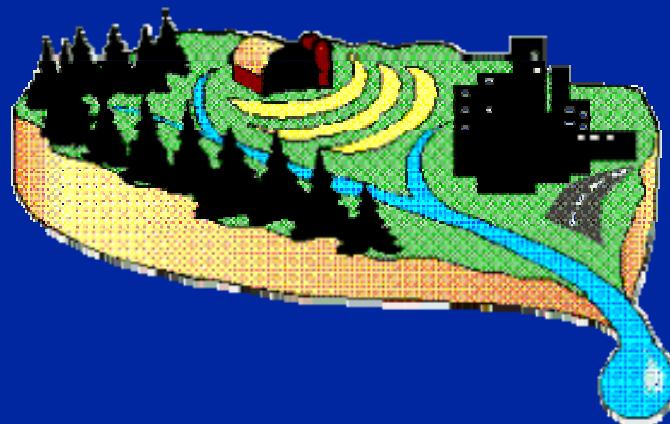
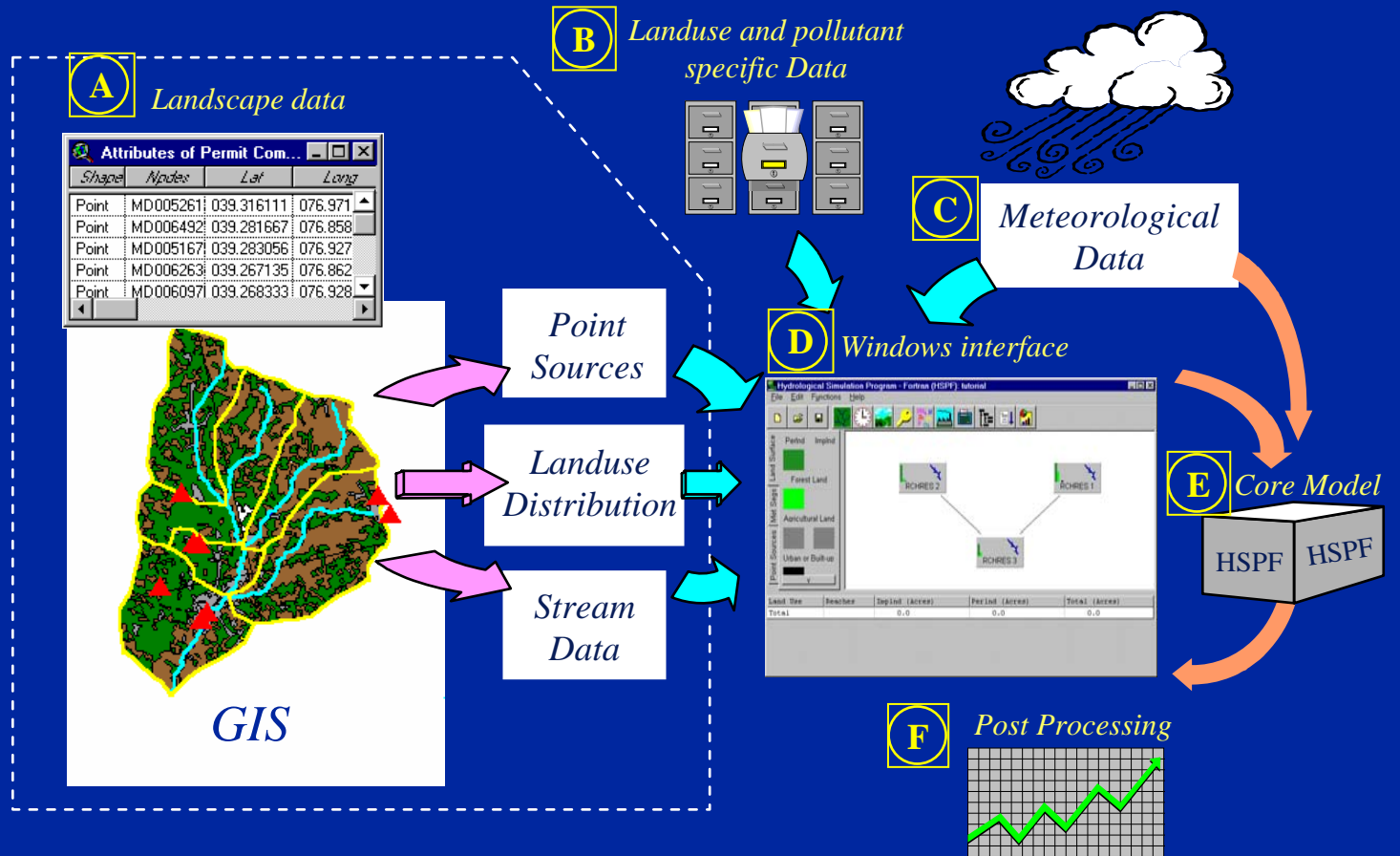


LECTURE #7

OPERATIONAL ASPECTS OF HSPF AND SUPPORTING SOFTWARE



HOW HSPF FITS INTO BASINS



HSPF SUPPORTING PROGRAMS

WinHSPF

- Interactive interface to HSPF
- Access to all HSPF Features
- Scenario development

WDMUtil

- Build/maintain WDM time series file and meteorologic data for BASINS
- Meteorologic data generation and fill-in
- Graphical and tabular display of time series data

GenScn

- output postprocessor

HSPEXP

- Hydrologic calibration support

FILES UTILIZED BY HSPF

UCI (User's Control Input)

- contains all input except time series data

Run Interpreter Output (MES, ECH)

- output summary of user's input

Operation Module Output

- state variables and fluxes at user-selected intervals

WDM or DSS

- Time series data input and output (binary format)

PLTGEN/MUTSIN/SEQ

- Time series data input and output (text format)

HSPF Binary Output

- Operation output in binary format

HSPF OPERATION

- Run Interpreter processes input, “echoing” it back to the user as it goes. The amount of output to the “echo file” is controlled by a flag in the input.
- Warning and error messages that occur during both the interpretation and execution phases appear in the “echo file”.
- If the Run Interpreter detects errors in the input, HSPF will attempt to complete as much of the interpretation as possible and then stop without executing the run. Warnings do not stop execution.
- If too many errors occur during the run, HSPF will halt execution and place a message in the “echo file”.

UCI CONCEPTS

The **User's Control Input** (UCI) file is a text (ASCII) file containing all program input except for timeseries data. Before the run begins, it is processed by the Run Interpreter.

- Formatted **column-dependent** input.
- Entire file delimited by keywords RUN and END RUN.
- Divided into **blocks** which are delimited by keywords. Each block controls a different aspect of the run.
- Many blocks are divided into **tables** of parameters. These tables are also delimited by keywords.
- Any line containing 3 consecutive stars (“***”) in the first 80 characters is treated as a comment by the Run Interpreter.
- A blank numeric field is assigned its default value (if any).

UCI BLOCKS

Run Specification Blocks:

GLOBAL
FILES
OPN SEQUENCE

Operation Module Blocks:

PERLND
IMPLND
RCHRES
COPY
etc.

Time Series Linkage Blocks:

EXT SOURCES
NETWORK
SCHEMATIC
MASS-LINK
EXT TARGETS

Other:

FTABLES
SPEC-ACTIONS
CATEGORY
MONTH-DATA
PATHNAMES

GLOBAL BLOCK

- Title of the run
- Starting and ending dates of the run
- Run Interpreter and Special Action Output Levels (0-10; normally 0-4)
- Run Flag (0-1)
- Units system flag: 1=English, 2=Metric

Example

GLOBAL

LOST CREEK CALIBRATION RUN #2

START 1986 1 1 0 0 END 1990 12 31 24 0

RUN INTERP OUTPUT LEVEL 4 3

RESUME 0 RUN 1 UNIT SYSTEM 1

END GLOBAL

FILES BLOCK

- Specifies external file names and corresponding unit numbers
- Some file types have special keywords
- Other files are referenced by unit number throughout UCI

Example

FILES

```
<type> <fun>***<-----file name----->
MESSU      21   lost_ck.ech
WDM        22   ..\wdm\lost_ck.wdm
WDM2       23   ..\wdm\calib.wdm
DSS        31   ..\dss\lost_ck.dss
           61   lost_ck.pls
           62   lost_ck.ils
           63   lost_ck.rch
```

END FILES

OPN SEQUENCE BLOCK

- Sets time step of the run INDELT in hours & minutes (1 min-1 day)
- Declares the operations to be performed, in downstream order (limited to 200 operations in Version 11)
- If an operation is "commented out", all other input for that operation is ignored

Example

```
OPN SEQUENCE
  INGRP                               INDELT  1:00
  ***  PERLND      4
        PERLND      5
        IMPLND      1
        RCHRES     30
  END  INGRP
END  OPN SEQUENCE
```

OPERATION-TYPE BLOCKS

- Application modules (PERLND, IMPLND, RCHRES)
- Utility modules (PLTGEN, DISPLY, GENER, etc.)
- These blocks are subdivided into tables

PERLND

ACTIVITY

...

END ACTIVITY

PRINT-INFO

...

END PRINT-INFO

GEN-INFO

...

END GEN-INFO

... additional tables containing options, parameters, and initial conditions

END PERLND

APPLICATION MODULE INPUT TABLES I (ACTIVITY, PRINT-INFO)

ACTIVITY TABLE - flags that turn module sections on or off (0,1)

```
ACTIVITY
  <PLS >
                Active Sections
  # - # ATMP SNOW PWAT  SED  PST  PWG  PQAL MSTL PEST NITR PHOS TRAC ***
  4  5  0   0   1   0   0   0   0   0   0   0   0   0   0
END ACTIVITY
```

PRINT-INFO TABLE - flags that govern printout of module sections (2 = every PIVL intervals, 3 = daily, 4 = monthly, 5 = yearly, 6 = never)

```
PRINT-INFO
  <PLS > ***** Print-flags ***** PIVL  PYR
  # - # ATMP SNOW PWAT  SED  PST  PWG  PQAL MSTL PEST NITR PHOS TRAC ***
  4  5  0   0   5   0   0   0   0   0   0   0   0   0   0   12
END PRINT-INFO
```

APPLICATION MODULE INPUT TABLES II (GEN-INFO, OTHER)

GEN-INFO TABLE - name of operation, units flags, and output files

GEN-INFO

<PLS >	Name	Unit-systems		Printer		***
# - #		time series		Engl	Metr	***
		in	out			***
4	LOW DENSITY RESID.	1	1	91	0	
5	FOREST	1	1	91	0	

END GEN-INFO

{ parameter tables for a module section }

{ initial condition table for a module section }

APPLICATION MODULE INPUT TABLES III (PARAMETER TABLE, INITIAL CONDITION TABLE)

PARAMETER TABLE - constant-valued parameters

```
PWAT-PARM4
  <PLS >      CEPSC      UZSN      NSUR      INTFW      IRC      LZETP ***
  # - #        (in)      (in)      NSUR      INTFW      IRC      LZETP ***
  4            0.12      1.0      0.35      3.0      0.7      0.65
  5            0.12      0.5      0.25      2.0      0.7
END PWAT-PARM4
```

INITIAL CONDITION TABLE - initialize state variables such as storages, concentrations, and temperatures

```
SSED-INIT
  RCHRES      Suspended sediment concentrations (mg/l) ***
  # - #        Sand      Silt      Clay      ***
  1 5          5.0      20.0     30.0
END SSED-INIT
```

APPLICATION MODULE INPUT TABLES IV (OPTION/FLAG, MONTHLY TABLES)

OPTION/FLAG TABLE - select methods for module section

PWAT-PARM1

<PLS >		Flags										***
#	- #	CSNO	RTOP	UZFG	VCS	VUZ	VNN	VIFW	VIRC	VLE	***	
4		0	1	1	1	0	0	0	0	0		
5		0	1	1	0	0	0	0	0	1		

END PWAT-PARM1

MONTHLY TABLE - monthly variable parameters

- Values given are for the first day of each month
- Daily values are interpolated between successive monthly values

MON-LZETPARM

<PLS >		Lower zone evapotranspiration parm at start of each month												***
#	- #	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	***
5		0.3	0.3	0.3	0.4	0.7	0.7	0.7	0.7	0.6	0.5	0.4	0.3	

END MON-LZETPARM

FTABLES BLOCK

- Specify volume-discharge relationship for RCHRES operations

FTABLES

FTABLE 30

ROWS COLS ***

8 4

DEPTH

AREA

VOLUME

DISCH

(FT)

(ACRES)

(AC-FT)

(CFS)

0.0

0.0

0.0

0.0

0.220

0.765

0.09

0.09

0.878

3.05

1.44

3.67

1.537

4.23

4.15

17.0

1.976

4.49

6.27

32.0

2.196

4.60

7.37

40.8

4.907

28.1

93.4

747.

8.315

54.5

238.

1860.

END FTABLE 30

END FTABLES

SPEC-ACTIONS BLOCK

- “special actions”
- Modify program variables at specified date/time (intervention)
- Examples: chemical applications, tillage practices, reservoir operations, etc.

SPEC-ACTIONS

*** User-Defined Variable Quantity Lines

```
*** kwd  varnam  optyp  opn  vari  s1 s2 s3 tp multiply  lc ls ac as agfn ***
<****> <----> <----> <-> <----><-><-><-><-><-----> <><-> <><-> <--> ***
UVQUAN  prec    PERLND   1  PREC          3                      DY  1  SUM

DISTRB  4    8  DY    1  SHIFT    .20  .20  .20  .20  .20    0    0    0
```

*** Nitrogen Fertilizer Application - 50% Surface and 50% Upper Layer ***

```
UVNAME  NO355    2  SNO3          0.5  QUAN    UNO3          0.5  QUAN
UVNAME  NH455    2  SAMAD          0.5  QUAN    UAMAD          0.5  QUAN
```

*** Action Lines ***

```
<****><f><-l>dcdts<yr><m><d><h><n>dstp  <vari><1><2><3><a><-value-->  tc  ts
```

IF (prec < 0.05) THEN

```
PERLND  1    DY  11976  2  15          3  NH455          2    10.50
PERLND  1    DY  11976  6  15          4  3  NO355          2    12.21
PERLND  1    DY  11976  4  13          3  DETS          1    3.0
```

END IF

END SPEC-ACTIONS



TIMESERIES LINKAGE BLOCK OVERVIEW (EXT SOURCES, EXT TARGETS, NETWORK, MASS-LINK, SCHEMATIC)

Used to specify:

- how data are input and output to WDM and other databases
- physical connections of land segments and reaches
- transfer of data to and from utility modules

Each connection includes:

- a source } such as a WDM dataset or an operation input or
- a target } output timeseries
- any transformation in units or change in time step

Block Names and Functions:

EXT SOURCES	Database to Operation
EXT TARGETS	Operation to Database
NETWORK	
SCHEMATIC	Operation to Operation
MASS-LINK	

TIME SERIES LINKAGES

- All HSPF operations involve input and output time series
- A watershed is defined by linking PERLND, IMPLND, & RCHRES operations with time series connections
- User is responsible for ensuring operations receive required “input” time series
- User can print/display/output any “output” time series
- Three types of time series connections
 1. from external files to operations (EXT SOURCES block)
 2. between operations (NETWORK block and/or SCHEMATIC and MASS-LINK blocks)
 3. from operations to external files (EXT TARGETS block)
- A list of input and output time series for each operation is provided in the Time Series Catalog (User’s Manual)

TIME SERIES BLOCKS

GENERAL FORMAT

<SOURCE> <M-FACTOR> <TRANSFORMATION> <TARGET>

Source or target

Operation time series

- operation name
- group name
- member name & subscripts

External time series

- file type (WDM, DSS, SEQ)
- id #
- name

M-factor

Multiplication factor for units or time conversion; default = 1.0

Transformation

Function based on time step and "kind" relationship between source and target

- AVER, SAME, SUM, DIV, INTP, LAST, MAX, MIN

EXAMPLE EXT SOURCES AND EXT TARGETS BLOCKS

EXT SOURCES BLOCK

- specify transfers from external files to operations

EXT SOURCES

```
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->***  
<Name> # <Name> # tem strg<-factor->strg <Name> # # <Name> # #***  
*** Meteorological input data  
WDM 106 HPCP PERLND 4 5 EXTNL PREC  
WDM 111 EVAP 0.8 PERLND 4 5 EXTNL PETINP  
WDM 106 HPCP IMPLND 1 EXTNL PREC  
WDM 111 EVAP 0.8 IMPLND 1 EXTNL PETINP  
END EXT SOURCES
```

EXT TARGETS BLOCK

- specify transfers from operations to external files

EXT TARGETS

```
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Aggr Amd***  
<Name> # <Name> # #<-factor->strg <Name> # <Name>qf tem strg strg***  
*** Output Results to Wdm and DSS files  
PERLND 5 PWATER PERO SUM WDM 29 FLOW ENGL AGGR REPL  
RCHRES 30 HYDR RO AVER DSS 881 ENGL REPL  
END EXT TARGETS
```

EXAMPLE SCHEMATIC AND MASS-LINK BLOCKS

Specify transfers between operations (watershed linkages):
 Area terms, unit conversions, sand-silt-clay fractions

SCHEMATIC

```

<-Source->                <--Area-->    <-Target->    <ML>    ***
<Name>    #                <-factor-->    <Name>    #    #    ***
PERLND    4                849.                RCHRES    30    1
PERLND    5                2611.               RCHRES    30    1
PERLND    4                234.                RCHRES    31    1
PERLND    5                1818.               RCHRES    31    1
END SCHEMATIC
  
```

MASS-LINK

```

MASS-LINK                1
<Srce>    <-Grp> <-Member-><--Mult-->    <Targ>    <-Grp> <-Member-> ***
<Name>    <Name> <Name> # #<-factor-->    <Name>    <Name> <Name> # # ***
PERLND    PWATER PERO                0.08333    RCHRES    INFLOW IVOL
PERLND    SEDMNT SOSED    1                0.05    RCHRES    INFLOW ISED    1
PERLND    SEDMNT SOSED    1                0.55    RCHRES    INFLOW ISED    2
PERLND    SEDMNT SOSED    1                0.4     RCHRES    INFLOW ISED    3
END MASS-LINK            1
END MASS-LINK
  
```

EXAMPLE SCHEMATIC AND MASS-LINK BLOCKS - 2

Specify transfers between operations (watershed linkages):

Area terms, unit conversions, labile and refractory organics

SCHEMATIC

```

<-Source->                <--Area-->    <-Target->    <ML>    ***
<Name>    #                <-factor-->    <Name>    #    #    ***
PERLND    4                849.                RCHRES    30    1
PERLND    5                2611.               RCHRES    30    1
PERLND    4                234.                RCHRES    31    1
PERLND    5                1818.               RCHRES    31    1
END SCHEMATIC

```

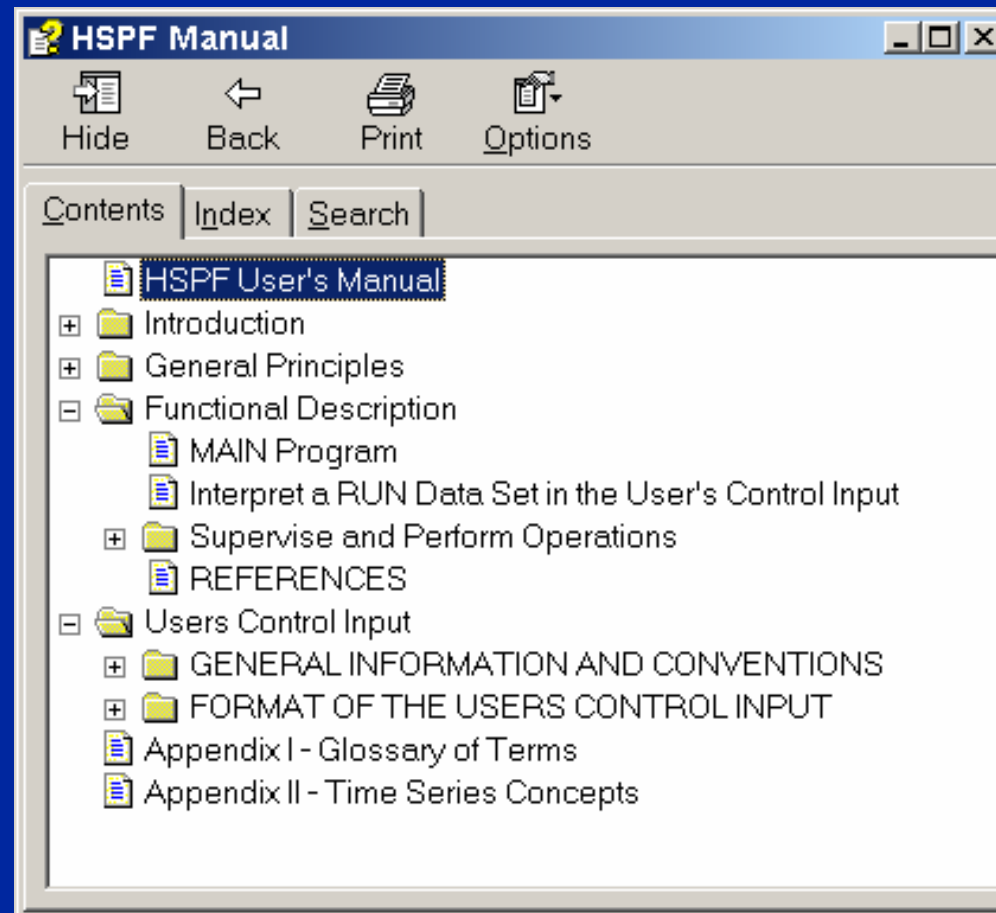
MASS-LINK

```

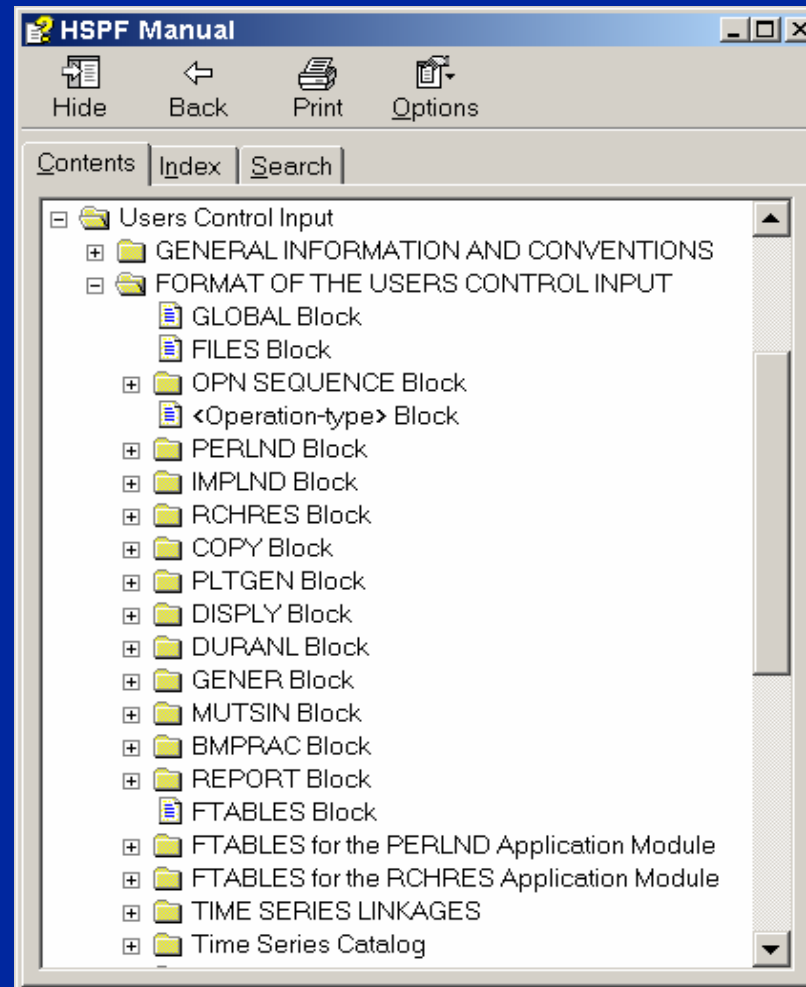
MASS-LINK                1
<Srce>    <-Grp> <-Member-><--Mult-->    <Targ>    <-Grp> <-Member->    ***
<Name>    <Name> <Name> # #<-factor-->    <Name>    <Name> <Name> # #    ***
PERLND    PWATER PERO                0.08333    RCHRES    INFLOW IVOL
PERLND    PQUAL  POQUAL 4                0.4        RCHRES    INFLOW OXIF 2
PERLND    PQUAL  POQUAL 4                0.048     RCHRES    INFLOW PKIF 3
PERLND    PQUAL  POQUAL 4                0.0023    RCHRES    INFLOW PKIF 4
END MASS-LINK                1
END MASS-LINK

```

USERS MANUAL OVERVIEW



USERS MANUAL: FORMAT FOR THE USERS CONTROL INPUT



EXAMPLE TIME SERIES CATALOG

HSPF Manual

Hide Back Print Options

Group SEDMNT

<---- Member ---->		K	Units		Description/comment
Name	Max subscr values	i	(external)		
	1 2	d	Engl	Metr	

Time series computed by module section SEDMNT:

Land-segment-wide values:

Parameter	1	2	*	Units	Units	Description
DETS	1	1	*	tons/ac	tonnes/ha	Storage of detached sediment
STCAP	1	1	*	tons/ ac.ivld	tonnes/ ha.ivld	Sediment transport capacity by surface runoff
COVER	1	1	*	none	none	Cover fraction
WSSD	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Washoff of detached sediment
SCRSD	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Scour of matrix (attached) soil
SOSED	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Total removal of soil and sediment
DET	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Quantity of sediment detached from soil matrix by rainfall impact
NVSI	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Net vertical sediment input

Input time series required to compute the above:

Group	Members	Requirement
Group EXTNL	PREC SLSSED	always required optional
Group SNOW	RAINF SNOCOV	only required if section SNOW is inactive and snow is considered (CSNOFG= 1)
Group PWATER	SURO SURS	only required if section PWATER is inactive

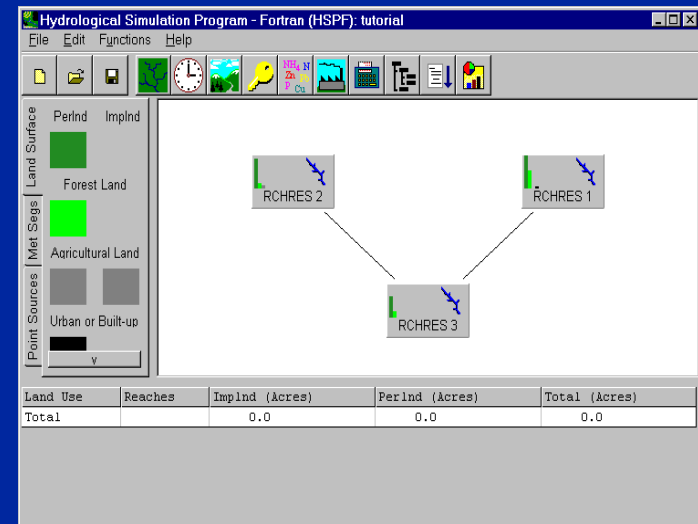
WINHSPF: FROM CARD-ORIENTED TO OBJECT-ORIENTED

- UCI File converted to UCI Object for user interaction
- UCI Object converted to card images for saving and running simulations

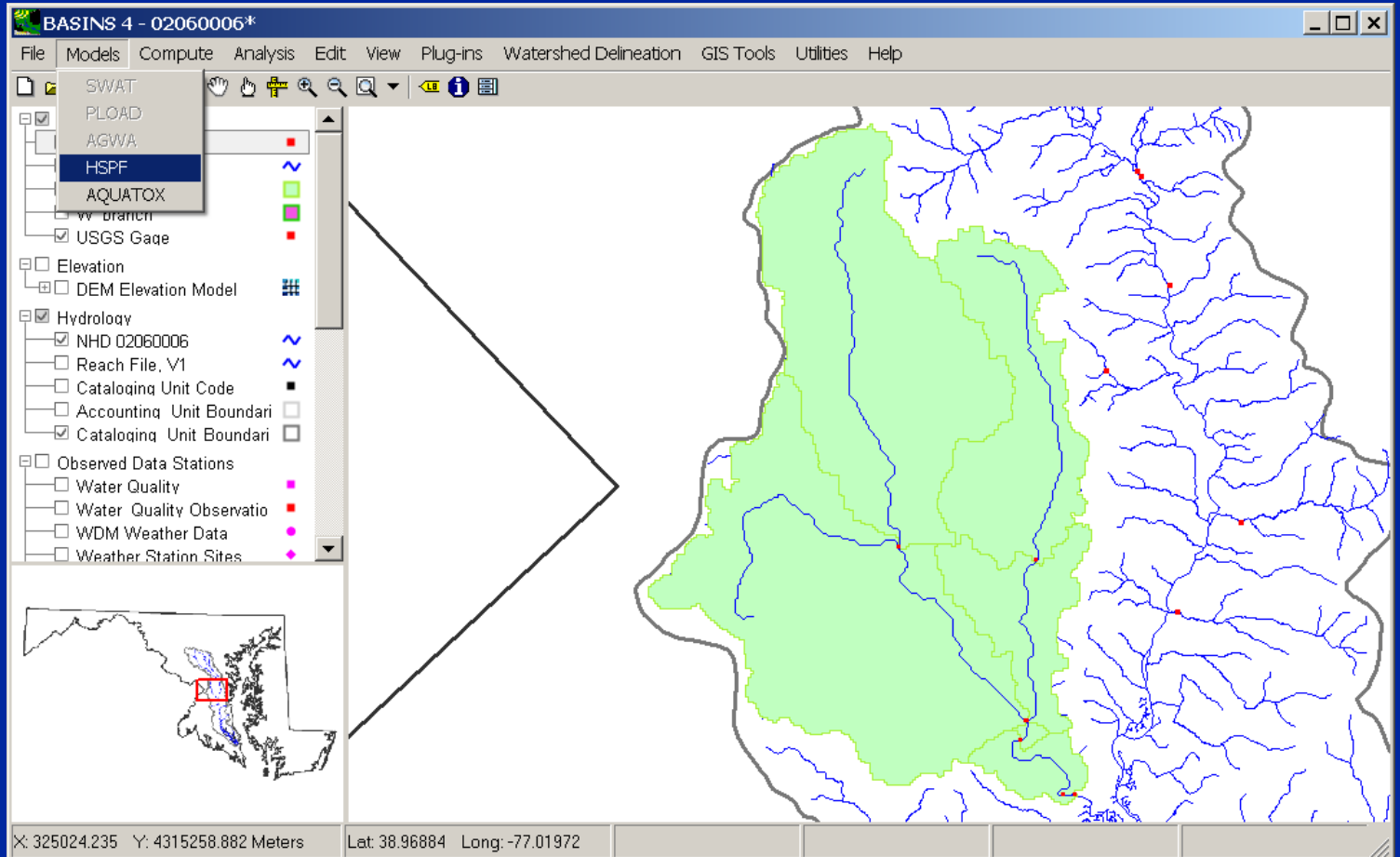
```
RUN
GLOBAL
UCI Created by WinHSPF for tutorial
START      1990/01/01 00:00  END    1995/12/31 24:00
RUN INTERP  OUTPT LEVELS    1    0
RESUME     0 RUN            1          UNITS    1
END GLOBAL

FILES
<FILE> <UN#>***<----FILE NAME----->
MESSU   24  tutorial.ech
        91  tutorial.out
WDM1    25  proj.wdm
WDM2    26  ..\..\data\met_data\tutorial.wdm
END FILES

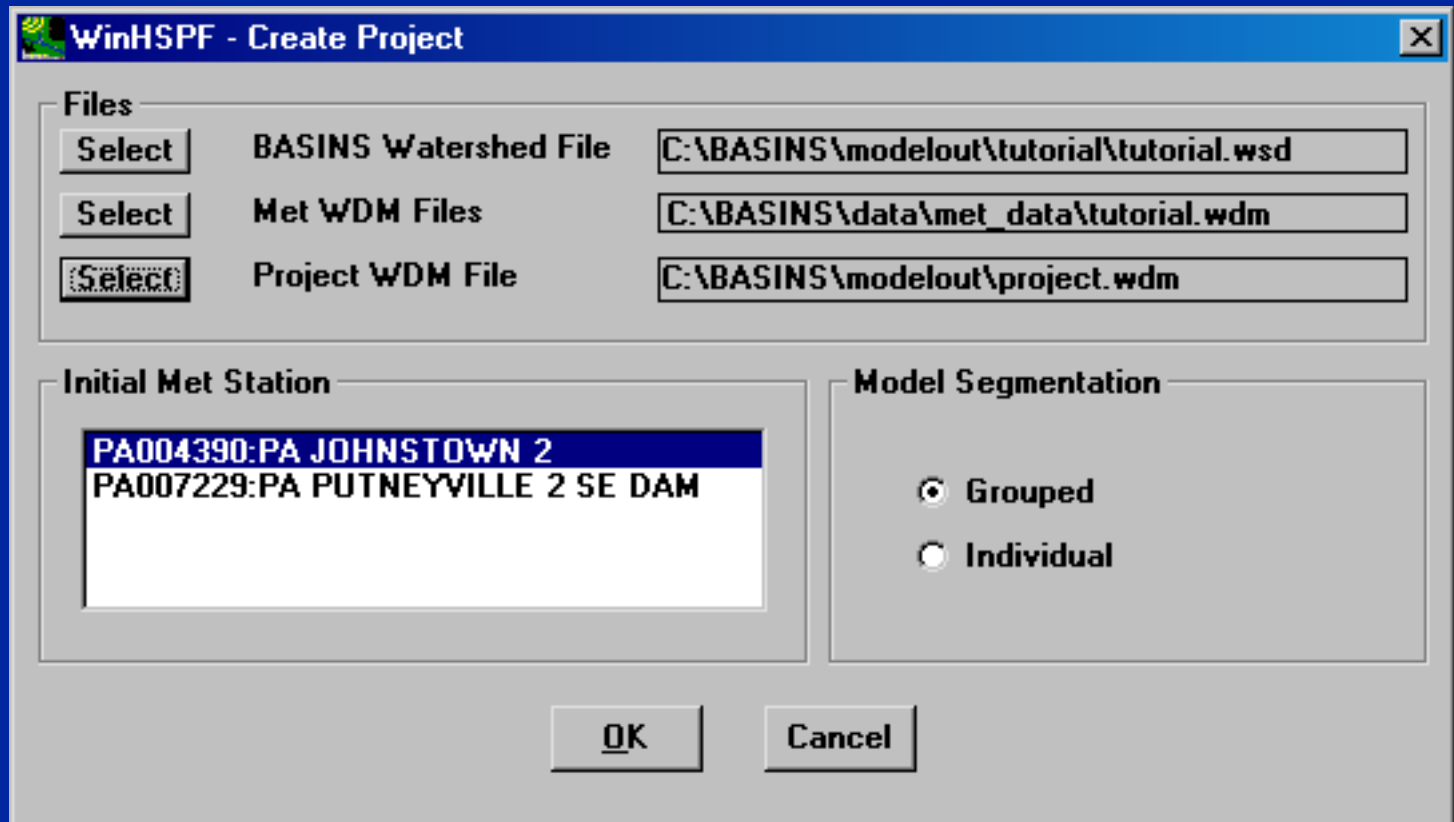
OPN SEQUENCE
INGRP           INDELT 01:00
PERLND         101
PERLND         102
PERLND         103
PERLND         104
PERLND         105
PERLND         106
IMPLND         101
RCHRES         1
RCHRES         2
END INGRP
```



FROM BASINS



CREATE PROJECT



The image shows a screenshot of the 'WinHSPF - Create Project' dialog box. The dialog has a title bar with a close button. It is divided into several sections:

- Files:** This section contains three rows, each with a 'Select' button, a label, and a text box containing a file path.
 - Label: 'BASINS Watershed File', Path: 'C:\BASINS\modelout\tutorial\tutorial.wsd'
 - Label: 'Met WDM Files', Path: 'C:\BASINS\data\met_data\tutorial.wdm'
 - Label: 'Project WDM File', Path: 'C:\BASINS\modelout\project.wdm'
- Initial Met Station:** A list box containing two entries: 'PA004390:PA JOHNSTOWN 2' (which is highlighted) and 'PA007229:PA PUTNEYVILLE 2 SE DAM'.
- Model Segmentation:** A section with two radio button options: 'Grouped' (which is selected) and 'Individual'.
- Buttons:** 'OK' and 'Cancel' buttons are located at the bottom center of the dialog.

MAIN WINDOW

Hydrological Simulation Program - Fortran (HSPF): tutorial

File Edit Functions Help

Land Surface: PerLnd Implnd, Forest Land

Met Segs: Agricultural Land

Point Sources: Urban or Built-up

RCHRES 2, RCHRES 1, RCHRES 3

Land Use	Reaches	Implnd (Acres)	PerLnd (Acres)	Total (Acres)
Total		0.0	0.0	0.0

OPERATION EDIT WINDOW

Edit Operation: RCHRES 650 - Middle R nr Grottoes

Tables Special Actions Input Timeseries Output Timeseries

Table Status (145 Possible)

3 required tables present.	3 optional tables present.	No required tables missing.	139 optional tables missing.
ACTIVITY GEN-INFO HYDR-PARM2	PRINT-INFO HYDR-PARM1 HYDR-INIT		MON-CONVF HYDR-IRRIG HYDR-CATEGORY HYDR-CINIT HYDR-CPREC HYDR-CEVAP HYDR-CFVOL

Active Sections

HYDR AD CONS HT SED GQAL OX NUT PLK PH

OK **Cancel** **Help** **Add** **Remove** **Edit**

MET DATA MANAGER

WinHSPF - Add Met Segment

Name: PA007229:PA PUTNEYVILLE 2 SE DAM

Constituent	WDM ID	TSTYPE	DSN	Mfact P/I	Mfact R
Precip	WDM2	PREC	31	1	1
Air Temp	WDM2	ATEM	33	1	1
Dew Point	WDM2	DEWP	37	1	1
Wind	WDM2	WIND	34	1	1
Solar Rad	WDM2	SOLR	35	1	1
Cloud	WDM2	CLOU	38	0	1
Evapotrans	WDM2	PEVT	36	1	0
Pot Evap	WDM2	EVAP	32	0	1

OK Cancel

POINT SOURCE MANAGER

WinHSPF - Point Sources

Available:

- SPECIALTY (OBS)
- GPU GENCO (OBS)
- FACTORY (OBS)**

In Use:

Buttons: Add ->, <- Remove, Add All ->>, <<- Remove All

Show Details

Buttons: Add New, Create Scenario

Details of FACTORY (OBS)

In Use	Reach	Pollutant	Target Member	MemSub1	MemSub2
No	RCHRES 1 - STREAM 1	FECAL CO	IVOL	0	0
No	RCHRES 1 - STREAM 1	FLOW	IVOL	0	0
No	RCHRES 1 - STREAM 1	SOLIDS	IVOL	0	0
No	RCHRES 1 - STREAM 1	CHLORINE	IVOL	0	0
No	RCHRES 1 - STREAM 1	BOD, CAR	IVOL	0	0

Buttons: OK, Cancel

OUTPUT MANAGER

WinHSPF - Output Manager

Output Type

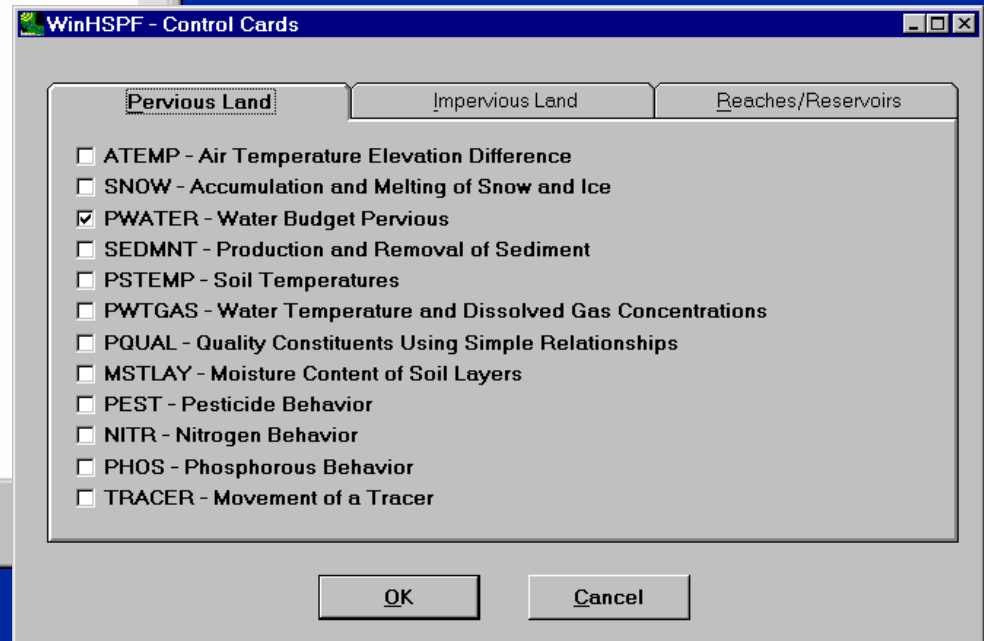
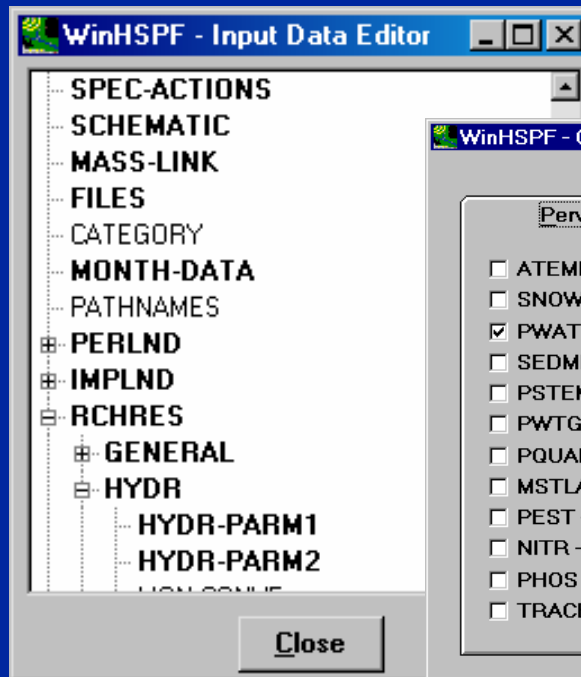
Hydrology Calibration AQUATOX Linkage
 Flow Other

Output will be generated at each 'Other' output location for the specified constituents.


Output Locations:

Name	Description	Group/Member
RCHRES 3	STREAM 3	HYDR:STAGE

INPUT DATA EDITOR



BASIC TABLE EDITING

 Edit PERLND:PWAT-PARM2

Show Description

OpNum	Description	FOREST	LZSN	INFILT	LSUR	SLSUR	KVARY	AGWRC
191	FOREST	0	8	0.06	200	0.22	0	0.995
192	HIGH TILL CROPLAND	0	8	0.06	300	0.07	0	0.995
193	LOW TILL CROPLAND	0	8	0.06	300	0.07	0	0.995
194	PASTURE	0	8	0.05	270	0.11	0	0.995
195	URBAN	0	8	0.05	300	0.07	0	0.995
196	HAY	0	8	0.05	270	0.11	0	0.995

PWAT-PARM2:AGWRC:
AGWRC is the basic groundwater recession rate if KVARY is zero and there is no inflow to groundwater (rate of flow today/rate yesterday).

POLLUTANT SELECTION

WinHSPF - Pollutant Selection

Available:

- F.COLIFORM
- NH3
- NO2 NO3
- ORTHO P
- BOD
- METALS
- SEDIMENT

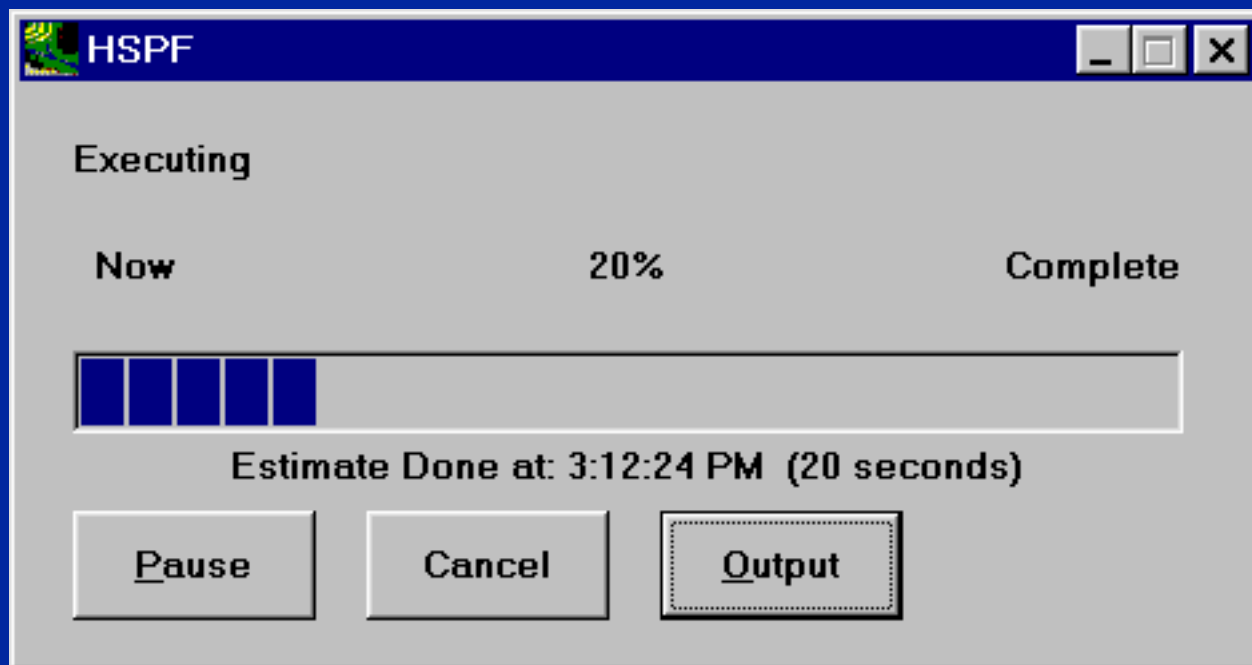
Add ->

<- Remove

Selected:

OK Cancel

RUN HSPF



DIRECT TO GENSCN

GenScn: Shena

File Analysis Map Locations Scenarios Constituents Time Series Help

Map

3 of 27 All None

Legend

Location ID	Reach	Name
LYNNWOOD	02070005003	S F SHENANDOAH RIVER
BURKETOW	02070005005	NORTH RIVER NEAR BUR
GROTTOES	02070005012	MIDDLE RIVER NEAR GR
HARRISTO	02070005007	SOUTH RIVER AT HARRI
VERONA	02070005014	MIDDLE RIVER NEAR VE
CHRISTIA	02070005024	CHRISTIANS CREEK NEA
SEG190	888	Seg 190

Scenarios

1 of 3 All None

All Location

BASE
OBSERVED
PROFILE

Activate Delete New

Constituents

1 of 15 All None

All Location

AGWD
ATMP
DEWP
EVAP
FLOW
IFWD
LZSX
PETX
PREC
RADH

Time Series

0 of 55

Type	Ind	DSN	Scenario	Location
------	-----	-----	----------	----------

Dates

No Dates are available until Timeseries are Selected

Analysis