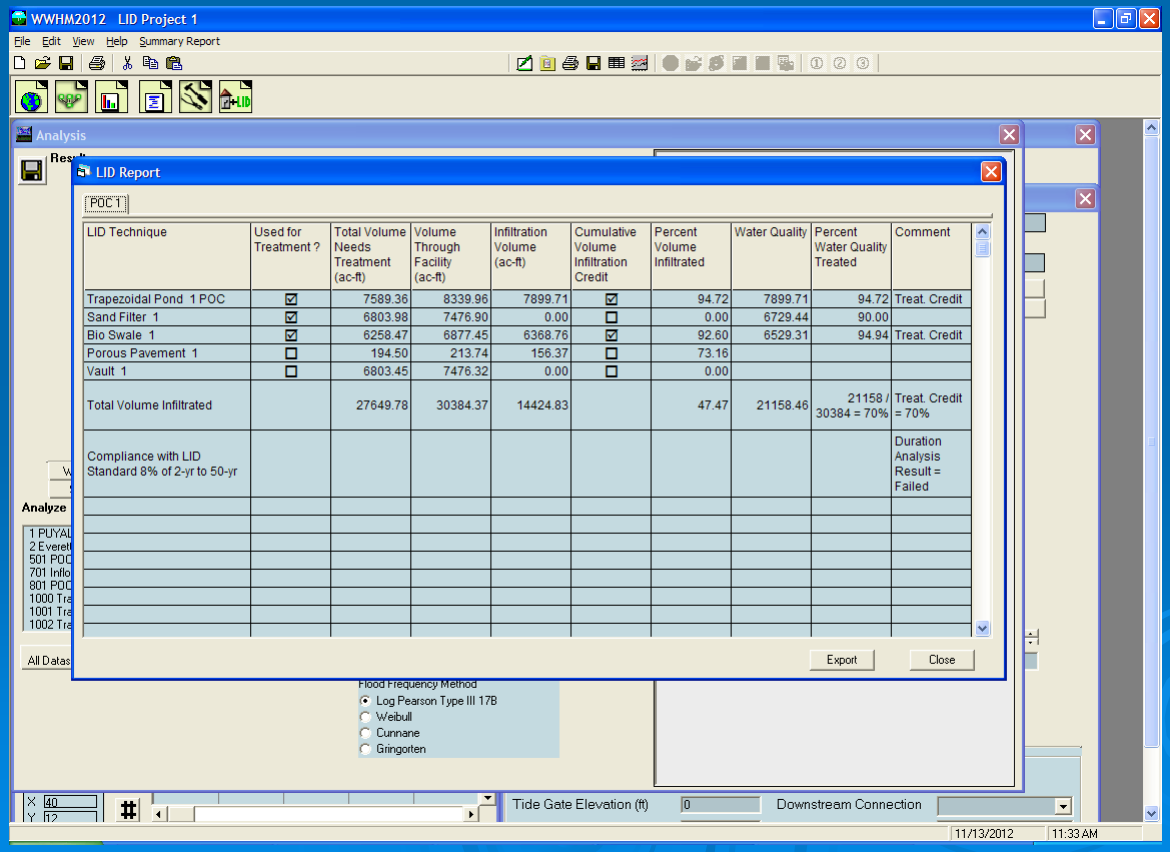
New LID Reporting Features

Specific changes and additions in WWHM2012 include:

- *New LID reporting features.*



LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Trapezoidal Pond 1 POC	☑	7589.36	8339.96	7899.71	☑	94.72	7899.71	94.72	Treat. Credit
Sand Filter 1	☑	6803.98	7476.90	0.00	☐	0.00	6729.44	90.00	
Bio Swale 1	☑	6258.47	6877.45	6368.76	☑	92.60	6529.31	94.94	Treat. Credit
Porous Pavement 1	☐	194.50	213.74	156.37	☐	73.16			
Vault 1	☐	6803.45	7476.32	0.00	☐	0.00			
Total Volume Infiltrated		27649.78	30384.37	14424.83		47.47	21158.46	21158 / 30384 = 70%	Treat. Credit = 70%
Compliance with LID Standard 8% of 2-yr to 50-yr									Duration Analysis Result = Failed

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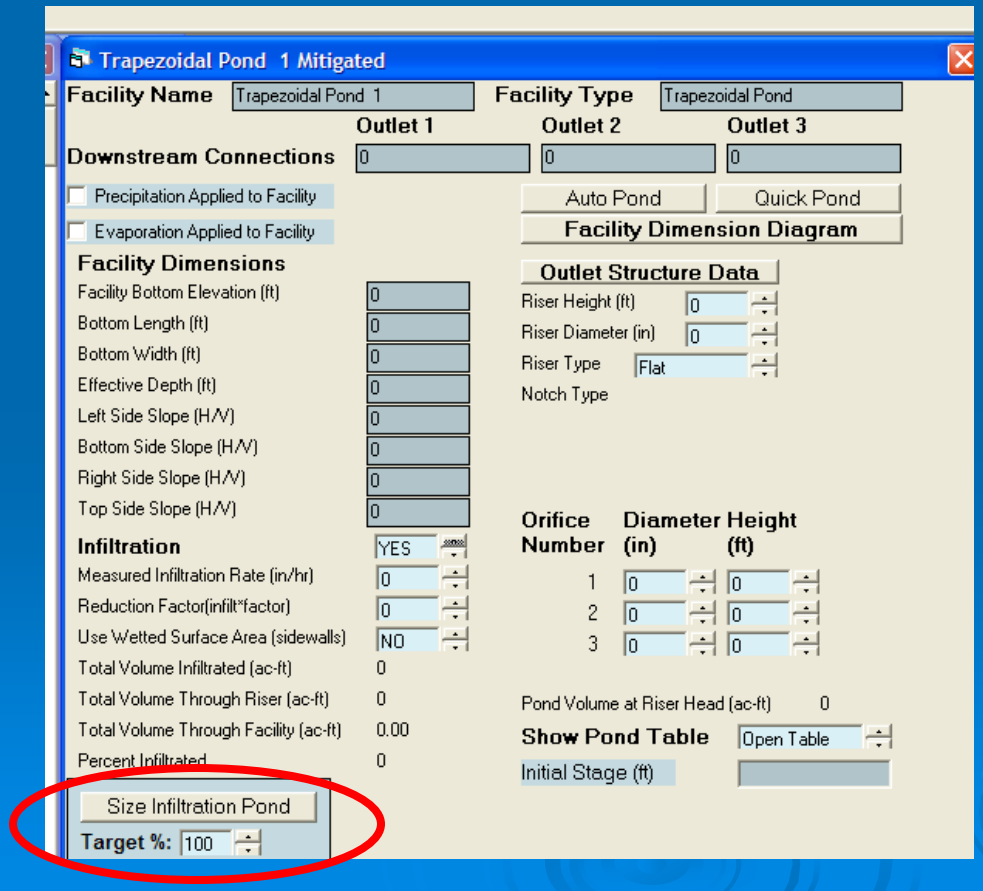
Automated Infiltration Facility Sizing

Specific changes and additions in WWHM2012 include:

- *Automated sizing options for infiltration facilities.*



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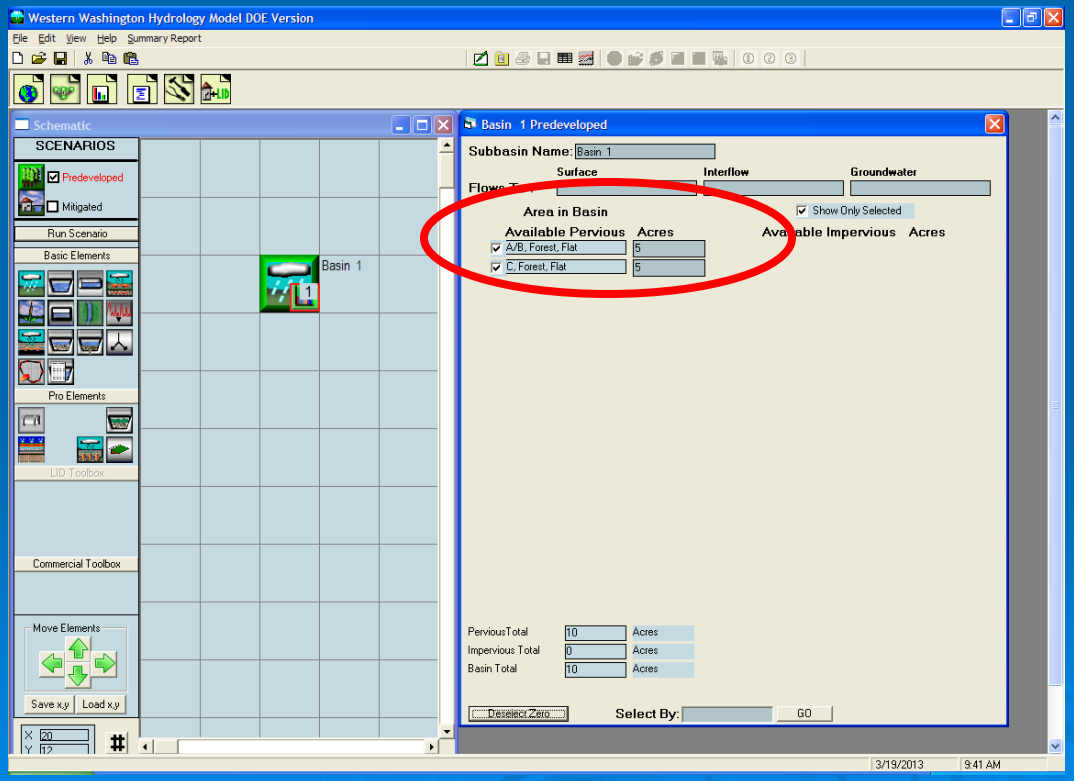
Infiltration Facility Sizing

Example: Partial infiltration (when there is a combination of A and C soils)

Predeveloped:



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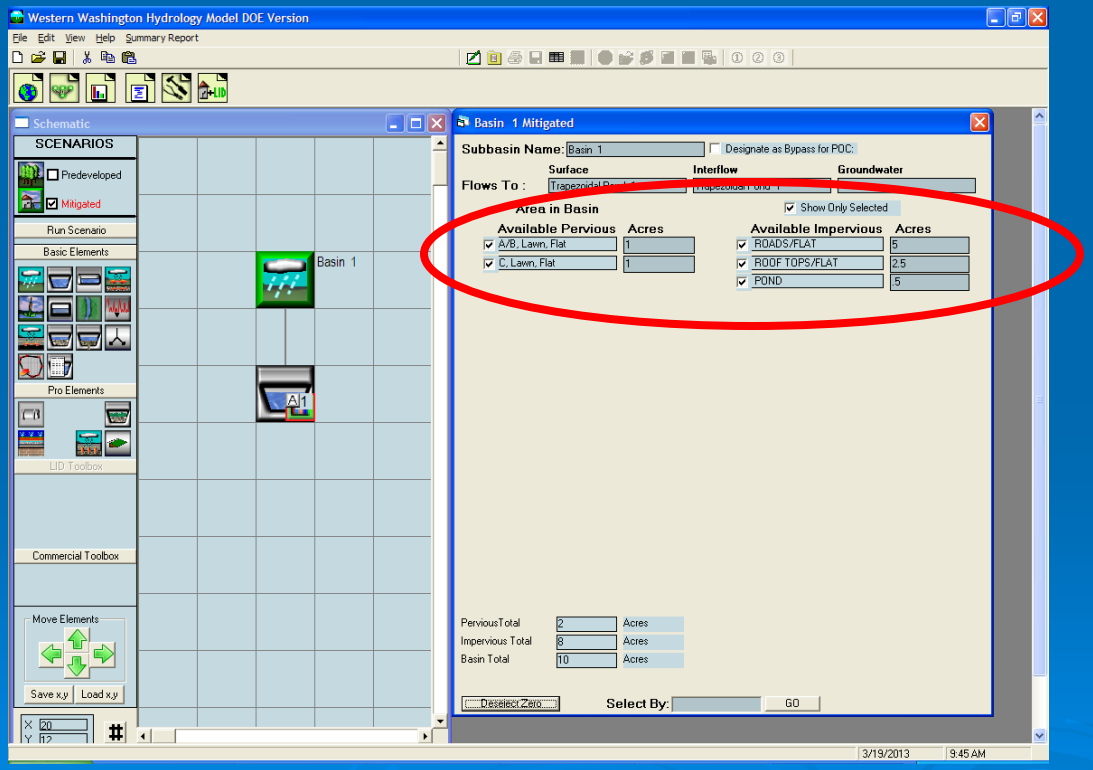
Infiltration Facility Sizing

Example: Partial infiltration (when there is a combination of A and C soils)

Development with mitigation:



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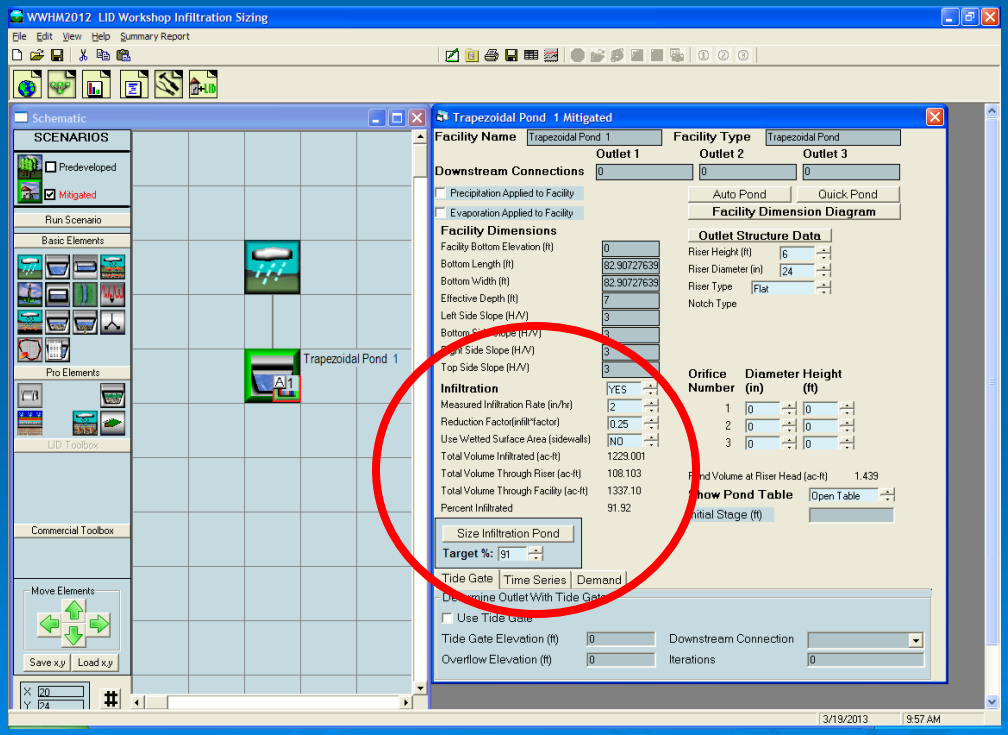
Infiltration Facility Sizing

Example: Partial infiltration (when there is a combination of A and C soils)
Still have to meet duration standards.
Development with mitigation: Set infiltration target = 91%.



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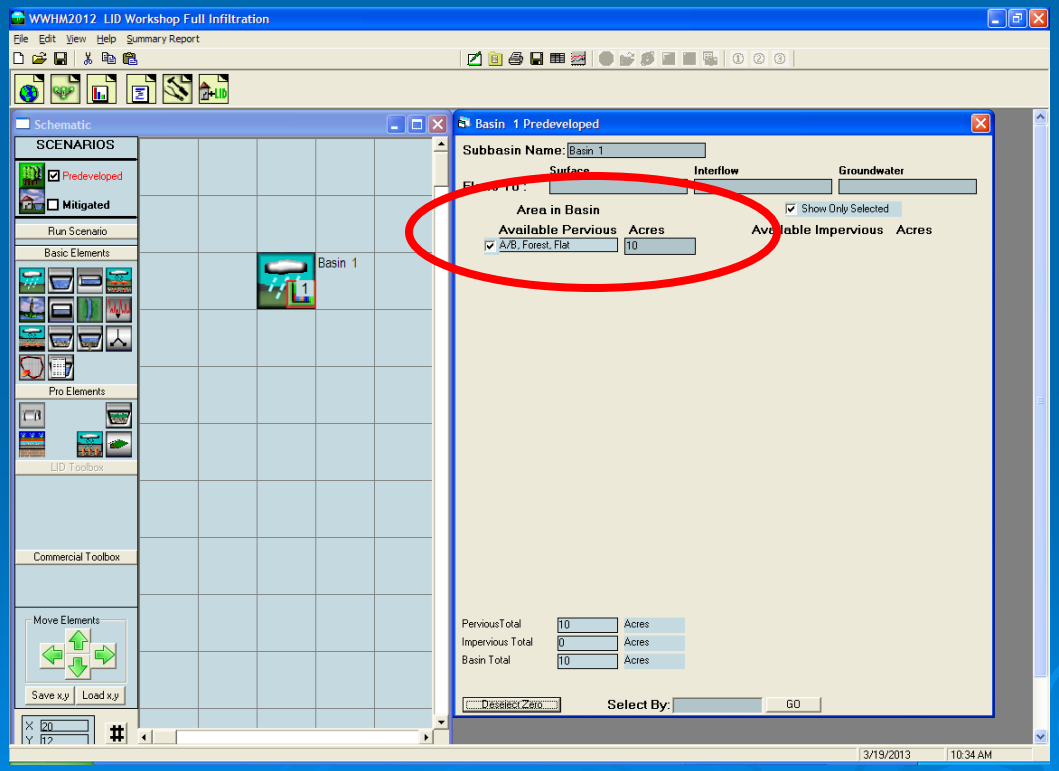
Infiltration Facility Sizing

Example: Full infiltration (when there are only A/B soils)

Predeveloped:

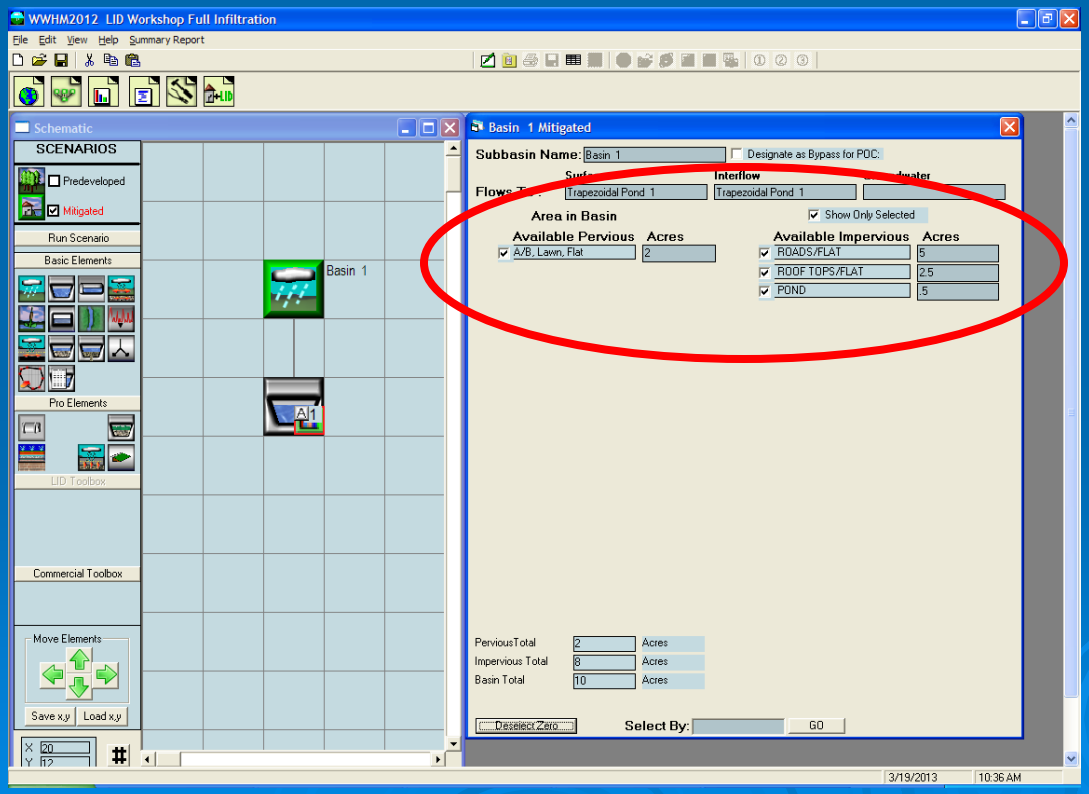


CLEAR CREEK SOLUTIONS

Infiltration Facility Sizing

Example: Full infiltration (when there are only A/B soils)

Development with mitigation:



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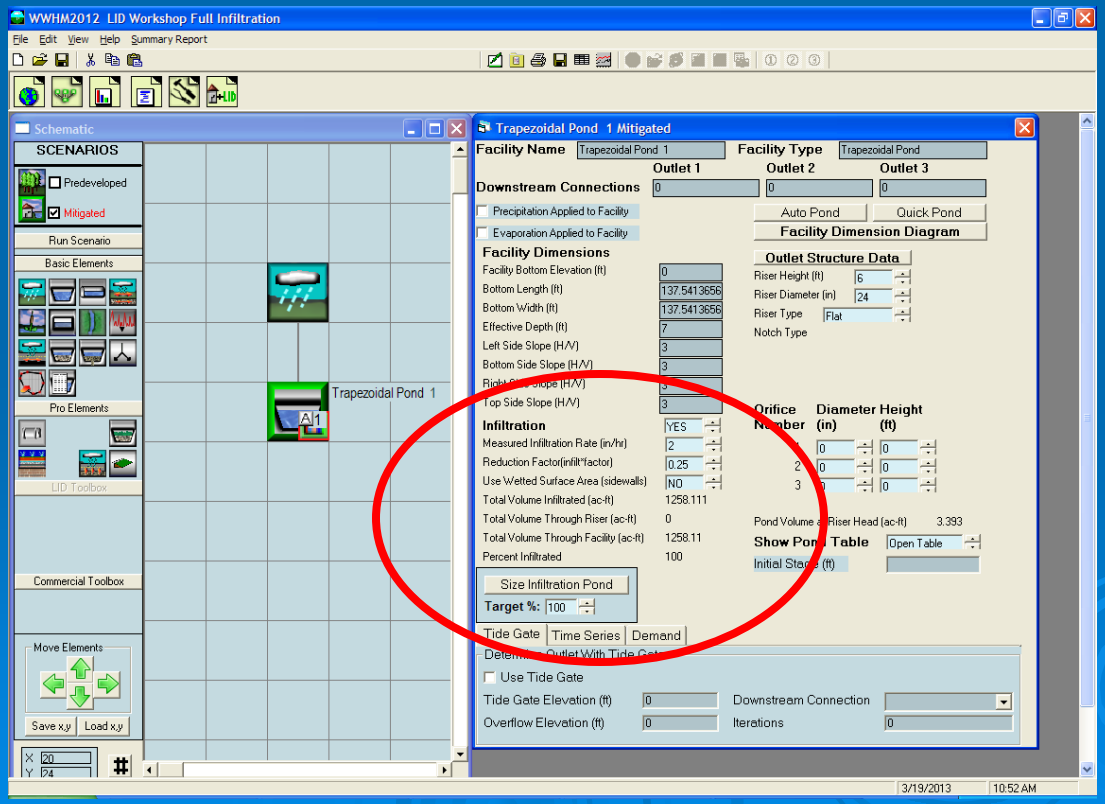
Infiltration Facility Sizing

Example: Full infiltration (when there are only A/B soils)
Do not have to meet duration standards.
Development with mitigation: Set infiltration target = 100%.



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Infiltration Facility Sizing

Infiltration facilities can be sized to meet:

- MR #5,
- MR #5 and MR #7,
- MR #6, or
- MR #5, MR #6, and MR #7.

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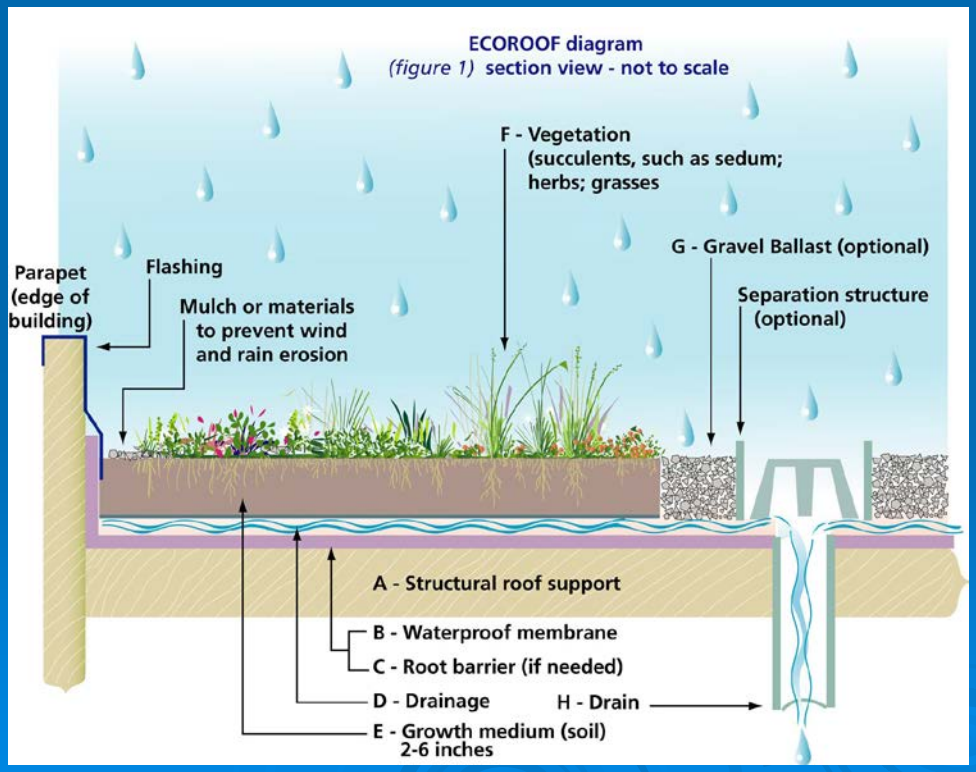
Green Roof Element

Specific changes and additions in WWHM2012 include:

- *Green roof element: increased evapotranspiration.*



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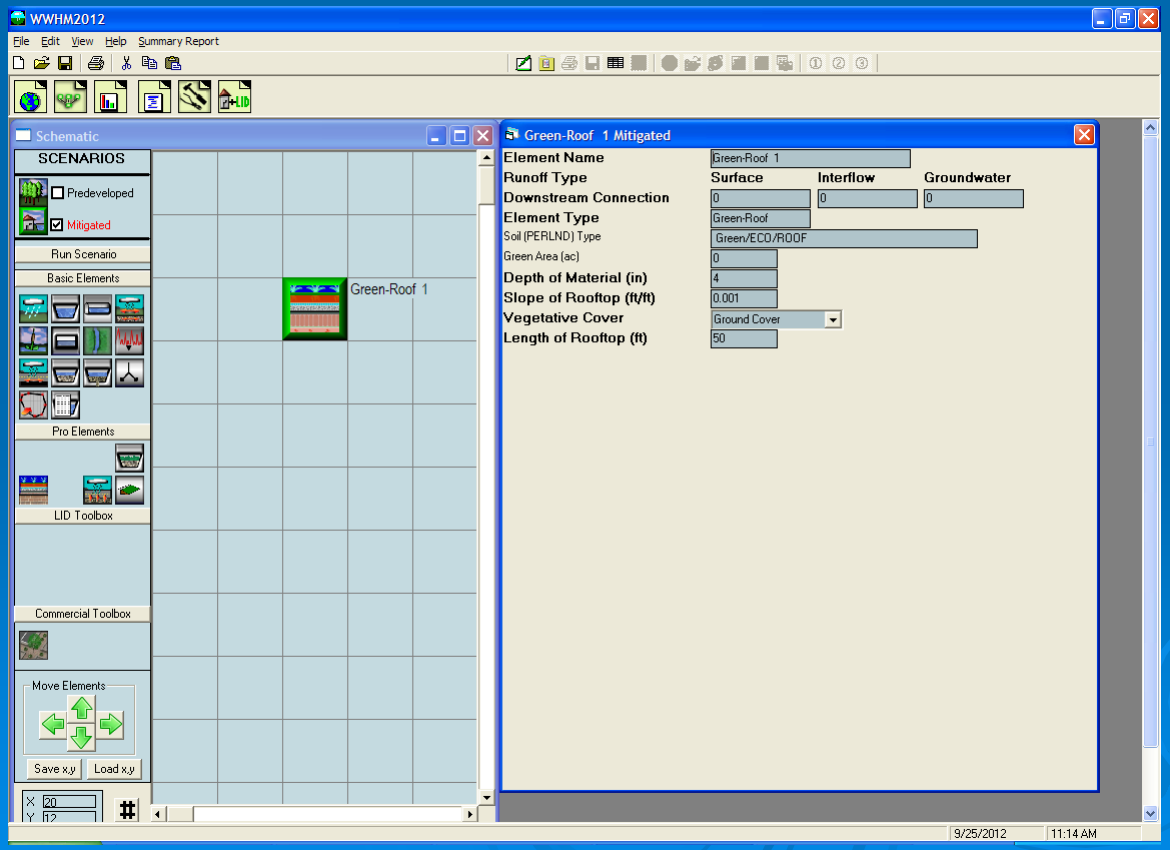
Green Roof Element

Specific changes and additions in WWHM2012 include:

- *New green roof element.*



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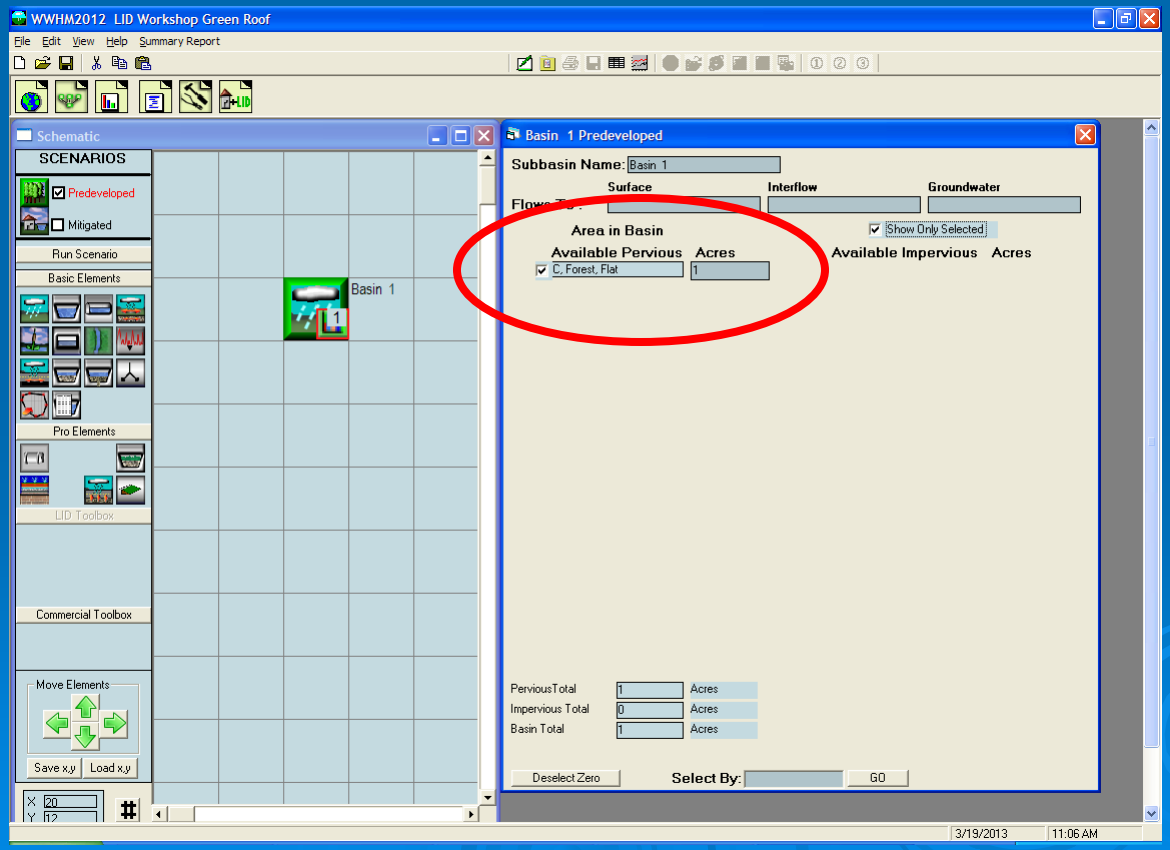
Green Roof Element

Example: 1-acre roof

Predeveloped:



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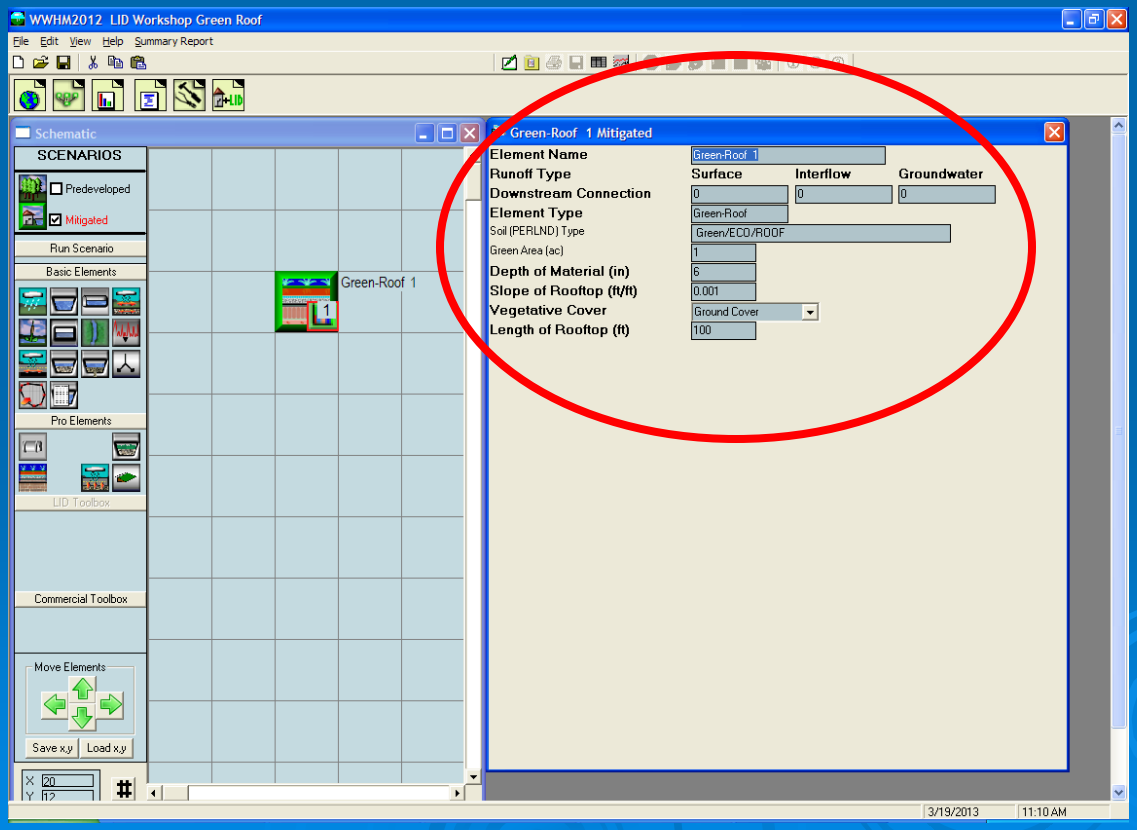
Green Roof Element

Example: 1-acre roof

Development with green roof:



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Green Roof Element

Major issues:

- All runoff (surface runoff, interflow, and groundwater) from green roof must be connected to either POC or downstream conveyance element.

- Length of rooftop is longest flow path on roof to roof drain.

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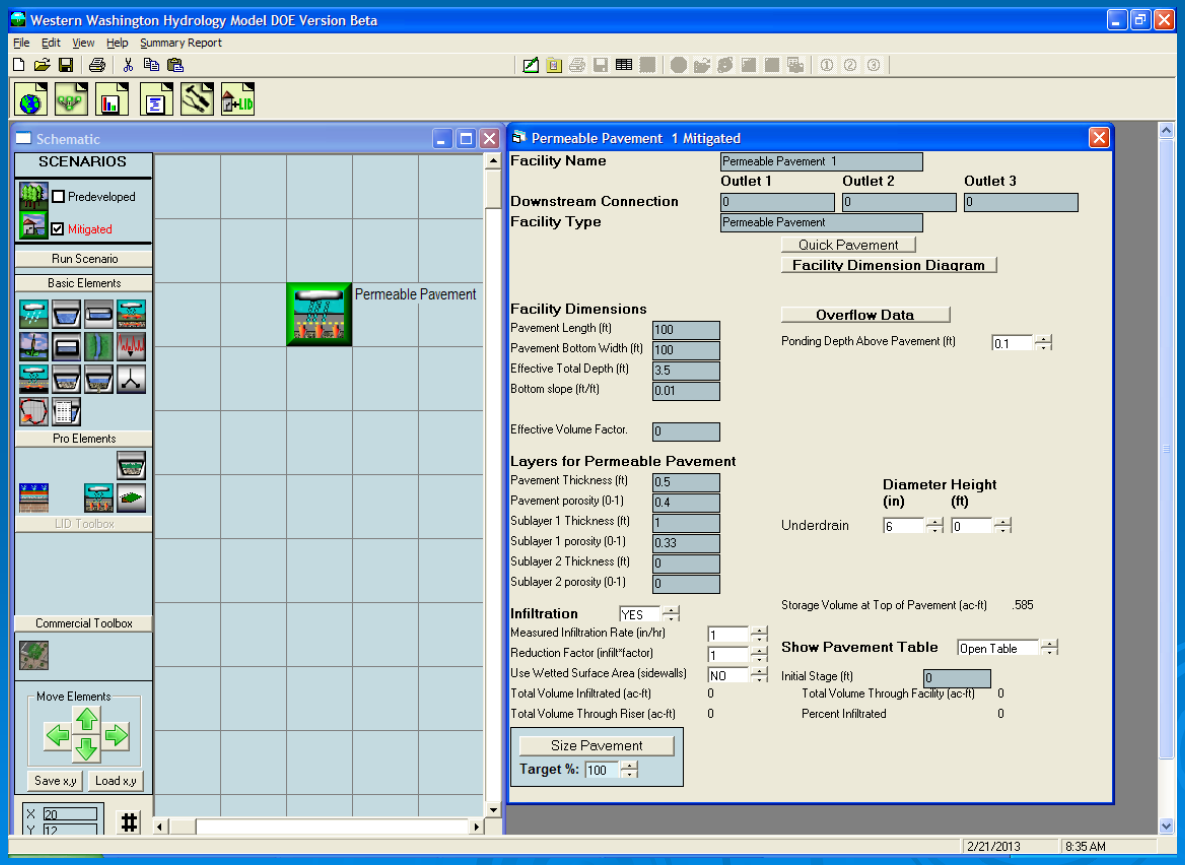
Permeable Pavement Element

Specific changes and additions in WWHM2012 include:

- *Permeable pavement element: increased evaporation and infiltration*



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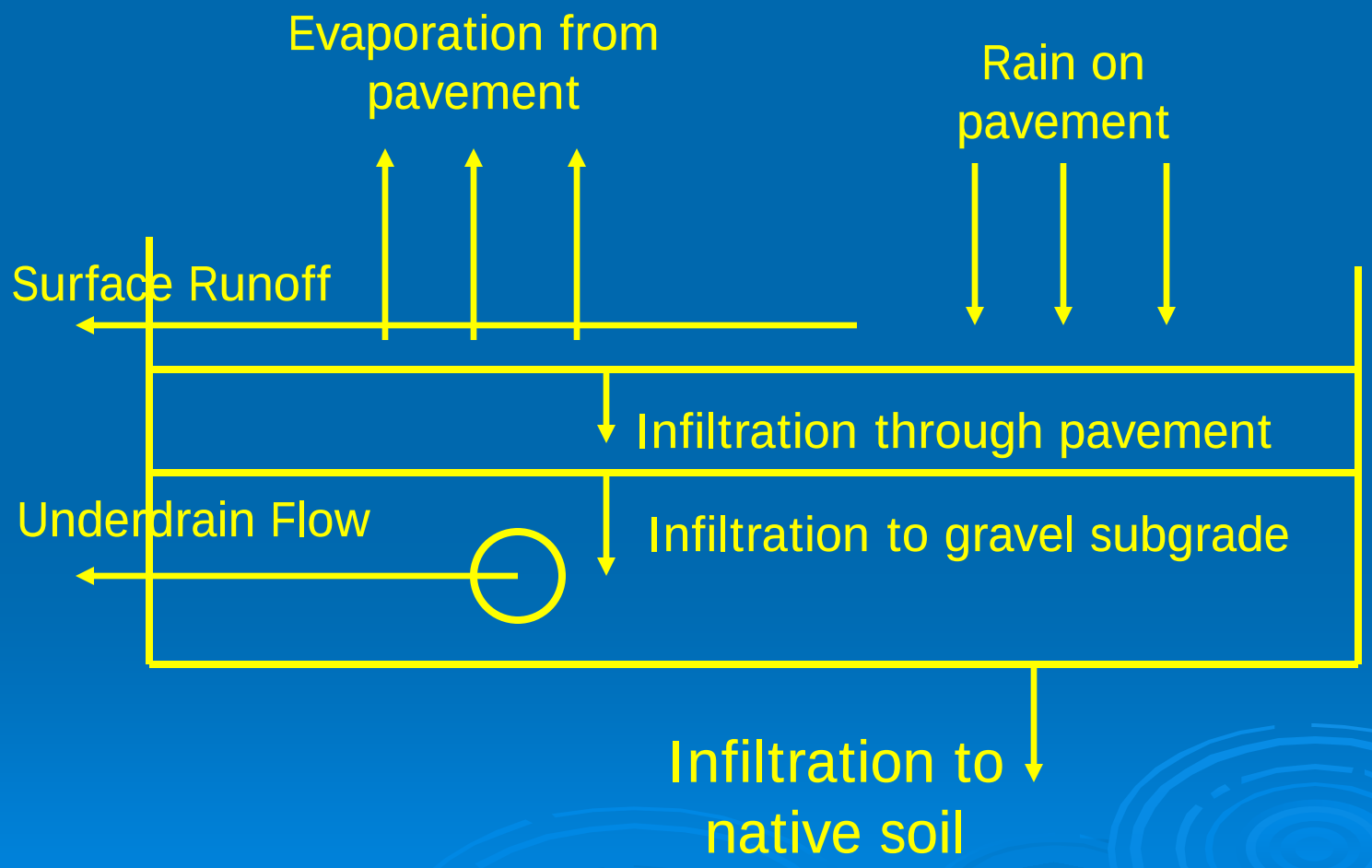
Permeable Pavement Element



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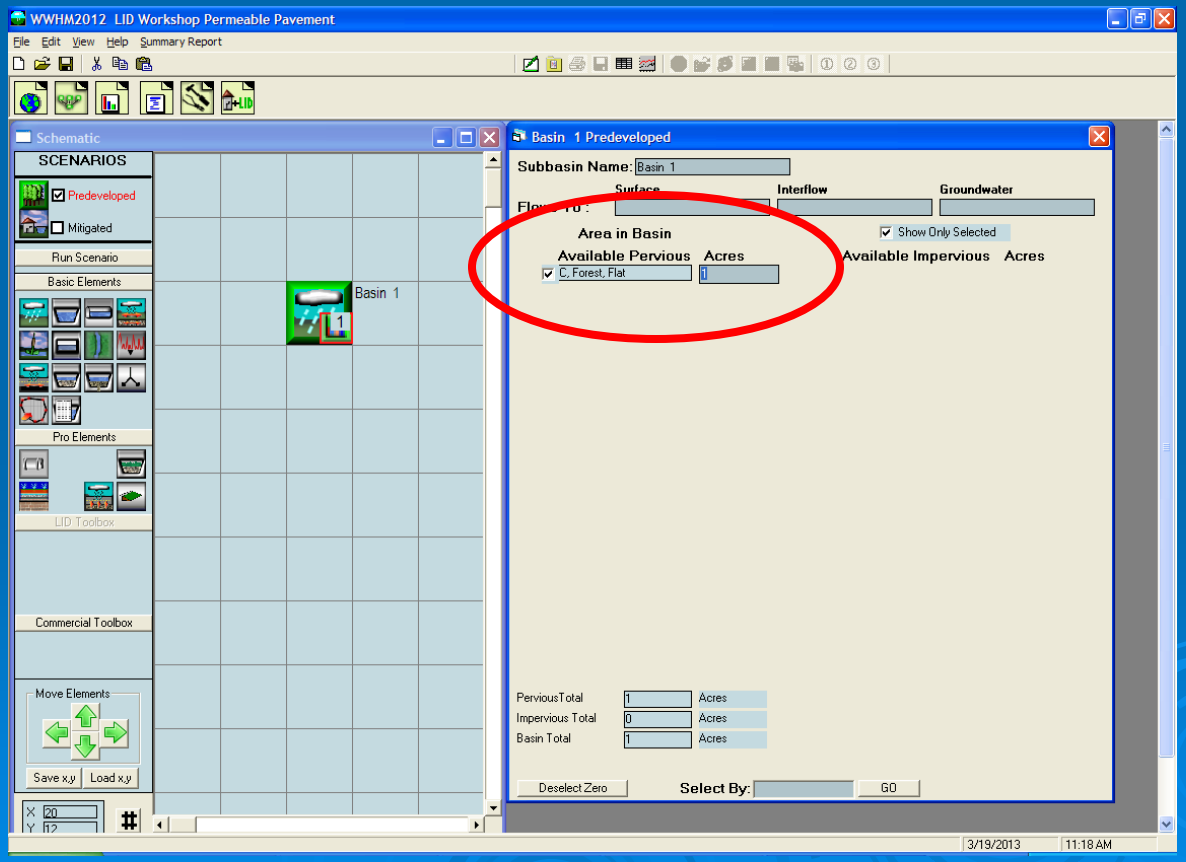
Permeable Pavement Element

Example: 1 acre parking

Predeveloped:

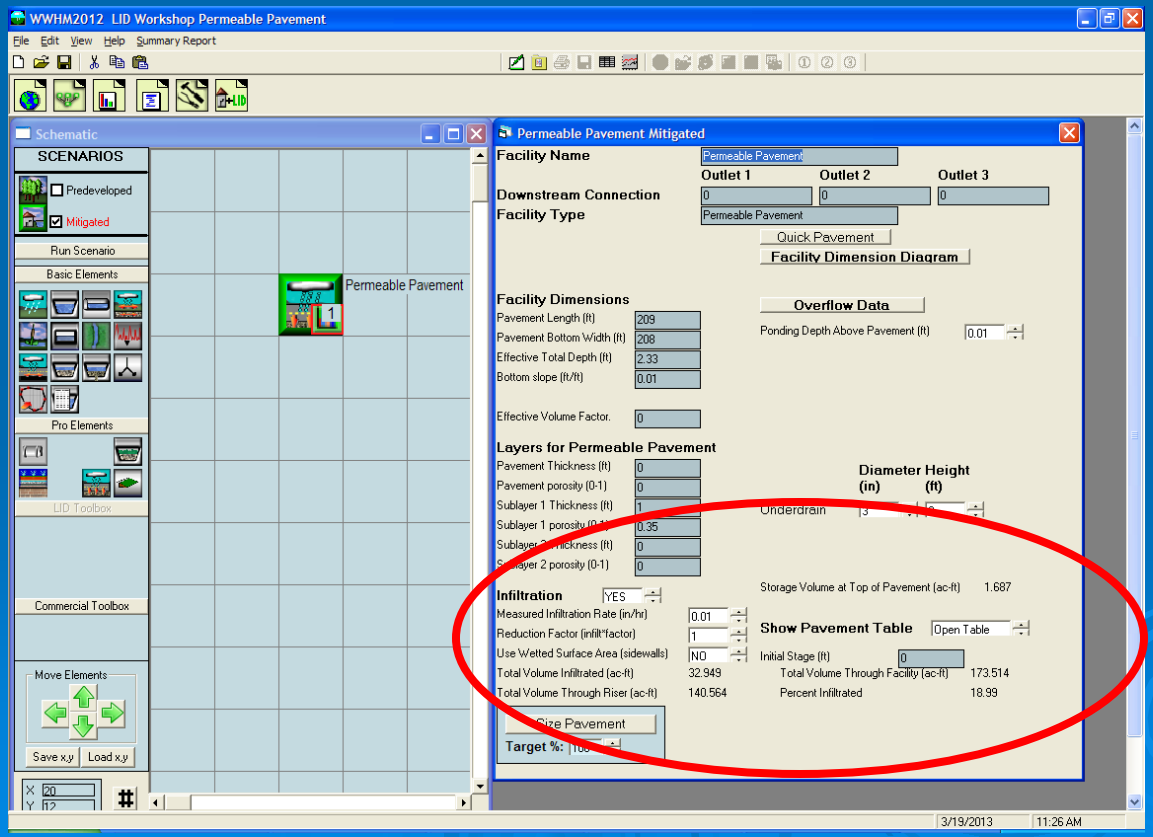


CLEAR CREEK SOLUTIONS

Permeable Pavement Element

Example: 1 acre parking

Development as permeable pavement:



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Permeable Pavement Element

Major issues:

- Pavements with bottom slopes greater than 2% must include Effective Volume Factor (average useable gravel depth/maximum gravel depth).

- Ecology does not want pavement thickness included in storage calculations.

- Permeable pavement must include infiltration into native soil and/or an underdrain to remove water from gravel subgrade.

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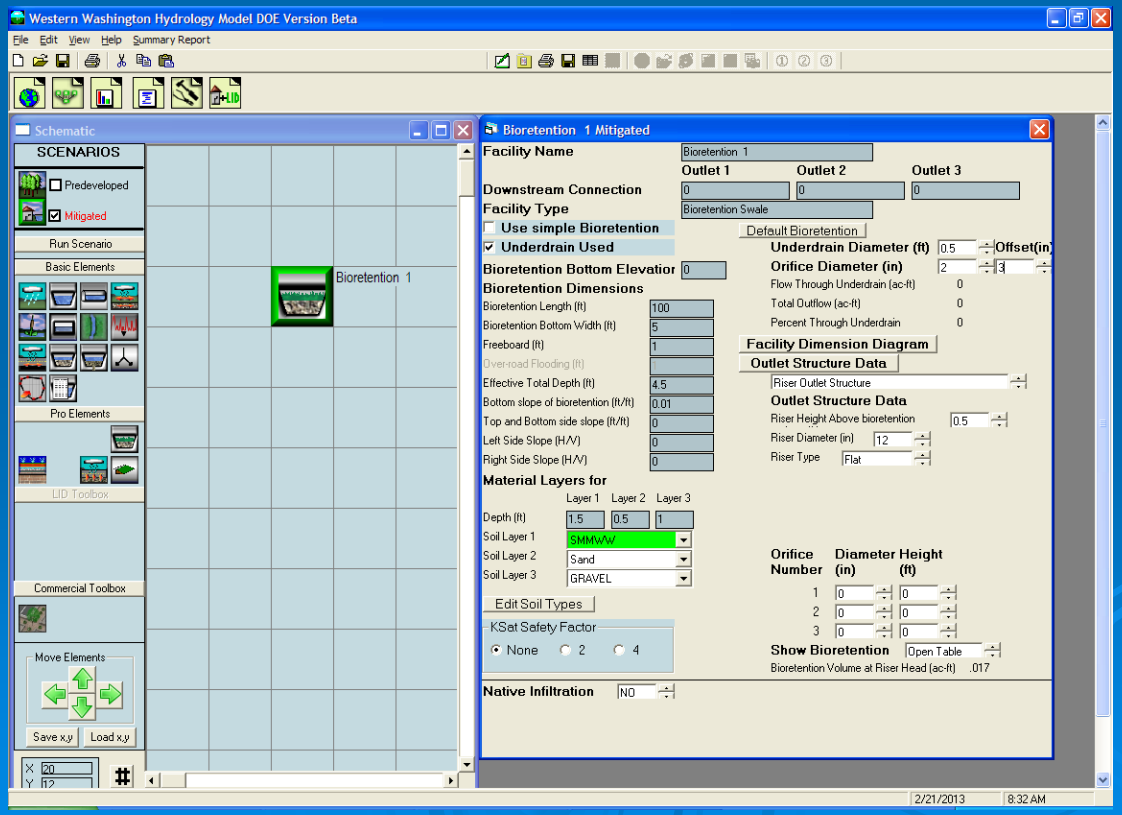
Bioretention Element

Specific changes and additions in WWHM2012 include:

- *Bioretention element: increased evapotranspiration and infiltration*



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Bioretention Element

Ecology SWMMWW Definitions:

Bioretention – Engineered facilities that treat stormwater by passing it through a specified soil profile, and either retain or detain the treated stormwater for flow attenuation. Refer to Chapter 7 of Volume V for Bioretention BMP types and design specifications.

Rain Garden – A non-engineered, shallow, landscaped depression, with compost-amended native soils or imported soils, and adapted plants. The depression is designed to pond and temporarily store stormwater runoff from adjacent areas, and to allow stormwater to pass through the amended soil profile. Refer to the *Rain Garden Handbook for Western Washington Homeowners* (WSU, 2007 or as revised) for rain garden specifications and construction guidance.

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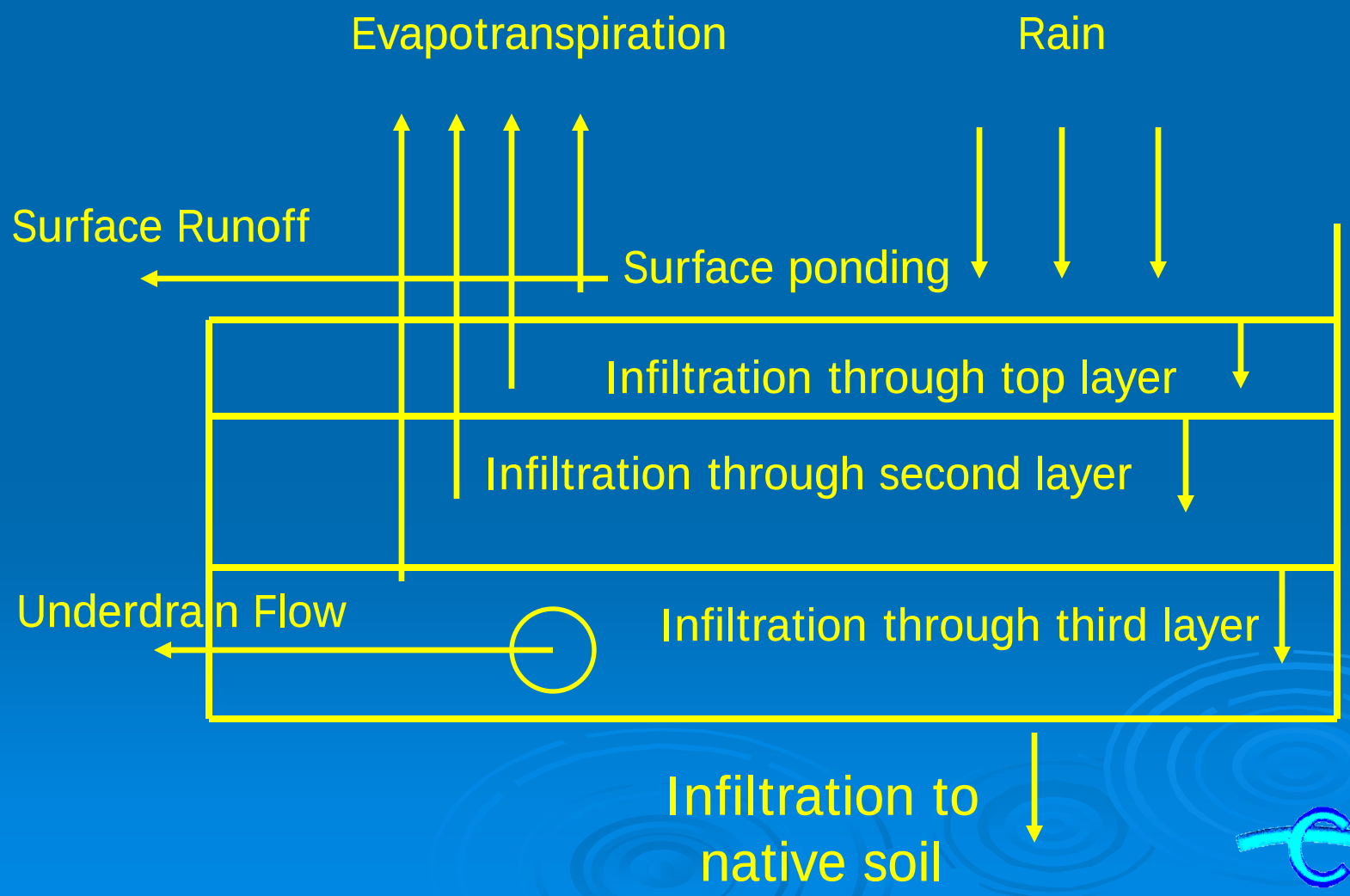
Bioretention Element



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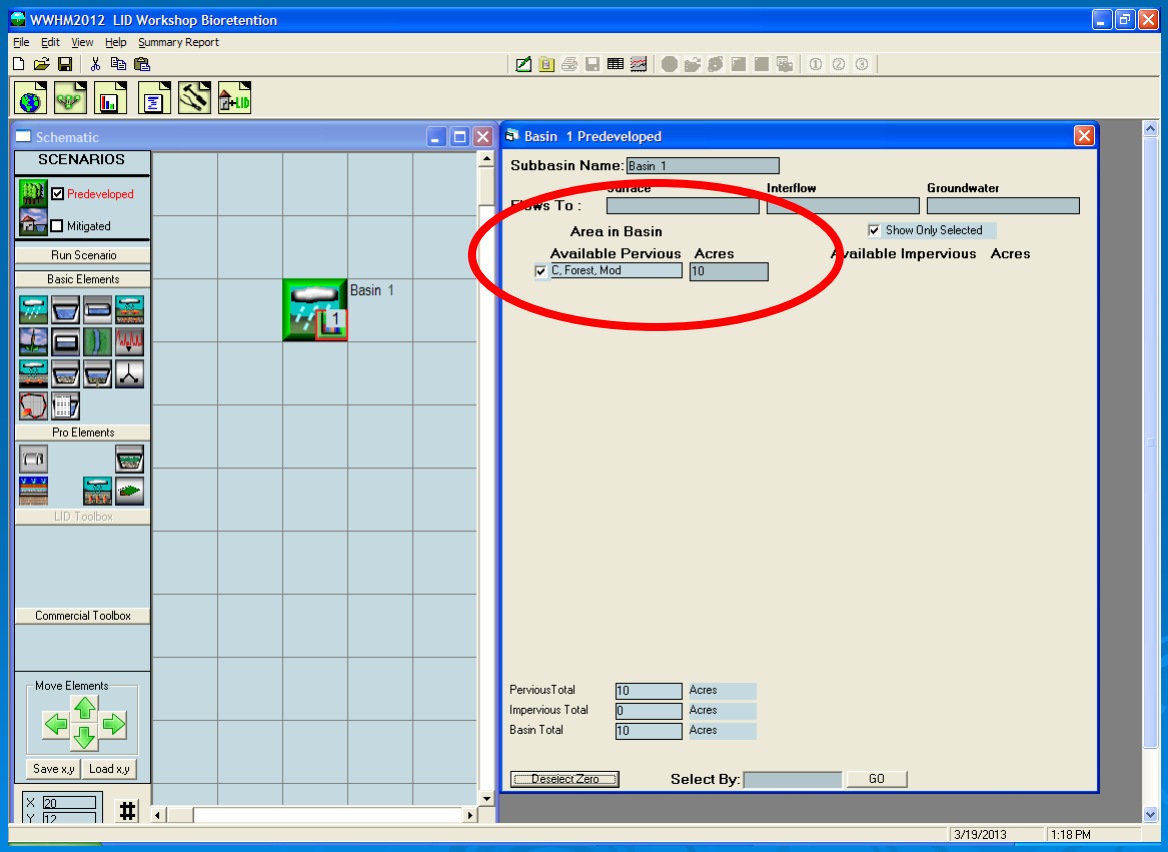
Bioretention Element

Predeveloped: 10 acre site



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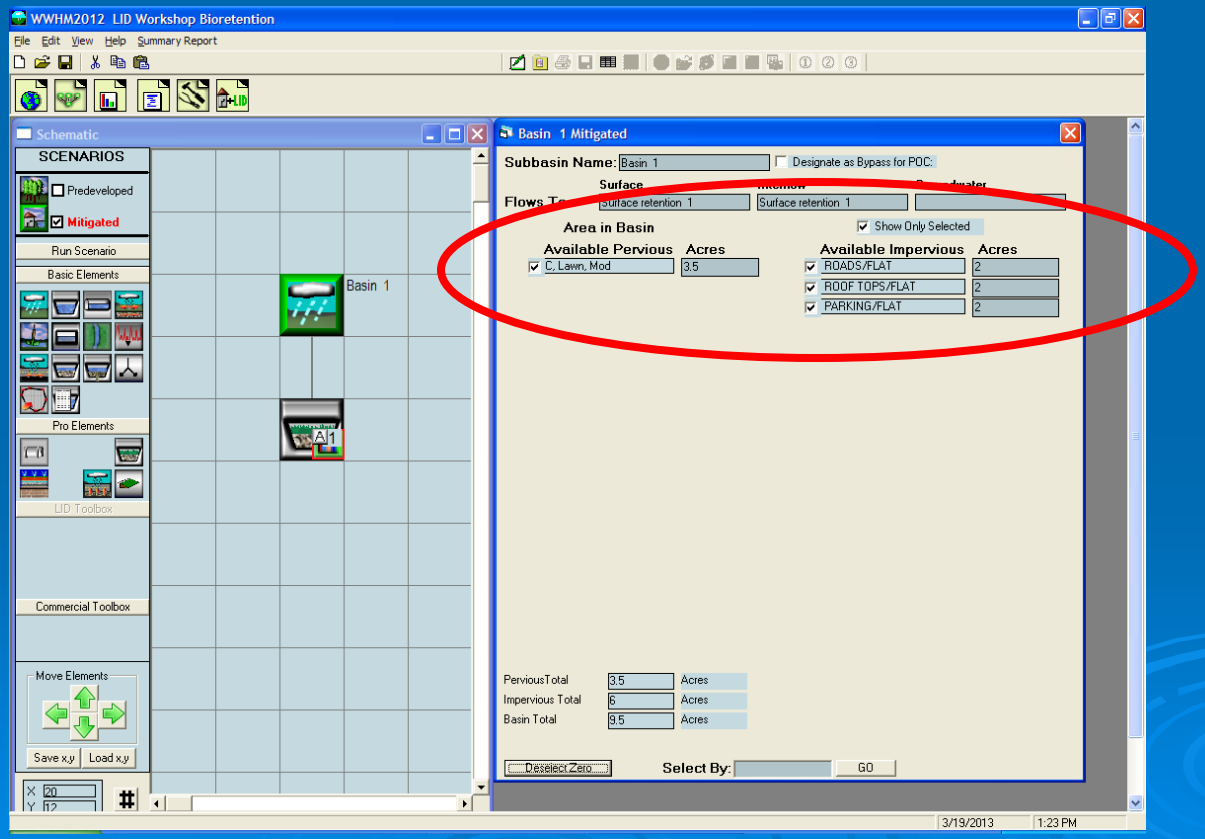
Bioretention Element

Development: Bioretention area is not included in drainage basin area.



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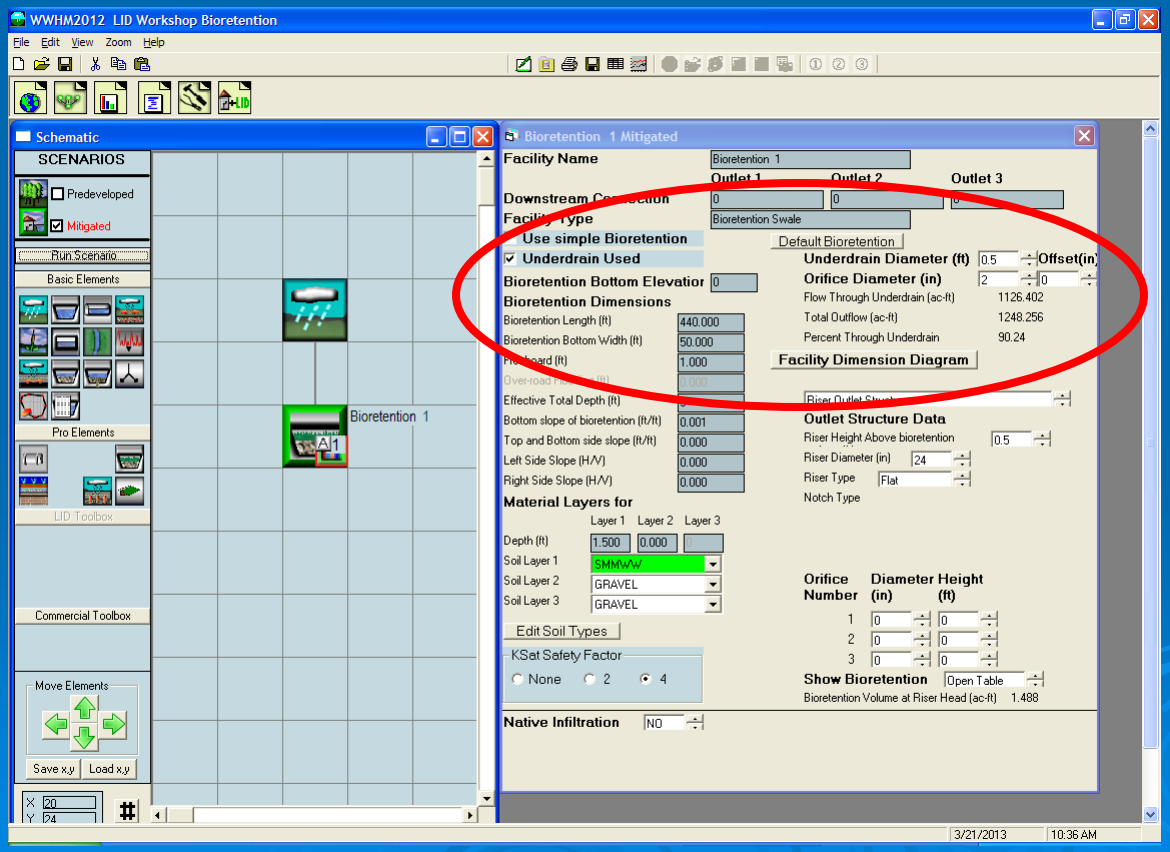
Bioretention Element



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Bioretention Element

Major issues:

• Bioretention area automatically includes rain and evapo-transpiration; do not include bioretention area in drainage basin area.

• Ecology requires the bioretention soil mix top layer (Layer 1) to meet SWMMWW specifications.

• Underdrain orifice controls flow from underdrain and bioretention soil mix layers, when soil layers are fully saturated.

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Bioretention Element

Major issues:

Ecology requires a Ksat safety factor of 4 if the drainage area is equal to or greater than any of the following amounts:

- 5000 sq ft of pollutant-generating impervious surfaces
- 10,000 sq ft of impervious surfaces
- 0.75 acres of lawn or landscape

Use a Ksat safety factor of 2 if the drainage area is less than all of the above amounts.

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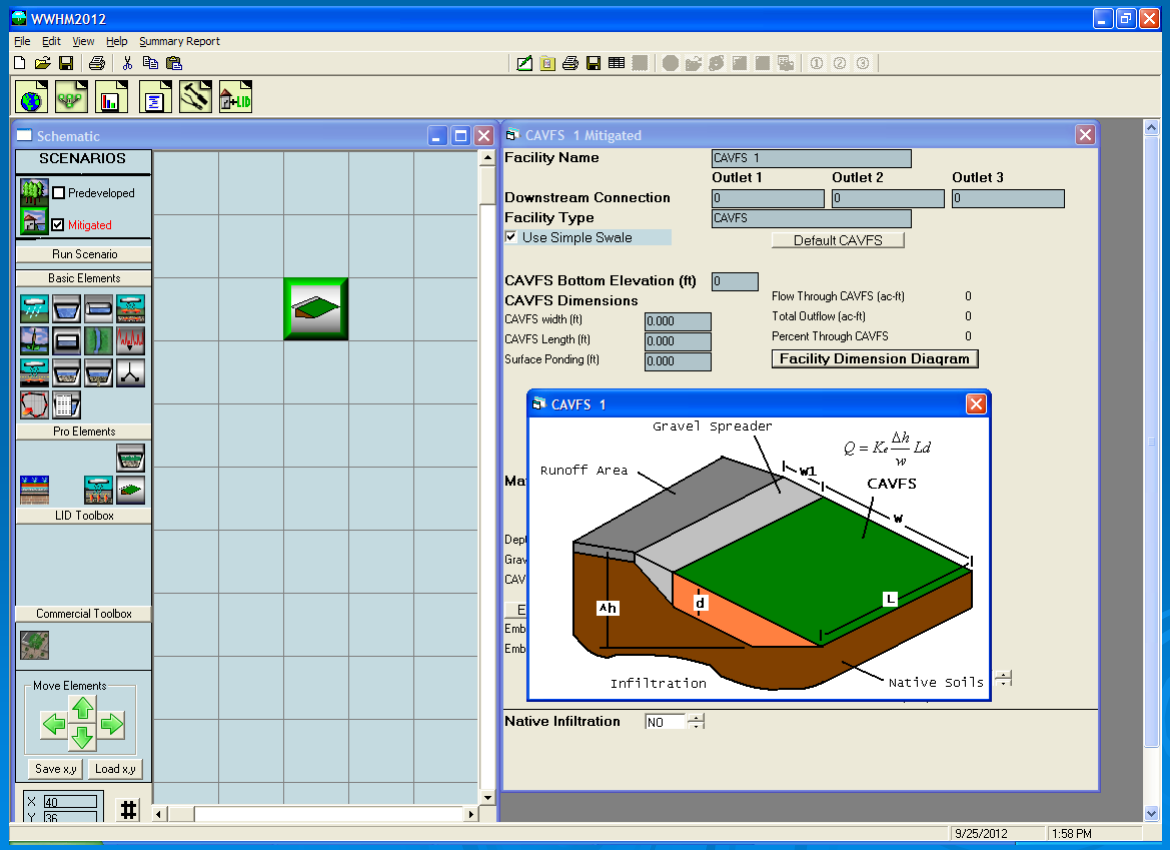
CAVFS Element

Specific changes and additions in WWHM2012 include:

- *New CAVFS (compost amended vegetated filter strip) element: for water quality treatment of roadway runoff*



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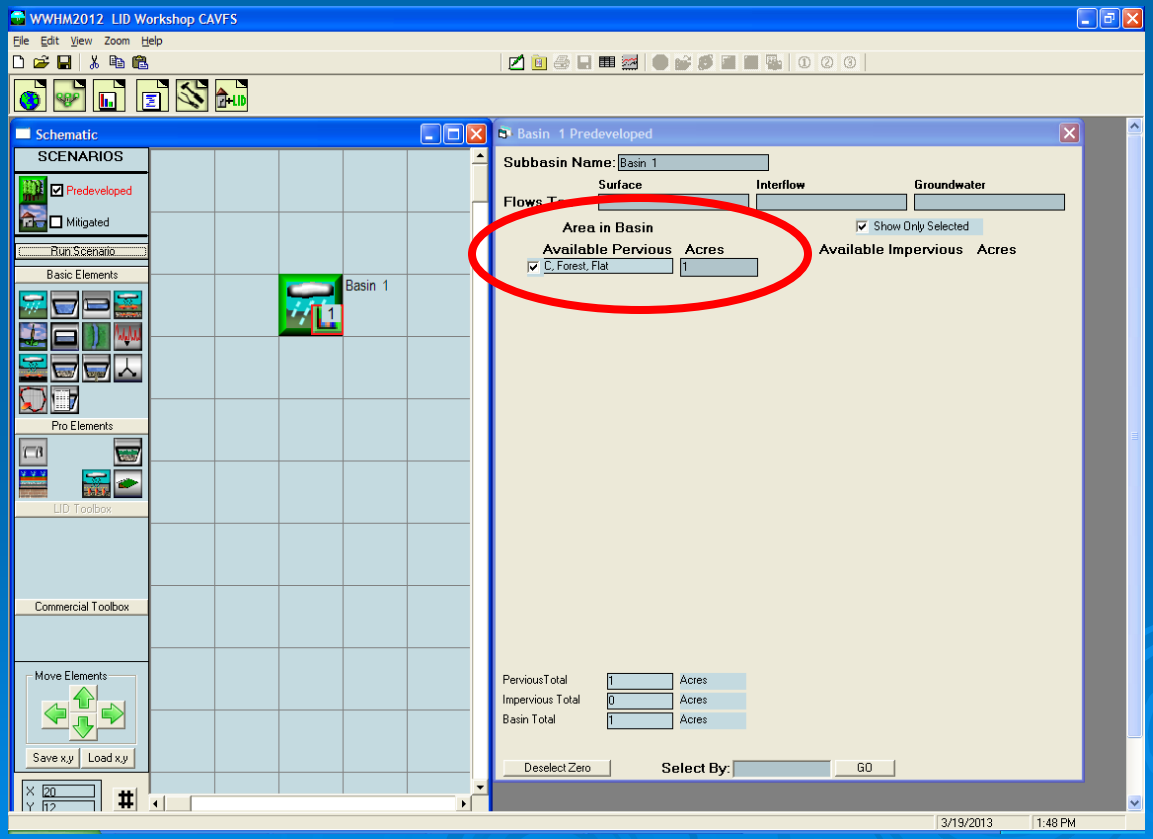
CAVFS Element

Predeveloped: 1 acre



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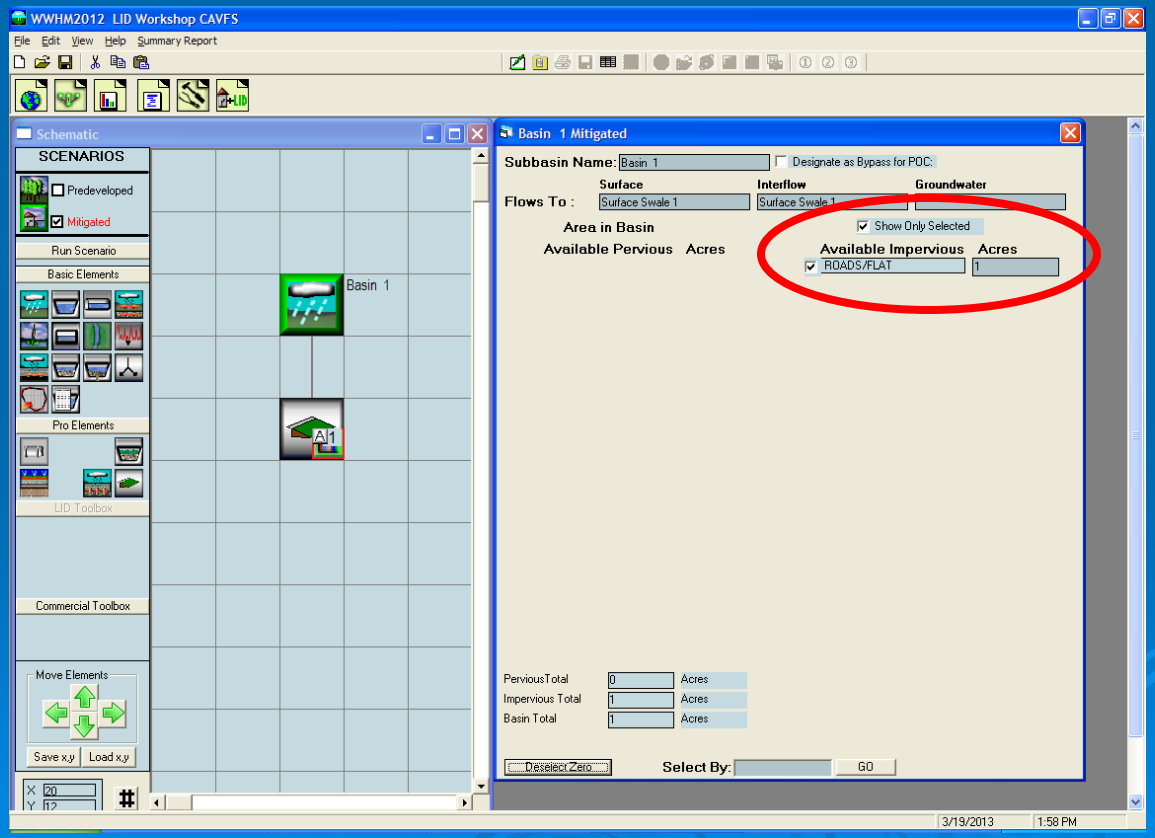
CAVFS Element

Development: 1 acre of roadway (length 1090 ft; width 40 ft)



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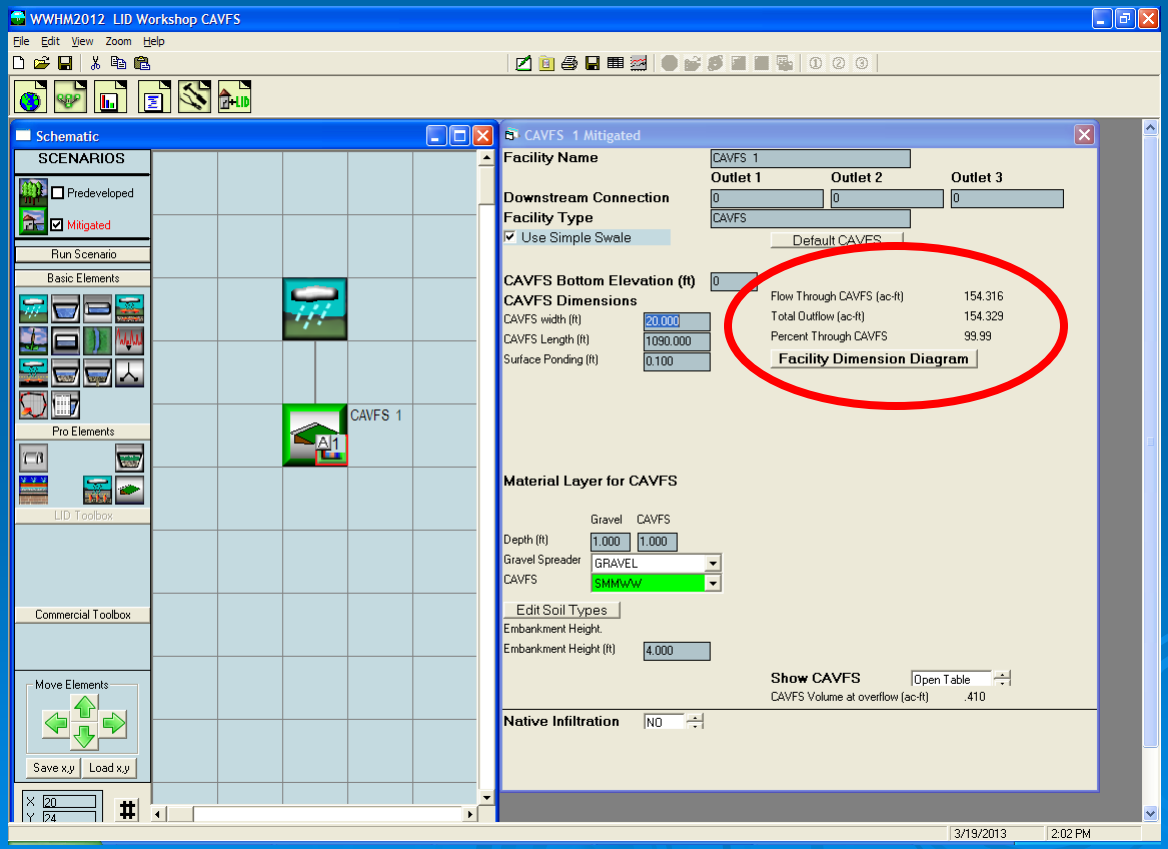
CAVFS Element

Development: CAVFS filters roadway runoff



CLEAR CREEK SOLUTIONS

CAVFS Element

Major issues:

• Ecology requires the CAVFS bioretention soil mix layer to meet SWMMWW specifications.

• Embankment height must be greater than material layer depths.

• Ecology requires a Ksat safety factor of 4 if the drainage area is equal to or greater than any of the following amounts:

5000 sq ft of pollutant-generating impervious surfaces
10,000 sq ft of impervious surfaces
0.75 acres of lawn or landscape

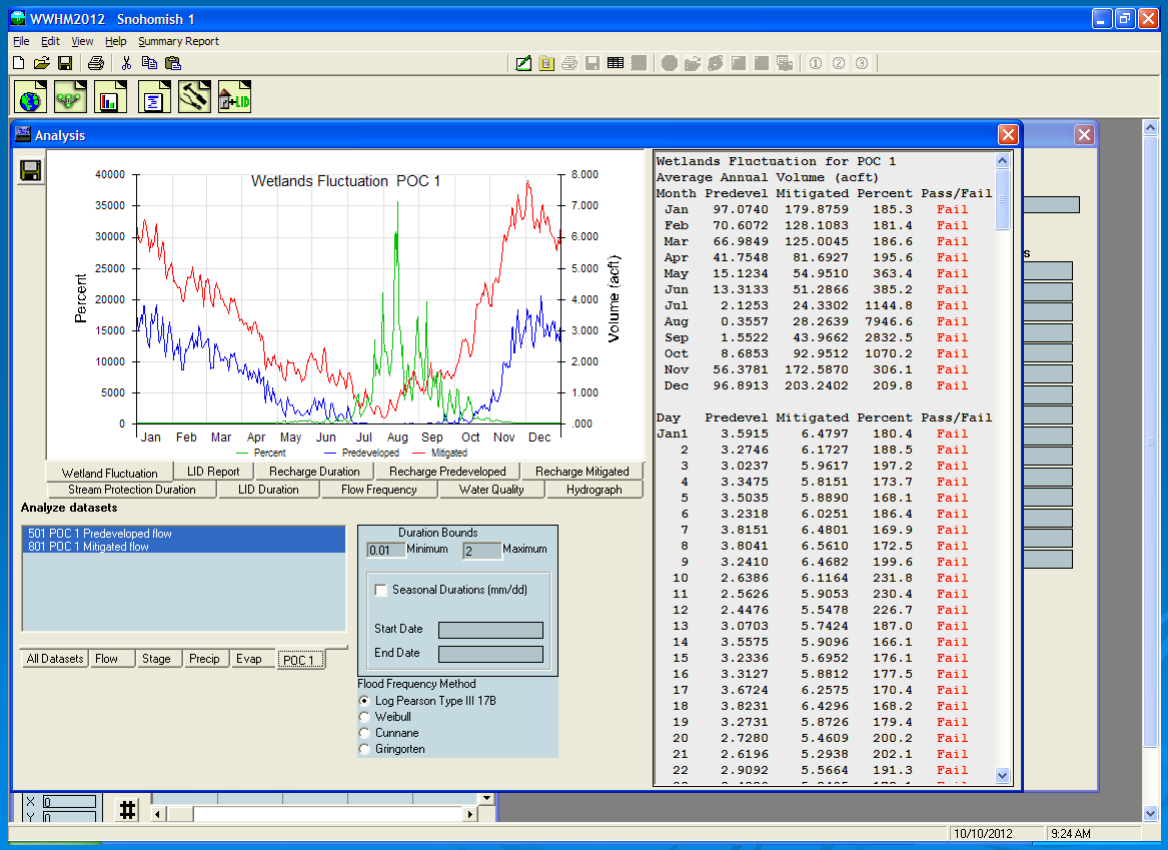
• Use a Ksat safety factor of 2 if the drainage area is less than all of the above amounts.

CLEAR CREEK SOLUTIONS

Wetland Protection

Specific changes and additions in WWHM2012 include:

- *Revised wetland input volume criteria calculations*



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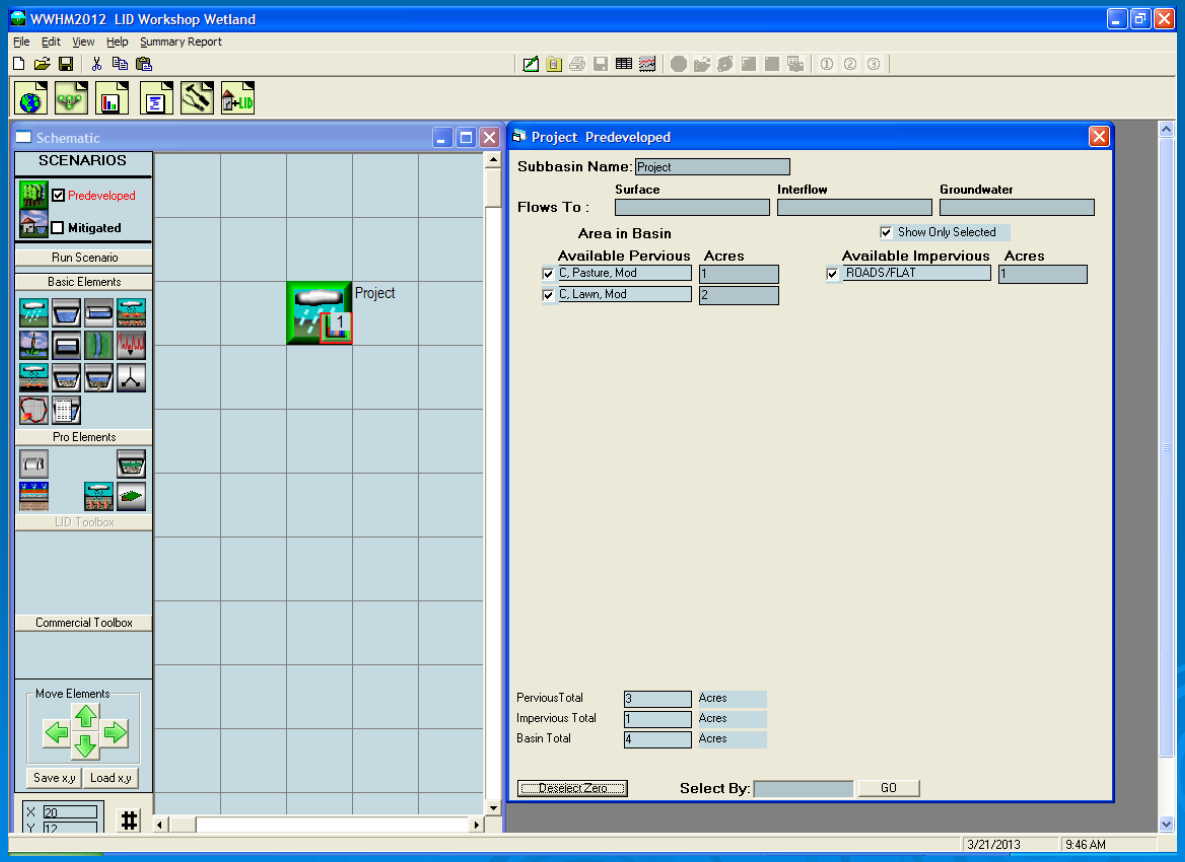
Wetland Protection

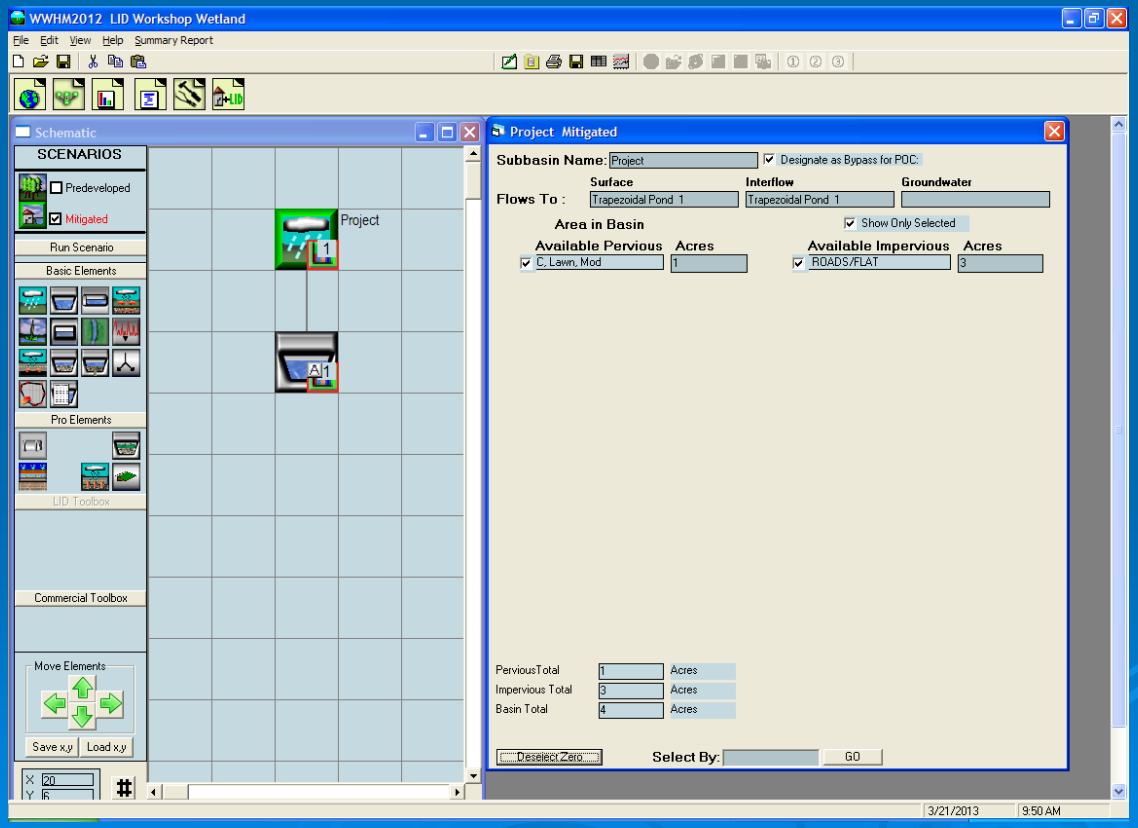
Predeveloped: Drainage to the wetland means existing conditions project area; no non-project drainage areas.



CLEAR CREEK SOLUTIONS

Wetland Protection

Development: Drainage to the wetland means developed land use with mitigation for project area; no non-project drainage areas.



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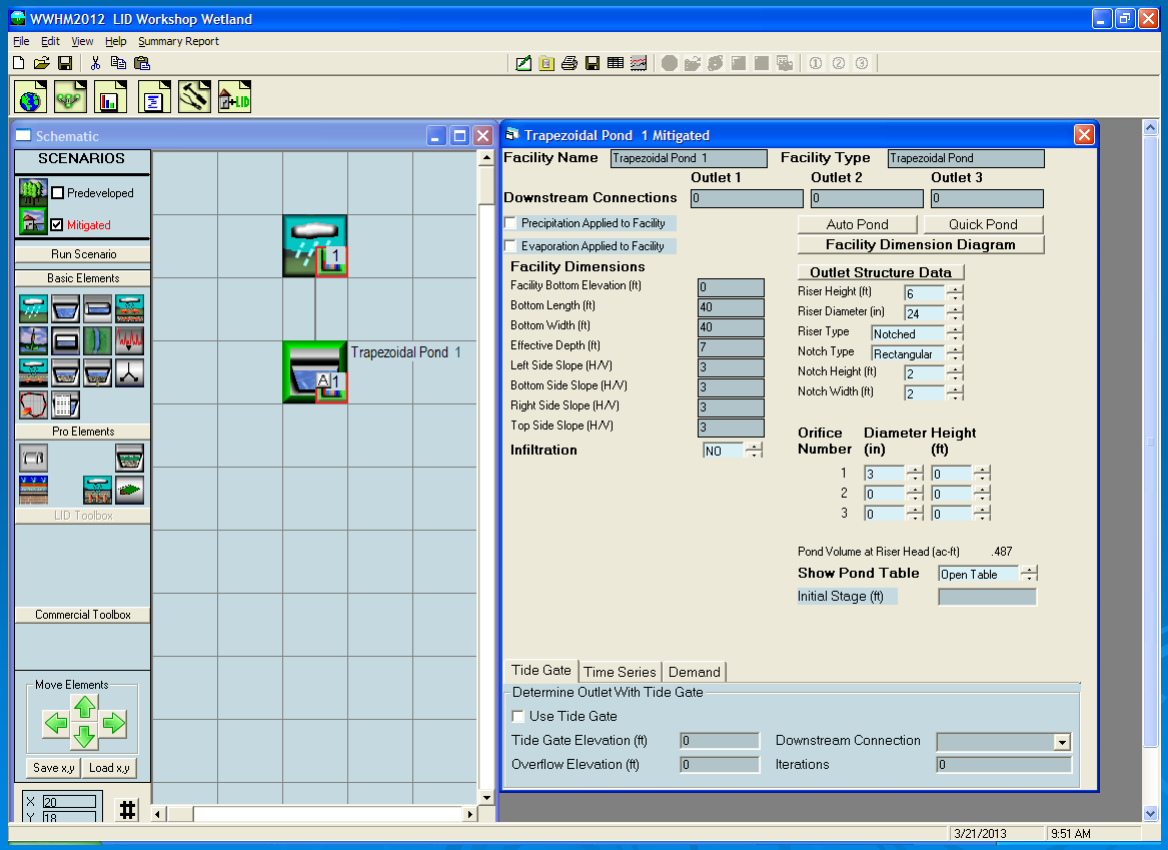
Wetland Protection

Development: Project area surface runoff and interflow drains to pond; pond drains to wetland (POC1); project area groundwater drains directly to wetland (POC1).



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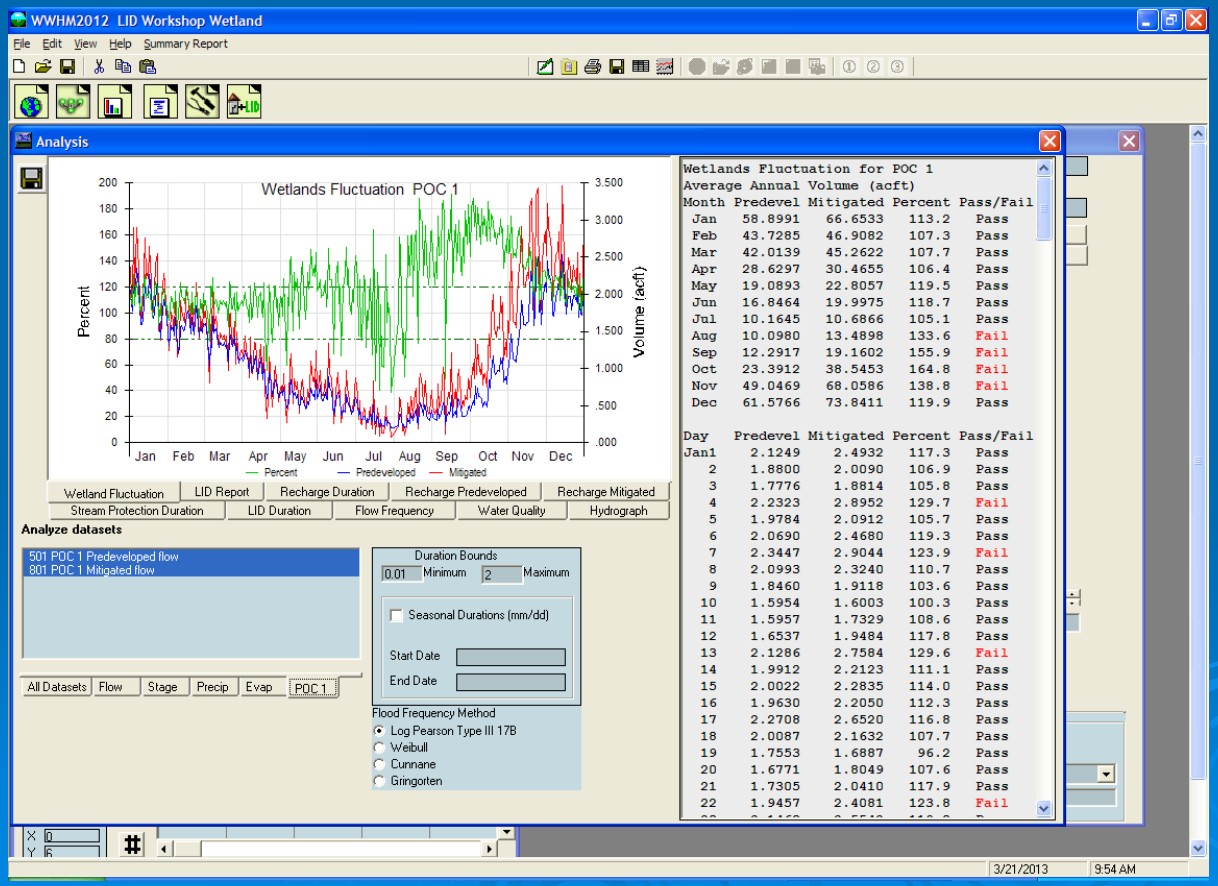
Wetland Protection

Wetland inflows (defined by POC1 flows) are compared and the change in inflow is checked against the wetland input volume criteria.



CLEAR CREEK SOLUTIONS

Wetland Protection

Major issues:

- For wetland input volume comparison the predevelopment is defined as existing conditions.
- Groundwater flow must be included in the POC inflows.
- If groundwater does not go to the stormwater mitigation facility then connect it directly to the POC.
- Include just the project area; not the entire drainage area to the wetland.

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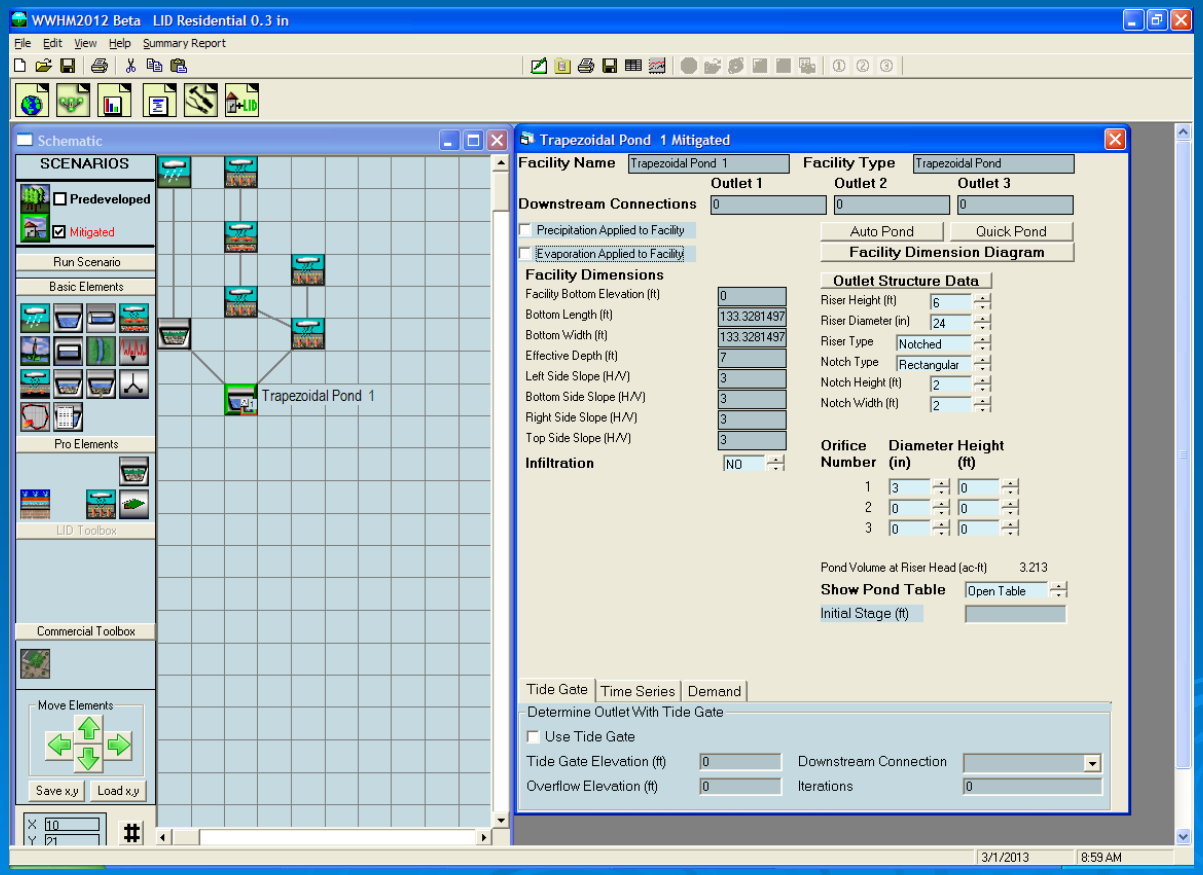
Multiple LID Facilities

Multiple LID facilities can be modeled as treatment trains:



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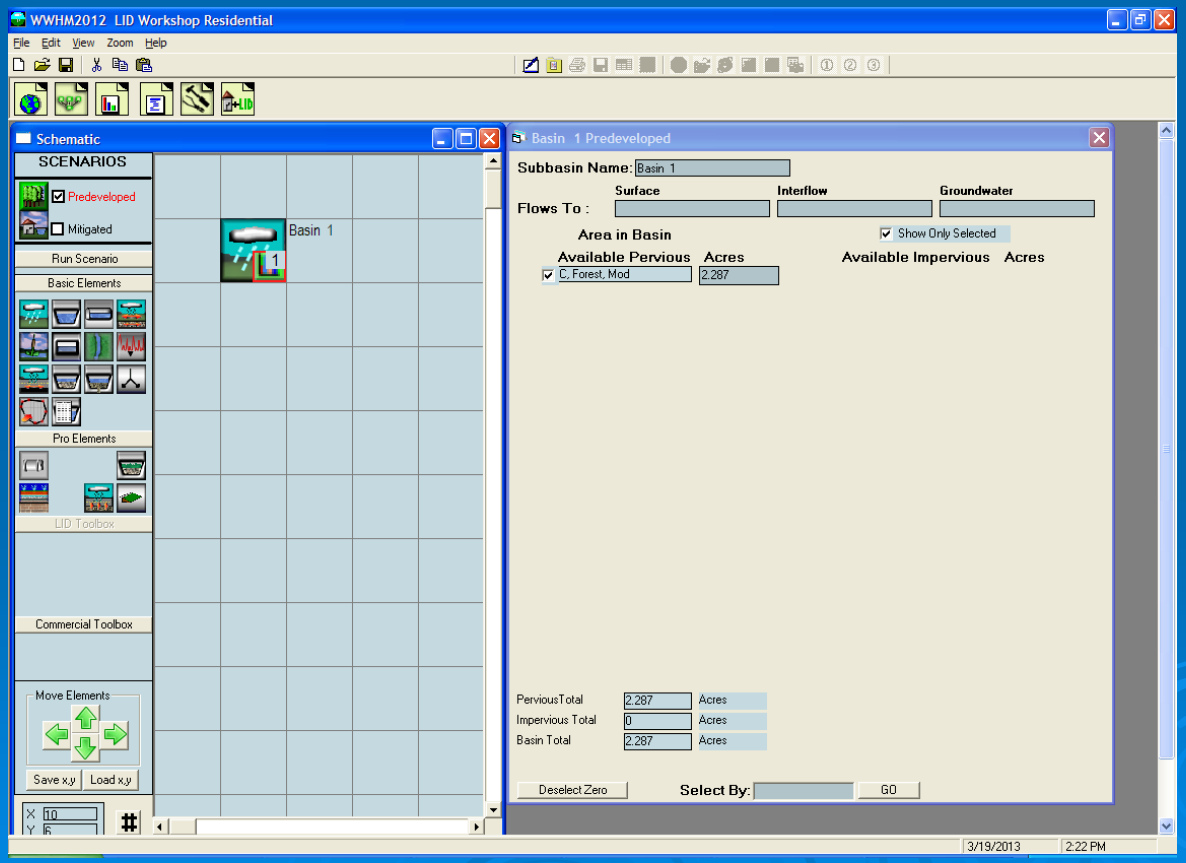
Multiple LID Facilities

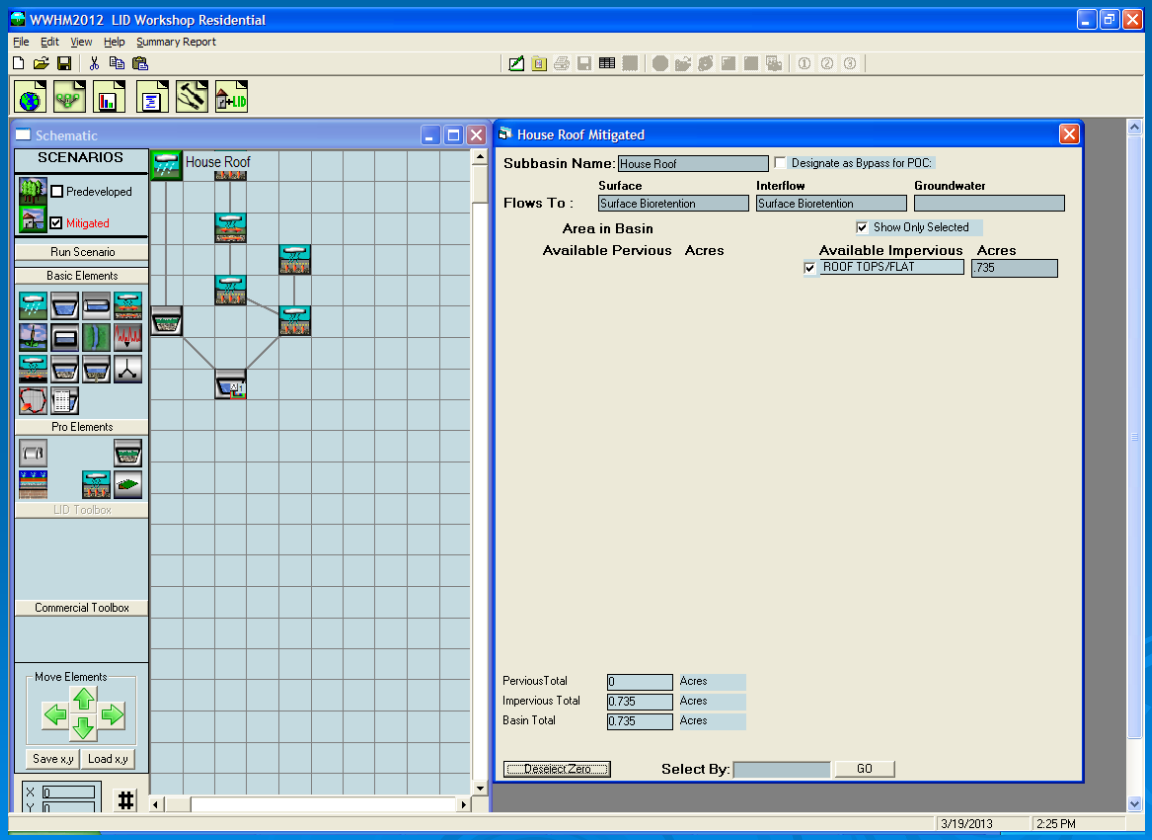
Predeveloped: 2.287 acres



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

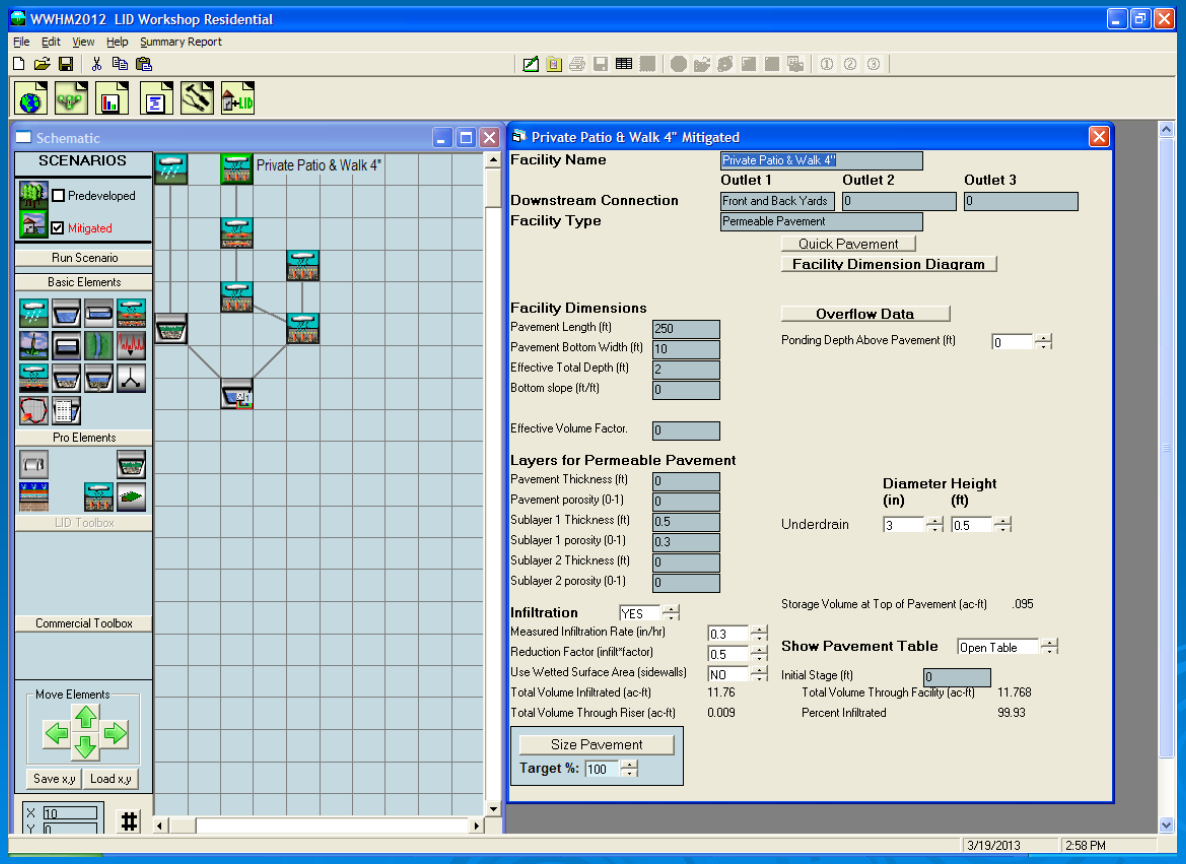
Development: residential with permeable pavement and bioretention. Roof runoff connected directly to bioretention.



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

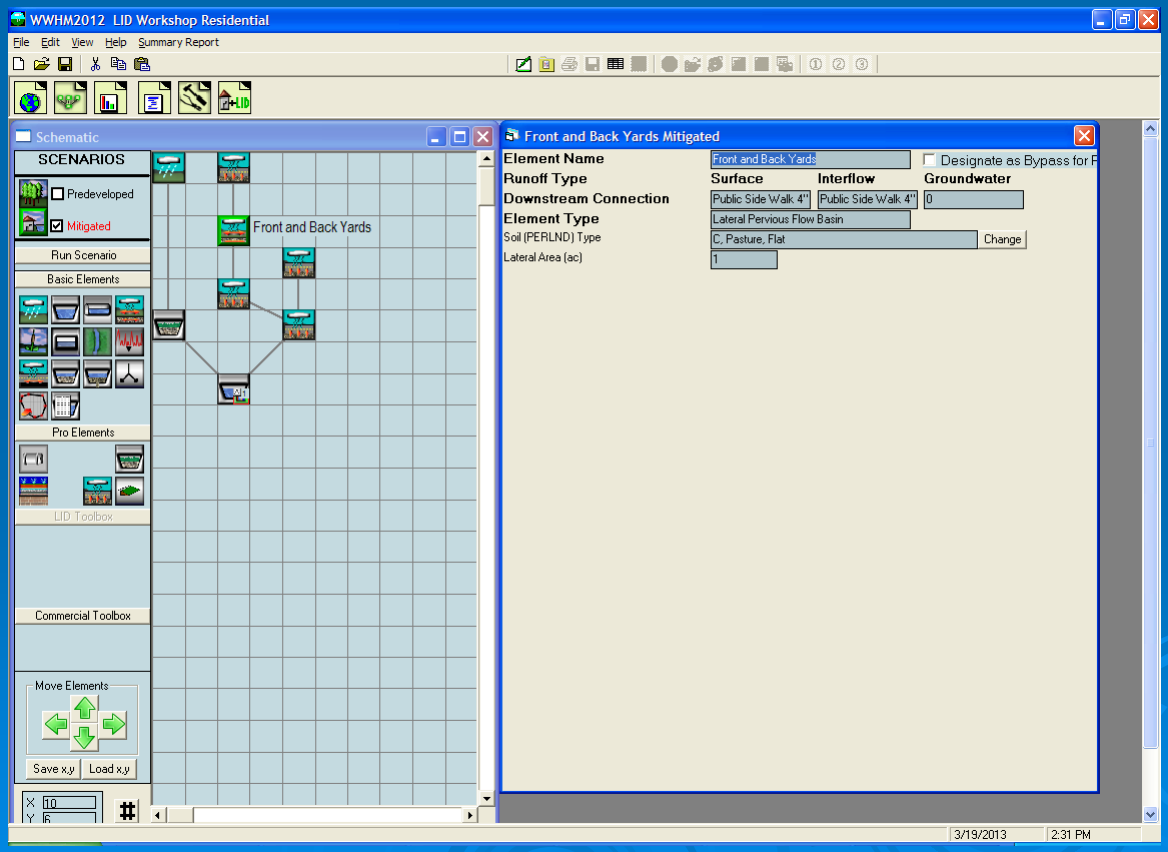
Development: residential with permeable pavement and bioretention. Patio and sidewalk permeable pavement runoff drains to adjacent yard areas.



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

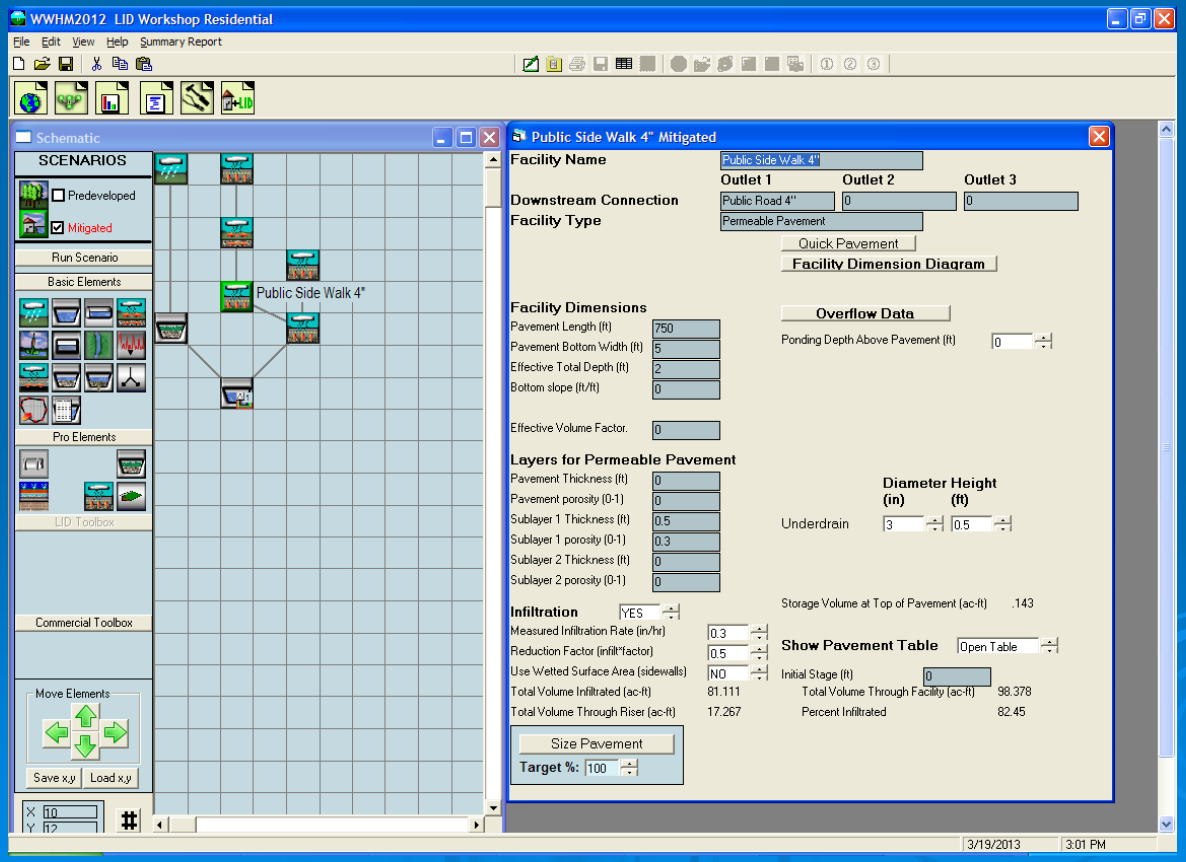
Development: residential with permeable pavement and bioretention. Yard area (amended soil modeled as pasture) runoff drains to adjacent public sidewalks.



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

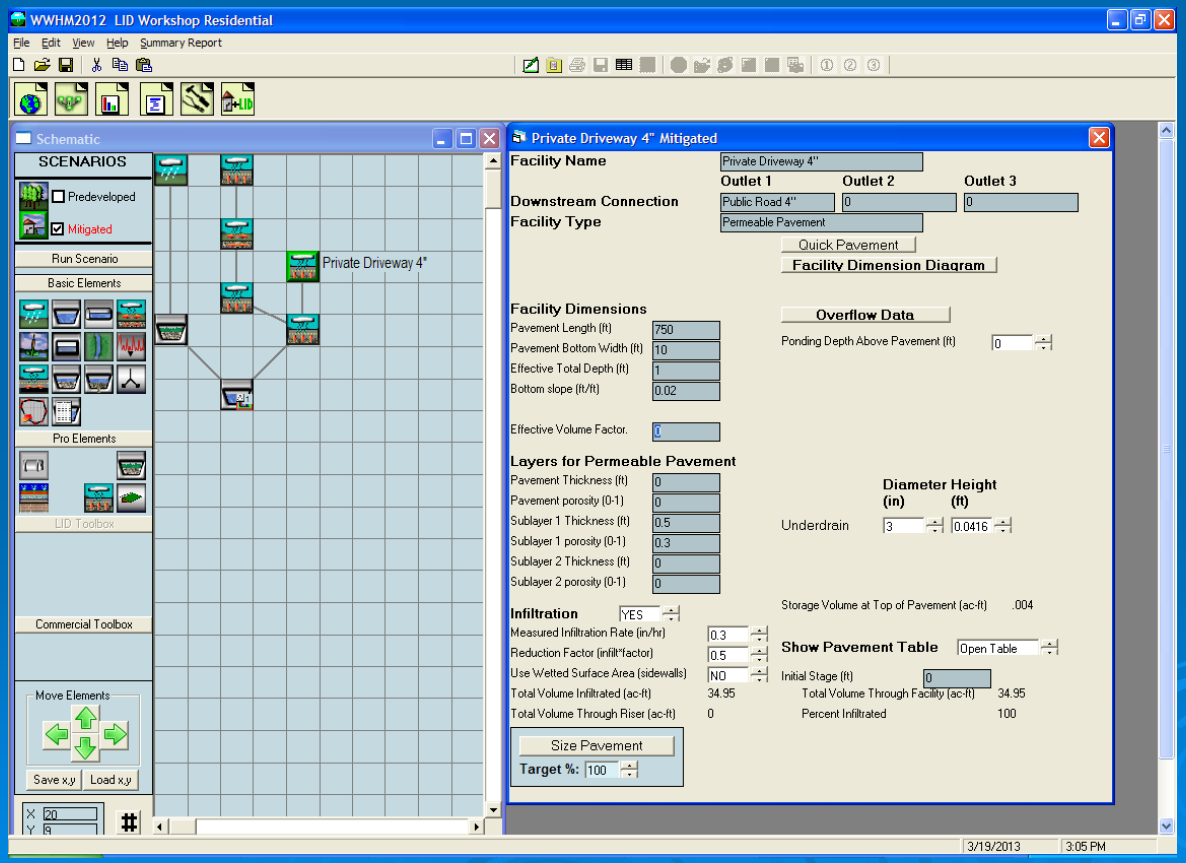
Development: residential with permeable pavement and bioretention. Public sidewalk runoff drains to adjacent roadway permeable pavement.



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

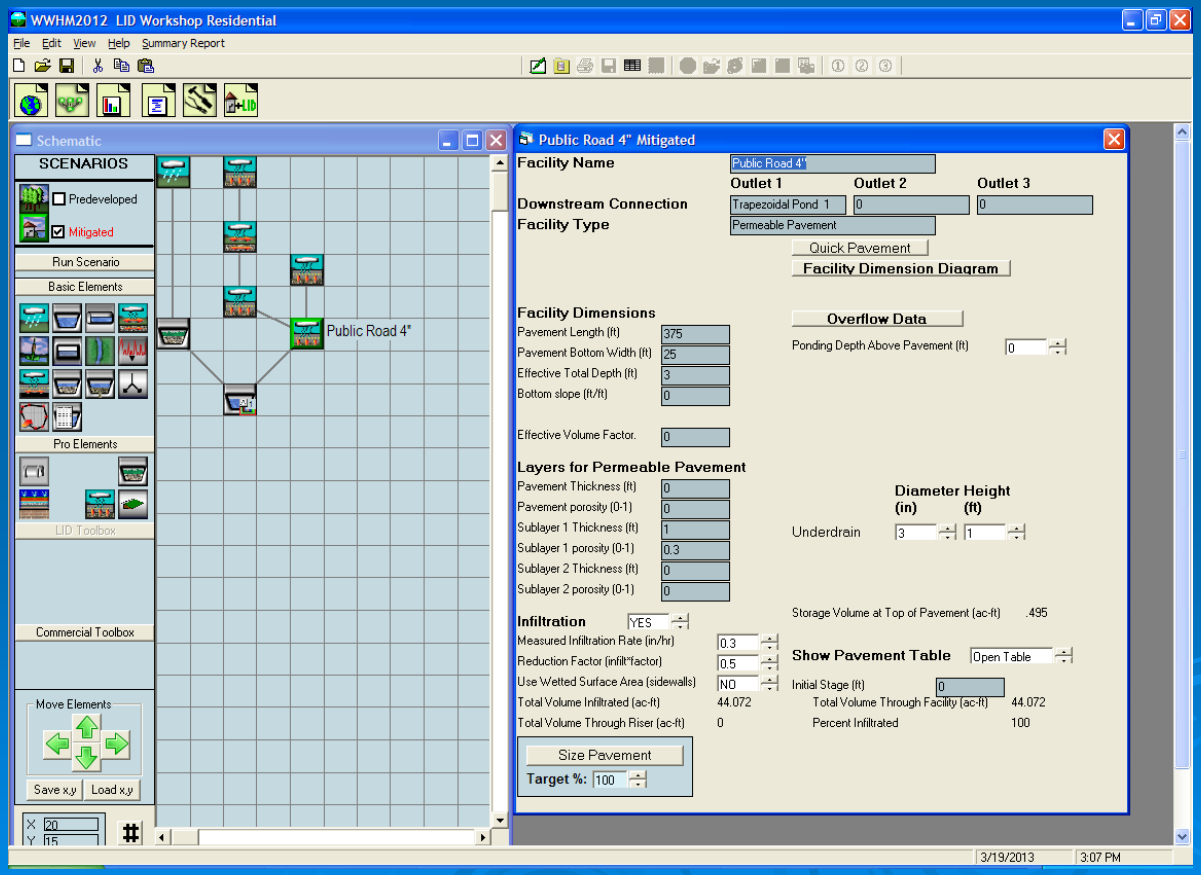
Development: residential with permeable pavement and bioretention.
Private driveway runoff drains to adjacent roadway permeable pavement.



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

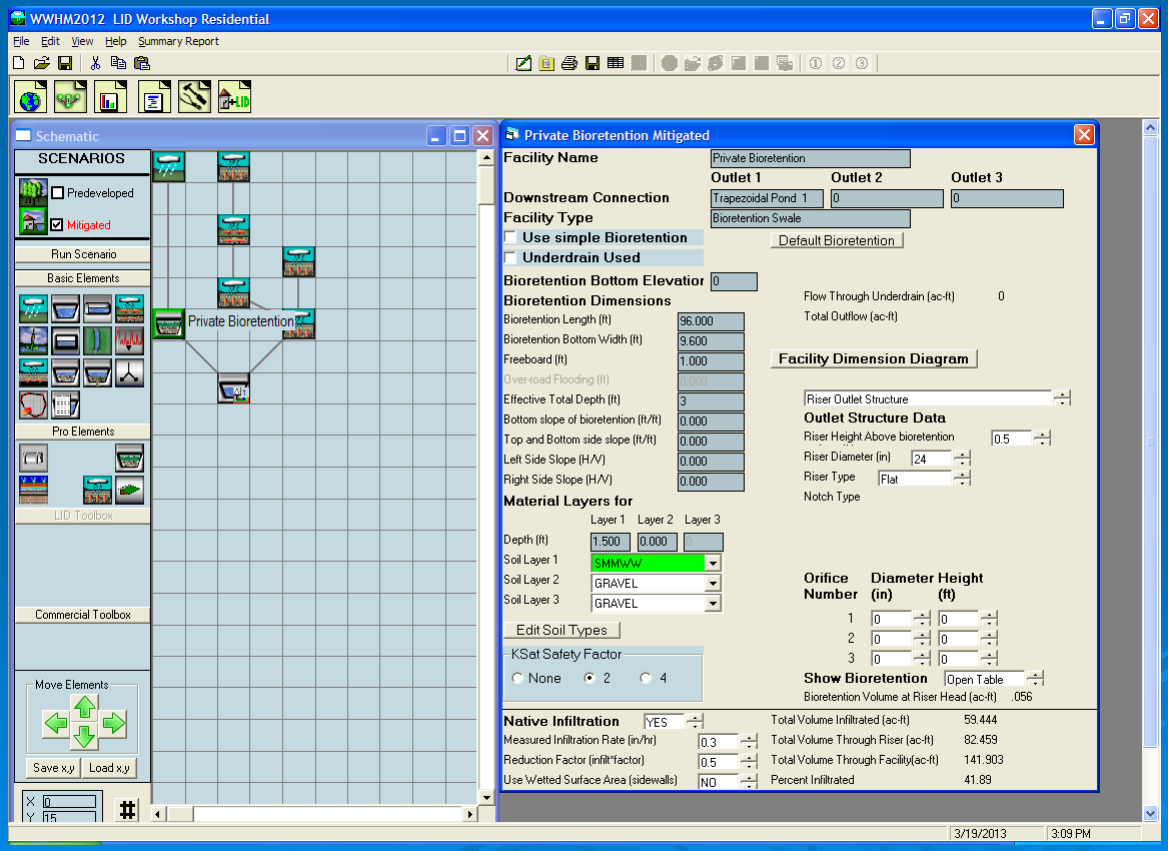
Development: residential with permeable pavement and bioretention. Road runoff drains to stormwater detention pond.



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

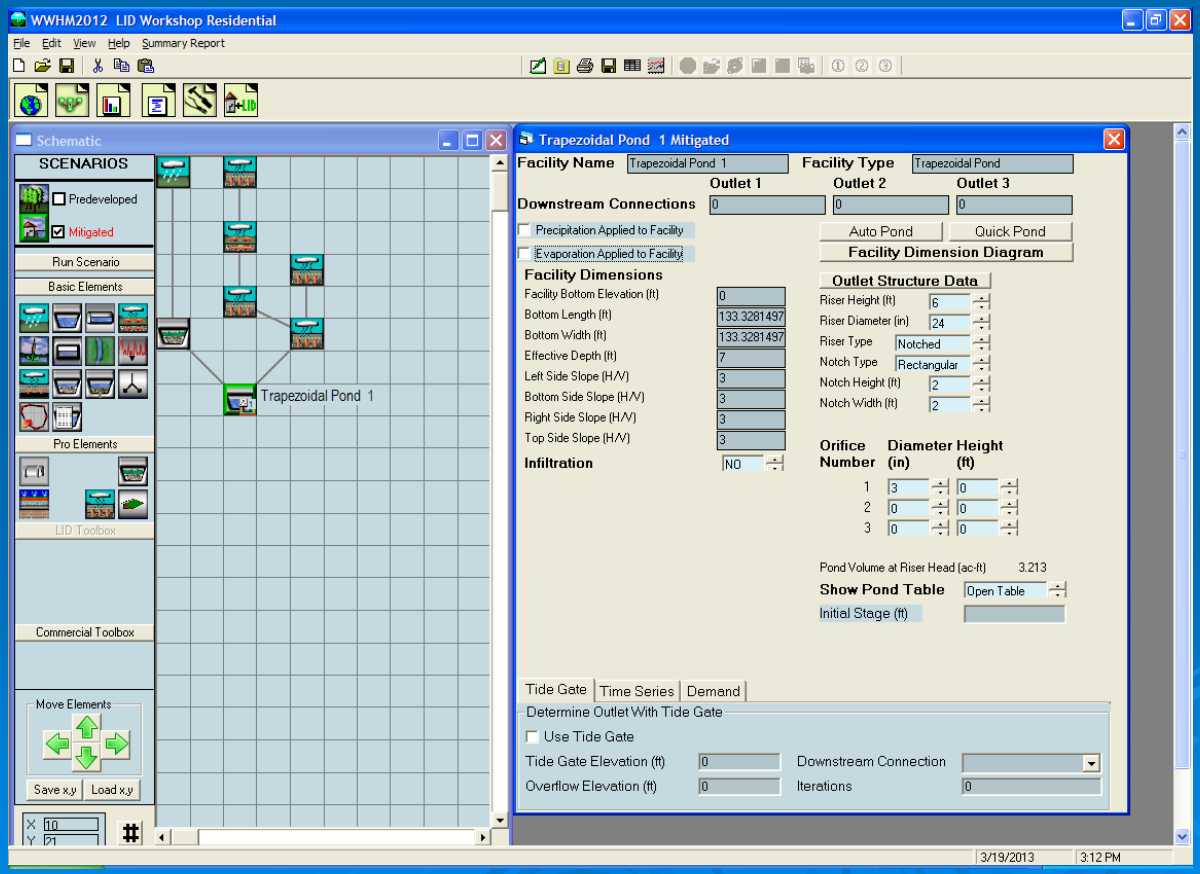
Development: residential with permeable pavement and bioretention. Bioretention drains to stormwater detention pond.



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

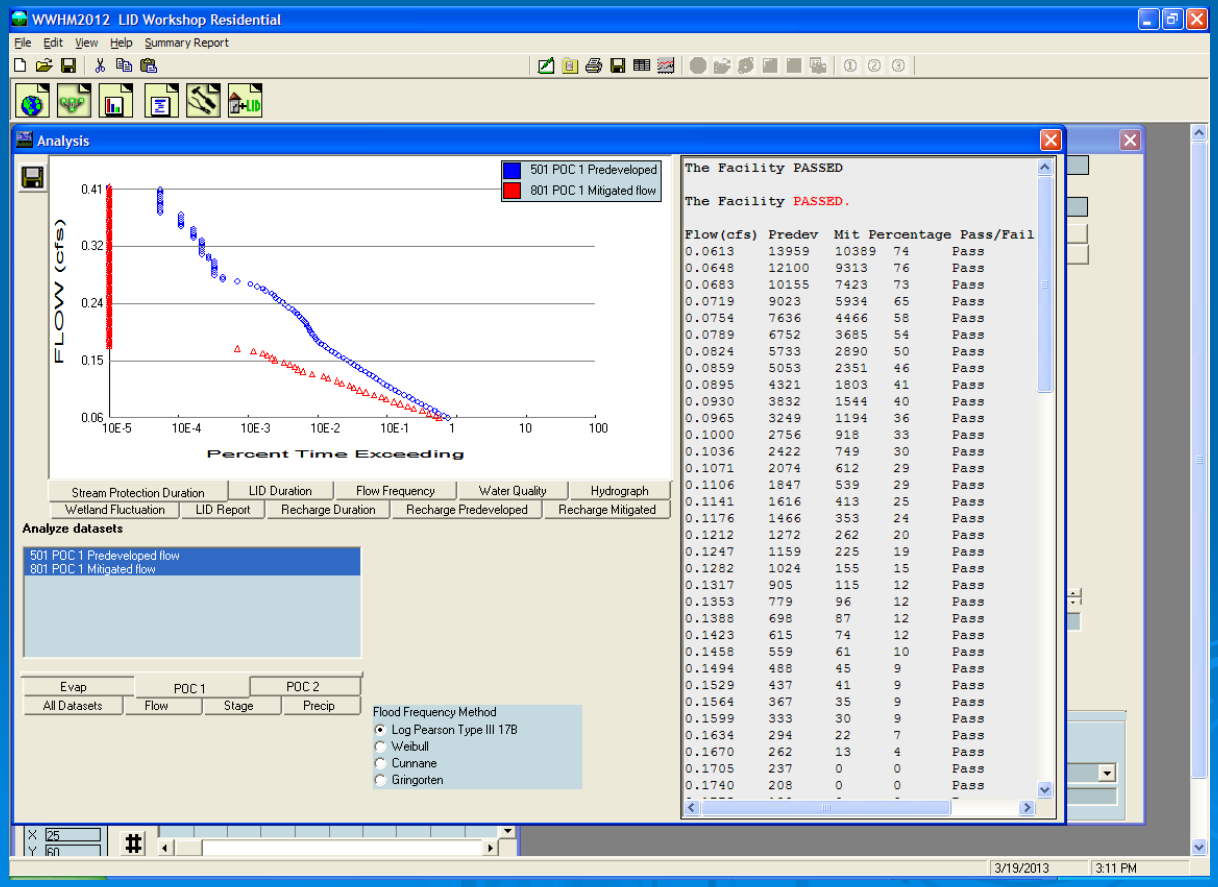
Development: residential with permeable pavement and bioretention. Stormwater detention pond is the downstream point of compliance (POC1).



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

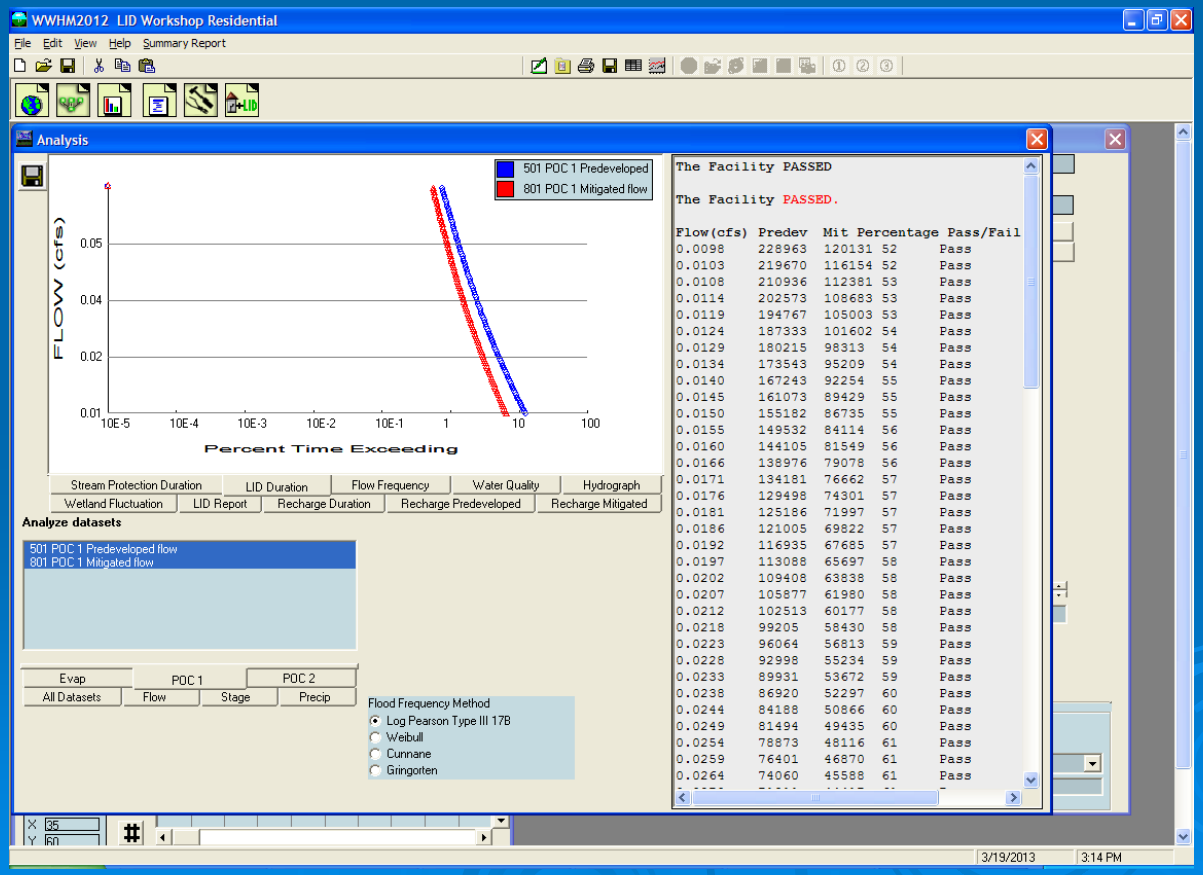
Development: residential with permeable pavement and bioretention. Pond meets stream protection flow duration standard.



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

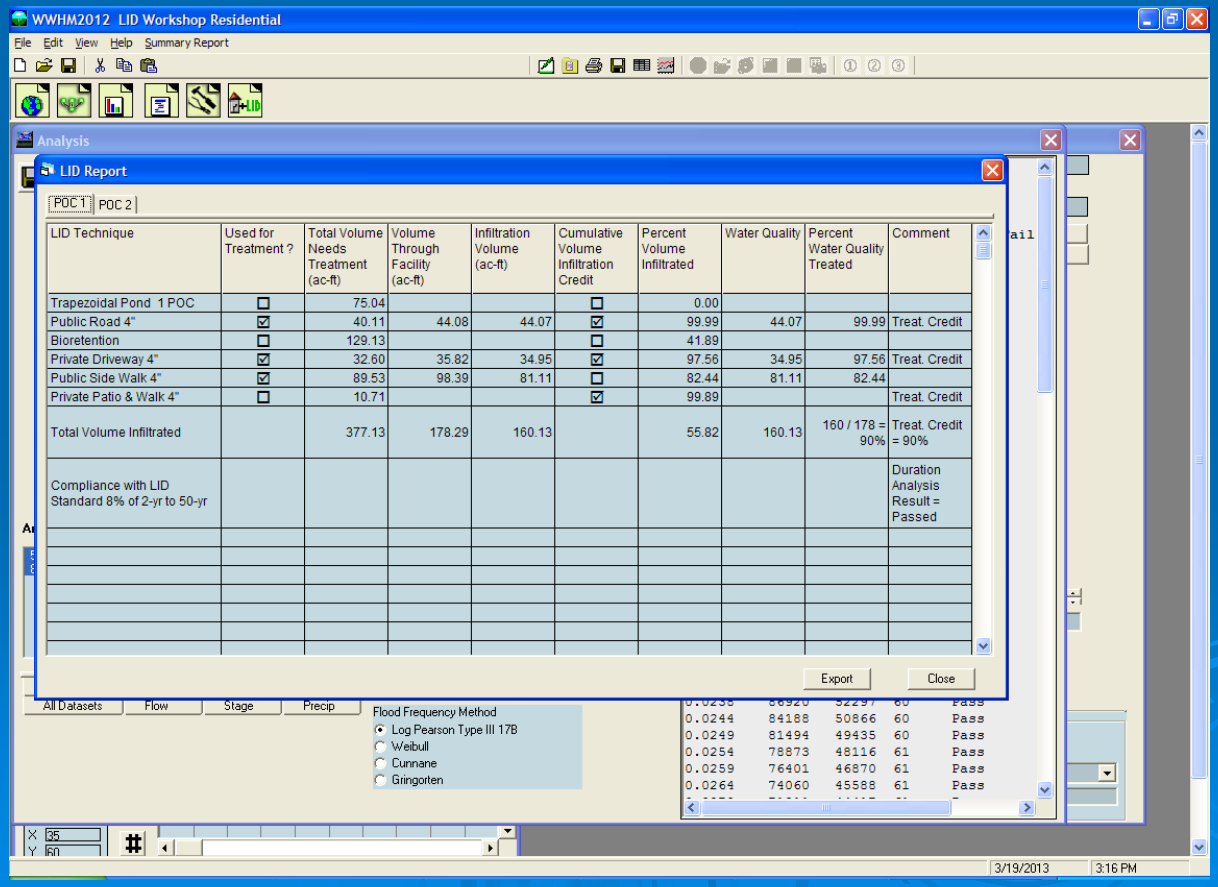
Development: residential with permeable pavement and bioretention. Pond meets LID flow duration standard.



CLEAR CREEK SOLUTIONS

Multiple LID Facilities

Development: residential with permeable pavement and bioretention.
LID Report:



LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Trapezoidal Pond 1 POC	☐	75.04			☐	0.00			
Public Road 4"	☑	40.11	44.08	44.07	☑	99.99	44.07	99.99	Treat. Credit
Bioretention	☐	129.13			☐	41.89			
Private Driveway 4"	☑	32.60	35.82	34.95	☑	97.56	34.95	97.56	Treat. Credit
Public Side Walk 4"	☑	89.53	98.39	81.11	☐	82.44	81.11	82.44	
Private Patio & Walk 4"	☐	10.71			☑	99.89			Treat. Credit
Total Volume Infiltrated		377.13	178.29	160.13		55.82	160.13	160 / 178 = 90%	Treat. Credit = 90%
Compliance with LID Standard 8% of 2-yr to 50-yr									Duration Analysis Result = Passed

0.0244	84188	50866	60	Pass
0.0249	81494	49435	60	Pass
0.0254	78873	48116	61	Pass
0.0259	76401	46870	61	Pass
0.0264	74060	45588	61	Pass

CLEAR CREEK SOLUTIONS

Questions and Answers

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