

Lesson 1 – Overview of ICPR and Modeling Basics

1.1	Overview	1-1
1.1.1	Brief History of ICPR	1-1
1.1.2	Help System	1-1
1.1.3	Menu System.....	1-5
1.1.4	Form System and Editing Basics	1-6
1.1.5	Options and Preferences.....	1-8
1.1.6	Importing & Exporting Data	1-11
1.2	Modeling Basics	1-13
1.2.1	The ICPR Building Blocks: Nodes, Links and Basins.....	1-13
1.2.2	Understanding Control Volumes and Computational Time Steps	1-15
1.2.3	Base Flows and Boundary Flows	1-17
1.2.3.1	Base Flows	1-17
1.2.3.2	Boundary Flows.....	1-18
1.2.4	Time-Stage Nodes and Boundary Stages.....	1-19
1.2.4.1	Time-Stage Node Types.....	1-19
1.2.4.2	Boundary Stages	1-19
1.2.5	Understanding Groups.....	1-23
1.2.6	Setting Up Simulations – Control Data.....	1-25
1.2.6.1	Hydrology Control Data	1-25
1.2.6.1.1	Simulation Name & Filename	1-26
1.2.6.1.2	Global Rainfall & Rainfall Specs	1-26
1.2.6.1.3	Importance of Output Increments	1-26
1.2.6.1.4	Including Groups	1-27
1.2.6.2	Routing Control Data.....	1-28
1.2.6.2.1	Simulation Name & Filename	1-29
1.2.6.2.2	Linking Hydrology, Boundary Stages & Flows ...	1-30
1.2.6.2.3	Times, Time Steps and Stability Criteria	1-30
1.2.6.2.4	Output Increments.....	1-32
1.2.6.2.5	Including Groups	1-32
1.2.6.2.6	Restarts.....	1-32
1.2.6.2.7	Patches and Alternatives	1-33

Lesson 2 – Wet Detention Pond Design in ICPR

2.1 Overview 2-1

2.2 Drainage Basin Parameters 2-3

 2.2.1 Pre-Development 2-3

 2.2.2 Post-Development 2-3

2.3 Hydrology Setup and Execution 2-8

 2.3.1 Create New Project 2-8

 2.3.2 Import Delmarva 284 Unit Hydrograph 2-8

 2.3.3 Build Nodal Network Schematic 2-9

 2.3.4 Enter Basin Data 2-13

 2.3.5 Storm and Hydrology Control Data 2-15

 2.3.6 Hydrology Execution 2-17

 2.3.7 A Quick Look at Some Key Results 2-18

2.4 Sizing the Pond and Outfall Structure 2-21

 2.4.1 Stage-Area-Storage (Rough Grading of Pond) 2-22

 2.4.2 Treatment Volume 2-22

 2.4.3 Permanent Pool 2-23

 2.4.4 Outfall Structure 2-24

2.5 Routing Setup and Execution 2-26

 2.5.1 Completing the Nodal Network Schematic 2-26

 2.5.2 Entering the Drop Structure Data 2-27

 2.5.3 Entering the Node Data 2-30

 2.5.4 Entering the Boundary Stage Data 2-33

 2.5.5 Entering the Routing Control Data 2-34

 2.5.6 Routing Execution 2-36

2.6 Analyzing Results 2-37

 2.6.1 Mass Balance Report 2-37

 2.6.2 Node Maximum Conditions Report 2-39

 2.6.3 Node Graphs: 1 Simulation Per Page 2-40

 2.6.4 Node Graphs: 1 Node Per Page 2-44

2.7 Draw Down Analysis 2-45

2.8 Refinements 2-48

Lesson 3 – Modeling Filters and Underdrains in ICPR

3.1 Overview 3-1

3.2 Side Bank Filter Example 3-3

3.2.1	Create New Project	3-4
3.2.2	Nodal Network Schematic	3-4
3.2.3	Pond Data	3-5
3.2.4	Boundary Data	3-6
3.2.5	Filter Link Data	3-6
3.2.6	Routing Control Data	3-7
3.2.7	Execute Simulation	3-8
3.2.8	Analyze Results	3-9
3.3	Side Bank Filter with Base Flow	3-13
3.3.1	Add Base Flow to Pond	3-13
3.3.2	Add New Routing Control Form	3-14
3.3.3	Execute Simulation	3-14
3.3.4	Analyze Results	3-15
3.3.5	Increase Filter Length to Compensate for Base Flow	3-17
3.4	Incorporating Pipe Hydraulics with Side Bank Filter	3-19
3.4.1	Make a Copy of the Project Using "Save As" Option	3-19
3.4.2	Re-Structure Nodal Network	3-19
3.4.3	Enter Data for Node "Pipe_Inlet"	3-20
3.4.4	Enter Data for Link "Pipe"	3-21
3.4.5	Enter Routing Control Data	3-22
3.4.6	Execute Simulation	3-23
3.4.7	Analyze Results	3-23
3.5	Modeling Pond Underdrains with a Filter Link	3-27
3.5.1	Create New Project	3-28
3.5.2	Construct Nodal Network Schematic	3-29
3.5.3	Enter Node Data	3-29
3.5.4	Enter Filter Data	3-30
3.5.5	Enter Pipe Data	3-31
3.5.6	Enter Routing Control Data	3-32
3.5.7	Execute Simulation	3-32
3.5.8	Analyze Results	3-33

Lesson 4 – Modeling Percolation in ICPR

4.1	Overview	4-1
4.2	Unsaturated Vertical Flow	4-2
4.3	Saturated Horizontal Flow	4-6

4.4	Parameters Related to the Unconfined Aquifer	4-12
4.5	Example – Percolation as the Only Outlet.....	4-15
4.5.1	Setup Storms	4-16
4.5.2	Enter Node Data.....	4-19
4.5.3	Enter Basin Data	4-21
4.5.4	Enter Percolation Link Data.....	4-22
4.5.5	Execute Simulations	4-24
4.5.6	Analyze Results.....	4-25
4.6	Example – Modeling Ponds in Close Proximity.....	4-32
4.6.1	Create New Project Called “Dual Ponds”	4-34
4.6.2	Construct Nodal Network in Network Builder.....	4-35
4.6.3	Enter Basin Data	4-36
4.6.4	Enter Node Data.....	4-37
4.6.5	Enter Link Data	4-39
4.6.6	Enter Control Data.....	4-43
4.6.7	Execute Simulation.....	4-45
4.6.8	Analyze Results.....	4-46
4.7	Example – Ditch in Close Proximity to a Pond.....	4-55
4.7.1	Create New Project Called “Pond and Ditch”	4-58
4.7.2	Construct Nodal Network in Network Builder.....	4-59
4.7.3	Enter Basin Data	4-59
4.7.4	Enter Node Data.....	4-60
4.7.5	Enter Link Data	4-61
4.7.6	Enter Control Data.....	4-63
4.7.7	Execute Simulation.....	4-65
4.7.8	Analyze Results.....	4-66
4.8	Example – Base Flow Calculations.....	4-71
4.9	Example – Construction Dewatering.....	4-77
4.10	Exfiltration Trench.....	4-83
4.10.1	Overview	4-83
4.10.2	Example – Exfiltration Trench, Simple Approach	4-85
4.10.2.1	Create New Project Called “Exfil Simple”	4-88
4.10.2.2	Build Nodal Network Schematic.....	4-89
4.10.2.3	Import Basin Data from a DBF File	4-89
4.10.2.4	Enter Node Data	4-91
4.10.2.5	Enter Link Data	4-93

4.10.2.6 Enter Control Data 4-98
 4.10.2.7 Execute Simulation 4-100
 4.10.2.8 Analyze Results 4-101

Lesson 5 – Modeling Pipes and Storm Sewers in ICPR

5.1 Overview 5-1
 5.1.1 Outlet Control (Sub-Critical Flow) 5-1
 5.1.1.1 Outlet Control Specification 5-2
 5.1.1.2 Friction Equation 5-3
 5.1.1.3 Entrance Loss Coefficient 5-4
 5.1.1.4 Exit Loss Coefficient 5-4
 5.1.2 Inlet Control (Super Critical Flow) 5-7
 5.1.2.1 Inlet Edge Descriptions 5-7
 5.1.2.2 Inlet Control Specification 5-8
 5.1.3 The Solution Algorithm Option 5-8
 5.1.4 Understanding Flow Codes 5-13
 5.1.5 Modeling Silt in Pipes 5-19
 5.1.6 Modeling Flap Gates on Pipes 5-19
 5.1.7 Standard Pipe Sizes 5-20
 5.1.8 Manhole Losses 5-21
 5.1.9 Summary of Recommendations for Modeling Pipes 5-25
 5.2 Nodal Network Strategies for Storm Sewer Systems 5-26
 5.2.1 Modeling Storm Drain Inlet Hydraulics in ICPR 5-27
 5.3 Example Storm Sewer System 5-30
 5.3.1 Create New Project Called “Storm Sewer” 5-32
 5.3.2 Build Nodal Network Schematic 5-33
 5.3.3 Enter Basin Data 5-34
 5.3.4 Enter Node Data 5-35
 5.3.5 Enter Link Data (3 Pipes) 5-38
 5.3.6 Enter Control Data 5-40
 5.3.7 Execute the Simulation 5-42
 5.3.8 Analyze the Results 5-43
 5.3.8.1 Mass Balance Report 5-43
 5.3.8.2 Node Maximum Conditions Report 5-44
 5.3.8.3 Potentially Problematic Pipes and Anomalies Check 5-45
 5.3.8.4 Stage Hydrographs 5-48

5.3.8.5 Velocities 5-49

5.4 Extra Credit..... 5-50

Lesson 6 – Combining Storm Sewers and Exfiltration Trenches

6.1 Overview 6-1

6.2 Example – Combining Exfiltration Trenches with Storm Sewers 6-3

6.2.1 Project Setup..... 6-3

6.2.2 Setup a Default Node Template 6-5

6.2.3 Setup a Default Pipe Template 6-8

6.2.4 Setup a Default Exfiltration Trench Template 6-11

6.2.5 Add New Nodes Using the Network Builder 6-13

6.2.6 Add New Pipes Using the Network Builder 6-14

6.2.7 Add New Exfiltration Trenches Using the Network Builder 6-15

6.2.8 Re-assign Basin Nodes (Re-distribute Surface Runoff)..... 6-16

6.2.9 Set Final Pipe Lengths and Bend Loss Coefficients 6-18

6.2.10 Set Final Exfiltration Trench Lengths 6-19

6.2.11 Setup Control Data (Hydrology and Routing) 6-20

6.2.12 Execute Simulation 6-24

6.2.13 Analyze the Results 6-26

6.2.13.1 Mass Balance Report 6-26

6.2.13.2 Node Maximum Conditions Report 6-29

6.2.13.3 List of Potentially Problematic Pipes 6-30

6.2.13.4 Check Link Flows for Anomalies 6-31

6.2.13.5 Check Stages at Inlets..... 6-35

6.2.13.6 Check Groundwater Mounding Impacts 6-36

6.2.13.7 Compare Simple and Complex Approaches 6-37

6.3 Disabling the Default Templates 6-42

Lesson 7 – Modeling Underground Stormwater Chambers in ICPR

7.1 Overview 7-1

7.2 Example – Stormwater Chambers with Percolation 7-2

7.2.1 Create New Project Called “StormTech” 7-3

7.2.2 Build Nodal Network Schematic 7-4

7.2.3 Enter Basin Data 7-5

7.2.4 Enter Basic Node Data 7-6

7.2.5 Size Storm Water Chamber System 7-8

7.2.6 Enter Link Data 7-11

7.2.7 Enter Control Data 7-15

7.2.8 Execute the Simulation 7-17

7.2.9 Analyze the Results 7-18

 7.2.9.1 Mass Balance Report 7-18

 7.2.9.2 Node Maximum Conditions Report 7-19

 7.2.9.3 Potentially Problematic Pipes and Anomalies Check 7-20

 7.2.9.4 Groundwater Mounding Impacts 7-26

 7.2.9.5 Volumetric Checks 7-27

Lesson 8 – Modeling Pump Stations in ICPR

8.1 Overview 8-1

8.2 Example – Pump Station with Seepage Considerations 8-1

 8.2.1 Create New Project Called “Pump Station” 8-1

 8.2.2 Build Nodal Network Schematic 8-2

 8.2.3 Import Boundary Flows 8-3

 8.2.4 Enter Node Data 8-5

 8.2.5 Enter Operating Tables for Pumps 8-7

 8.2.6 Enter Link Data 8-9

 8.2.7 Enter Routing Control Data 8-11

 8.2.8 Execute the Simulation 8-13

 8.2.9 Analyze the Results 8-13

 8.2.9.1 Mass Balance Report 8-13

 8.2.9.2 Node Maximum Conditions Report 8-15

 8.2.9.3 Analysis of Pumping and Seepage Flow Rates 8-16

 8.2.9.4 Groundwater Mounding Impacts 8-17

 8.2.9.5 Volumetric Checks 8-18

Lesson 9 – Modeling Channels in ICPR

9.1 Overview 9-1

 9.1.1 Channel Hydraulics and Some Recommended Settings 9-1

 9.1.2 Irregular Cross Sections 9-4

 9.1.2.1 Potential Problems with Irregular Cross Sections 9-8

 9.1.2.2 Recommendations When Using Irregular Cross Sections
 with Channels or Bridges 9-15

 9.1.3 Modeling Ineffective Flow Areas 9-15

9.2 Example – Open Channel System 9-20

 9.2.1 Create New Project Called “Channel System” 9-21

 9.2.2 Setup Default Channel Template 9-22

 9.2.3 Enter Cross Section Data 9-24

 9.2.4 Build Nodal Network Schematic 9-27

 9.2.5 Setup Boundary Flows 9-28

 9.2.6 Enter Node Data 9-29

 9.2.7 Enter Link Data 9-31

 9.2.8 Enter Routing Control Data 9-33

 9.2.9 Execute the Simulation 9-34

 9.2.10 Analyze the Results 9-35

 9.2.10.1 Mass Balance Report 9-35

 9.2.10.2 Node Maximum Conditions Report 9-36

 9.2.10.3 List of Potentially Problematic Pipes and Channels 9-39

 9.2.10.4 Re-Execute the Simulation 9-41

 9.2.10.5 Re-Check Node Maximum Conditions 9-42

 9.2.10.6 Re-Check List of Potentially Problematic Pipes and
 Channels 9-43

 9.2.10.7 Other Checks 9-45

 9.2.11 Disabling the Default Templates 9-48

9.3 Example – Modeling Percolation from Swales 9-49

 9.3.1 Create New Project Called “Swale with Perc” 9-50

 9.3.2 Setup Default Percolation Template 9-51

 9.3.3 Build Nodal Network Schematic 9-52

 9.3.4 Enter Basin Data 9-54

 9.3.5 Enter Node Data 9-55

 9.3.6 Enter Link Data 9-57

 9.3.7 Enter Control Data 9-63

 9.3.8 Execute the Simulations 9-66

 9.3.9 Analyze the Results 9-67

 9.3.9.1 Mass Balance Report 9-67

 9.3.9.2 Node Maximum Conditions Report 9-68

 9.3.9.3 List of Potentially Problematic Channels 9-69

 9.3.9.4 Flow Checks 9-73

 9.3.9.5 Stage Checks 9-76

 9.3.9.6 Volume Analysis 9-77

9.3.9.7 Groundwater Mounding Impacts 9-79
 9.3.10 Disabling the Default Templates 9-80

Lesson 10 – Modeling Bridges in ICPR

10.1 Overview 10-1
 10.2 Example – Bridge 10-12
 10.2.1 Open Existing Project Called “Bridge” 10-13
 10.2.2 Add Bridge Link to Nodal Network 10-13
 10.2.3 Shut Pipe “A-030P” Off 10-15
 10.2.4 Enter Cross Section Data 10-16
 10.2.5 Enter Bridge Data 10-21
 10.2.6 Set Rating Curve Control Data 10-25
 10.2.7 Execute WSPRO 10-27
 10.2.8 Review and Refine Rating Curves 10-27
 10.2.9 Reset Filenames for Both Hydrology and Routing Control 10-33
 10.2.10 Execute Simulations 10-34
 10.2.11 Analyze Results 10-35

Lesson 11 – Multi-Event and Long Term Simulations in ICPR

11.1 Overview 11-1
 11.2 Example – Back to Back Storm Events 11-1
 11.2.1 Make a Copy of the “Wet Pond” Example from Lesson 2 11-2
 11.2.2 Add a Basin and Set Basin Rainfall Data 11-4
 11.2.3 Extend Boundary Stage Data to Encompass Both Storms 11-7
 11.2.4 Reset Initial Stage to Elevation 100’ at Node “Pond” 11-8
 11.2.5 Add New Hydrology and Routing Control Data 11-9
 11.2.6 Execute Simulations 11-11
 11.2.7 Analyze Results 11-13
 11.3 Example – Long Term Simulation 11-16
 11.3.1 Make a Copy of the “Dual Ponds” Example from Lesson 4 11-17
 11.3.2 Import 1994 Rainfall Library 11-18
 11.3.3 Change Basin Data 11-19
 11.3.4 Enter Operating Tables for Evaporation 11-22
 11.3.5 Node Data 11-24
 11.3.6 Add Rating Curve Link for Evaporation 11-26
 11.3.7 Change Percolation Links (Include Recharge) 11-27

11.3.8 Change Control Data..... 11-29
11.3.9 Execute the Simulation..... 11-31
11.3.10 Analyze the Results 11-32