WWHM3 DESCRIPTION OF HSPF HIGH GROUNDWATER PARAMETERS

The high groundwater/wetland element in the WWHM3 is experimental and the user should use this element with caution. The user should use the default parameter values unless instructed to do otherwise. Please consult with Foroozan Labib, Environmental Engineer, Department of Ecology, Water Quality Program, (360) 407-6439, flab461@ecy.wa.gov, before changing any of the default values.

Note that the following description of the high groundwater parameters is directly from the HSPF User Manual.

4.2(1).3.8 Simulate Water Budget for a Pervious Land Segment in High Water Table/Low Gradient Areas

Soil Moisture Concepts

To represent the high water table/low gradient environment, it is necessary to keep track of the groundwater levels (saturated zone elevation) and to model the interaction between the saturated zone and the unsaturated zone. The interaction between the saturated and unsaturated zones corresponds to transfers between the groundwater storage and the other storages. Determining when and how the rising groundwater starts affecting the other storages requires being more specific about the location and capacity of the storages.

The porosity of a soil is the volume of pore space as a fraction, or a percentage, of the total soil volume. Porosity varies, with typical values for sand of about 40%, and higher values for silts and clays.

Water is stored in soil as adhesion water, cohesion water, and gravitational water. Adhesion water is electrically bonded to soil particles and is immobile except at very high temperatures (in drying ovens). Cohesion water is bonded in soil by capillary forces and weaker electrical forces. Cohesion water is roughly equal to the "available water", the difference between the wilting point and field capacity. Gravitational water will drain from soils in the unsaturated zone unless drainage is inhibited. Gravitational water can be defined to be present in macropores (cohesion water is present in micropores).

For modeling purposes the total porosity is divided into porosity in micropores (PCW, cohesion water), and porosity in macropores (PGW, gravitational water). The upper layer of the soil may be disturbed and have a larger porosity in macropores (UPGW). The porosity of micropores is assumed to be the same throughout the soil column. In PWATER, cohesion water is stored in the lower zone storage, while gravitational water is stored in the upper zone and interflow storages.

Figure 4.2(1).3-7 defines these concepts. In Figure 4.2(1).3-7, Pcw is the porosity of cohesion water and Pgw is the porosity of gravity water.

The "groundwater level" is the elevation of the saturated zone above an arbitrary datum such as mean sea level. The active groundwater storage is gravity water stored above the minimum channel or canal elevation that is within or adjacent to the land.

An "influence depth" is also shown in Figure 4.2(1).3-7. The influence depth is the maximum depth where soil moisture varies seasonally due to evapotranspiration. Soil moisture within the influence depth could be defined as "hydrologically active".

Model Overview

Figure 4.2(1).3-8 is the main definition sketch for the model to simulate the high water table hydrology. It locates the PWATER storages in the conceptual representation of the soil introduced in Figure 4.2(1).3-7. It also summarizes

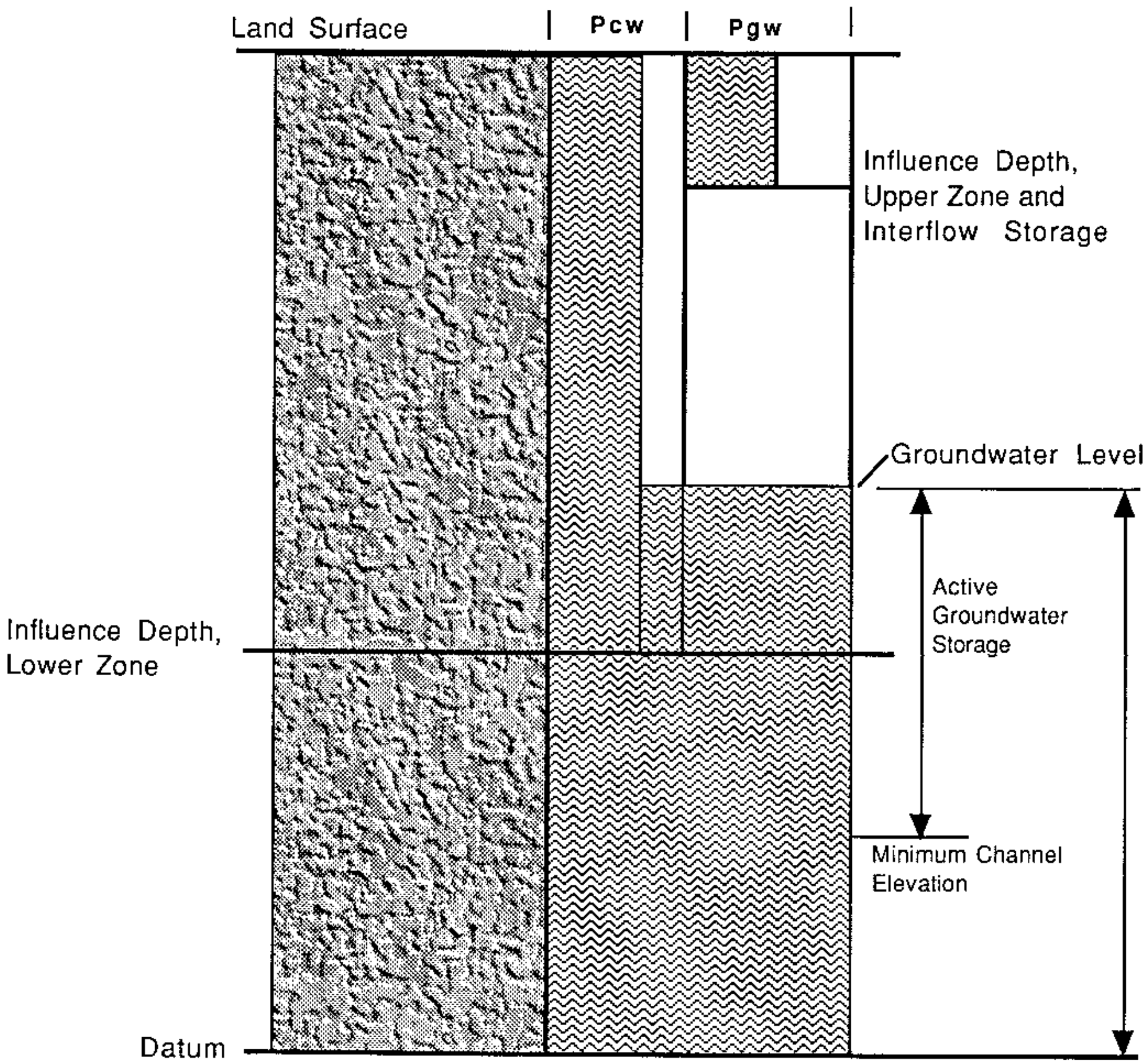
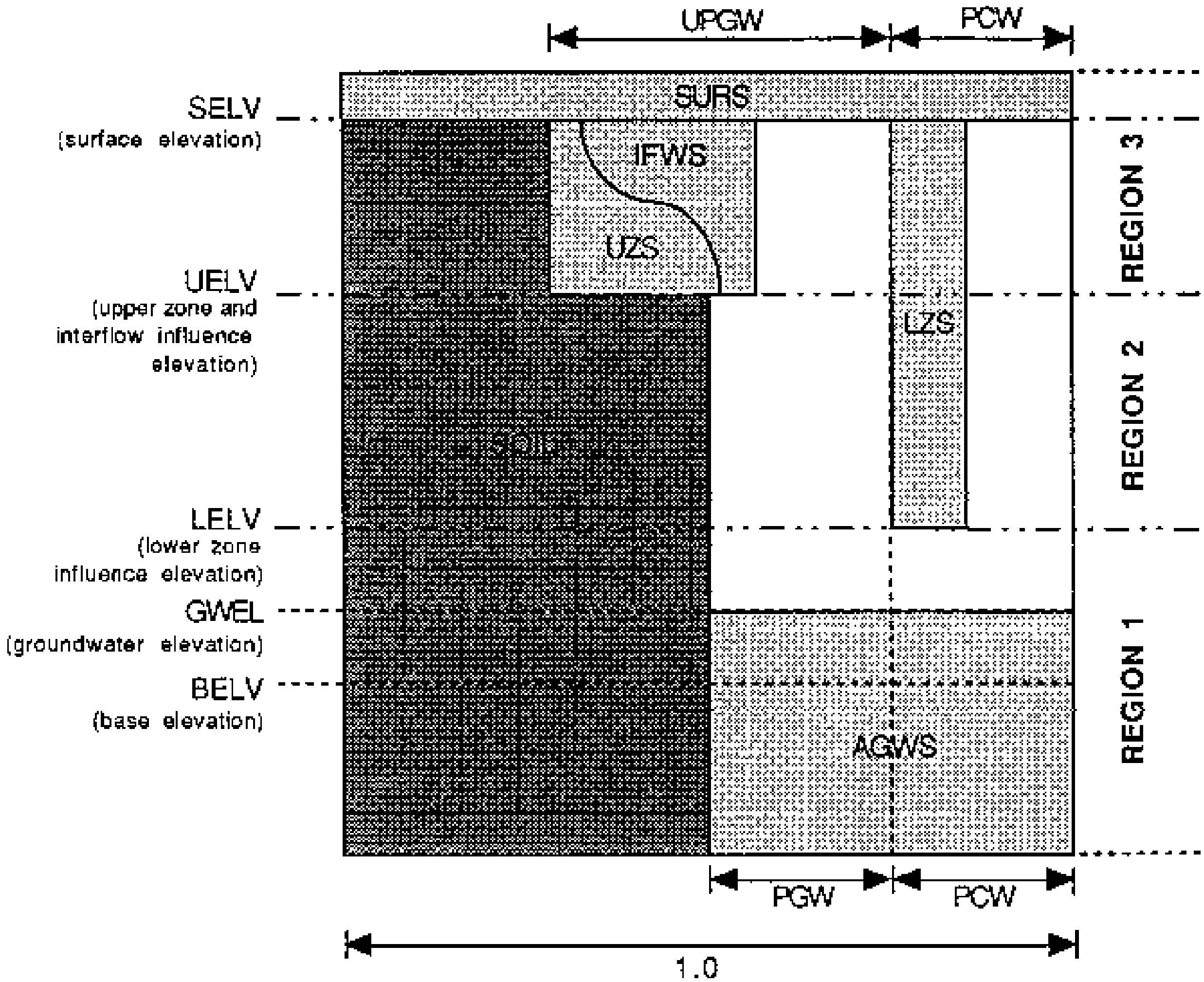


Figure 4.2(1).3-7 Sketch of soil moisture in the unsaturated zone under high water table conditions



Available Pore Space

REGION 3: $\left(1 - \frac{LZS}{2\ LZSN}\right) PCW + \left(1 - \frac{UZS + IFWS}{3\ UZSN + IFWSC}\right) UPGW$

REGION 2: $\left(1 - \frac{LZS}{2\ LZSN}\right) PCW + PGW$

REGION 1: $PCW + PGW$

Figure 4.2(1).3-8 Soil moisture storage concepts under high water table conditions some of the variables and constants used in the model. As shown in Figure 4.2(1).3-8, the soil column is divided into three soil regions according to two influence elevation lines: the lower and upper influence elevations.

When the groundwater elevation is below the lower influence elevation, (Region 1 in Figure 4.2(1).3-8), there is no interaction between the saturated and the unsaturated zones. The algorithms operate in essentially the same way as the standard PWATER. Groundwater elevation in this region is a function of the groundwater storage and the total porosity (macropores and micropores).

When the groundwater elevation reaches the lower influence elevation, (region 2), the groundwater storage starts interacting with the lower zone storage. Rising groundwater that occupies micropores is reassigned to the lower zone, according to the saturation level of the lower zone. Groundwater in this region is assumed to occupy macropores and it is subject to evapotranspiration. As the groundwater rises in this region it may start interacting with, and "drowning" the interflow storage, if this storage is large enough. Groundwater elevation in this region is a function of groundwater storage and the porosity in macropores.

When the groundwater elevation reaches the upper influence level, (region 3), the groundwater affects upper zone behavior. Interflow storage is not "drowned" anymore in this region, but it is limited to a maximum capacity. Groundwater storage shares macropores with the interflow storage and the upper zone storage. Changes in groundwater storage that are not reassigned to the lower zone storage, are distributed between upper zone, interflow and groundwater storage, according to their relative saturation levels. Groundwater elevation in this region is a function of interflow, upper zone and groundwater storages.

When the groundwater level reaches the surface, any additional water is assigned to surface detention storage and the surface detention storage represents the depth of inundation over the land segment. Evaporation from the surface storage takes place at the potential rate, after interception storage has been exhausted. Surface runoff is only a function of surface detention storage.

Detailed Definition of Influence Levels and Storages

In each time step the behavior of the various storages and the interactions between them depend on the current elevation of the groundwater (the current "region" in Figure 4.2(1).3-8). This section explains the way in which the model determines the influence levels and associated groundwater storages that define the soil regions. It also describes how groundwater elevation is calculated in the various regions.

The three soil regions in the soil column are determined by the lower influence elevation (LELV) and the upper influence elevation (UELV).

The lower influence elevation is the elevation above which the groundwater affects lower zone behavior and, depending on the current interflow storage, it may also affect interflow behavior. The lower influence elevation is defined in terms of the lower zone nominal storage as:

$$LELV = SELV - (2.5*LZSN)/PCW \qquad (27)$$

where:

LELV = lower zone influence level (in)
SELV = mean surface elevation (in)
LZSN = lower zone nominal storage (in)
PCW = porosity in micropores (-)
2.5 = factor derived from PWATER equations; this factor is implemented as a model parameter (LELFAC) to allow users to investigate its sensitivity

The total groundwater storage associated with a groundwater elevation equal to LELV is:

$$LLGWS = LELV*(PCW + PGW) \qquad (28)$$

where:

LLGWS = total groundwater storage below LELV (in)
PCW = porosity in micropores (-)
PGW = porosity in macropores (-)

Below LELV (Region 1 in Figure 4.2(1).3-8) there are no interactions between the saturated and the unsaturated zones. The rising groundwater occupies the total porosity (macropores and micropores). Groundwater elevation in this region is calculated as:

$$GWEL = TGWS/(PCW + PGW) \quad (29)$$

where:

GWEL = groundwater elevation (in)
TGWS = total groundwater storage (in)

Above LELV (Region 2), the lower zone storage represents water stored in micropores. Consequently, the portion of the rising water table that occupies the micropores is reassigned to the lower zone storage. The groundwater storage is assumed to occupy the macropores. Groundwater elevation in this region is calculated as:

$$GWEL = LELV + (TGWS - LLGWS)/PGW \quad (30)$$

Interflow storage also occupies macropores. Interflow storage increases from the surface down. If it is below the upper influence level, it will share macropores with the groundwater. The model assumes that in this region the interflow path is drowned by the rising groundwater; if the rising groundwater storage reaches the interflow storage, the excess interflow storage is transferred to groundwater storage.

The upper influence elevation is the elevation above which the groundwater affects upper zone behavior. In this region (region 3 in Figure 4.2(1).3-8), upper zone and interflow share the macropores with the groundwater storage. In the conceptual model upper zone storage is the portion of the water stored in macropores which will not reach the channels, but will percolate, evaporate or transpire; interflow storage is the portion of the water stored in macropores which will flow to the channels through a subsurface flow path. The groundwater storage that enters this region will flow to the channels as base flow, or transpire, if the potential evapotranspiration has not been met by the upper zone.

Groundwater that occupies micropores is reassigned to lower zone storage, as in the previous region. The remaining changes in groundwater storage are reassigned between interflow storage, upper zone storage and groundwater storage. In this region, the interflow path is not assumed to be drowned by the rising groundwater. However the interflow storage is limited to a maximum, given by a new parameter, the interflow storage capacity, IFWSC. This capacity represents the portion of macropores that will continue to produce interflow into the channels when the saturated zone reaches the surface.

The upper influence elevation is defined in terms of the upper zone nominal storage and the interflow storage capacity:

$$UELV = SELV - (4.0*UZSN + IFWSC)/UPGW \quad (31)$$

where:

UELV = upper zone and interflow influence level (in)
SELV = mean surface elevation (in)
UZSN = upper zone nominal storage (in).
IFWSC = interflow storage capacity (in)
UPGW = porosity in macropores in upper soil layer (-)
4.0 = factor derived from PWATER equations; this factor is implemented as a model parameter (UELFAC) to allow users to investigate its sensitivity

The total groundwater storage corresponding to a groundwater elevation of UELV is:

$$ULGWS = LLGWS + (UELV - LELV)*PGW \quad (32)$$

where:

ULGWS = total groundwater storage below upper influence level (in)
LLGWS = total groundwater storage below lower influence level (in)
PGW = porosity in macropores (-)

The saturation level of macropores in the upper portion of the soil is a function of the upper zone storage, the interflow storages and the groundwater storage above UELV. Therefore, groundwater elevation in this region is calculated as:

$$GWEL = UELV + (UZS + IFWS + (TGWS - ULGWS))/UPGW \quad (33)$$

where:

UPGW = porosity in macropores in the upper soil region (-)

It is important to notice that, even though the calculation of the groundwater elevation above the lower influence level is based only on water stored in macropores, the water that occupies the micropores as the water table rises is being accounted for through the transfers to lower zone storage.

When the groundwater elevation reaches the surface, any additions to groundwater storage are transferred to surface detention storage, and the depth of water over the surface is given by the surface detention storage.

Groundwater transfers to the lower zone, interflow and upper zone are based on the available pore space in each region as defined in Figure 4.2(1).3-8.

Operation of the Algorithms

The hydrologic processes are modeled in essentially the same order as in PWATER. After the groundwater is simulated, the algorithms compare the current groundwater storage with the value at the beginning of the time interval. Changes in total groundwater storage are a consequence of percolation, evapotranspiration and outflow. Depending on the current value of the total groundwater storage and the current elevation of the water table, the calculated change in total groundwater storage is re-distributed between the various storages affected by the saturated zone. The storages are updated accordingly and the final groundwater storage (after the re-distribution has taken place) is used to determine the new groundwater elevation.

The following sections describe the way in which the model represents the processes in each soil region.

Region 1: Groundwater Elevation Below Lower Zone Influence Level

When the groundwater elevation is below the lower influence elevation, there is no interaction between the saturated and the unsaturated zones.

The PWATER algorithms operate in essentially the same way as before, with two exceptions:

- surface storage and surface runoff calculations; and
- active groundwater outflow calculation.

Surface Runoff and Surface Storage

The standard overland flow algorithms may not be appropriate to represent surface runoff in flat areas, even when the groundwater is well below the surface. The hydraulics of surface flows is complex and is not solely a function of local gradient and roughness. Additionally, water may pond on the surface and be subject to evaporation. Ideas on how to calculate surface runoff and surface storage are discussed later.

Active Groundwater Outflow

The groundwater in these areas is not "perched" groundwater as assumed in the standard PWATER algorithms. If the groundwater elevation is high enough, a portion of the groundwater storage may be "active", i.e. it may provide base flow to nearby channels; the rest is "deep" or "inactive" groundwater. However, it is necessary to account for the entire storage, to calculate the groundwater elevation in each time step.

The algorithms that simulate groundwater storage are modified to represent deep (inactive) groundwater, as well as perched (active) groundwater (groundwater that contributes to base flow). This was done by introducing a new parameter, BELV (active groundwater base elevation parameter). Theoretically, this parameter represents the water elevation in the surrounding channels. However, since water level in channels is a variable that cannot be calculated within PWATER, BELV is approximated by the bottom elevation or the mean water level in the channels.

The total groundwater storage below that base elevation is:

$$BGWS = BELV/(PCW + PGW) \tag{34}$$

where:

BGWS = groundwater storage below which there is no groundwater outflow (in)

When the groundwater elevation is below BELV, there is no outflow from the groundwater storage (AGWO = 0). When the groundwater elevation is above BELV, the groundwater outflow is a function of the active groundwater storage, i.e., the storage above the base level (AGWS=TGWS-BGWS).

Region 2: Groundwater Elevation Between Lower Influence Level and Upper Influence Level.

In this region there are interactions between the saturated and the unsaturated zone, but the upper part of the soil column has not been affected. The upper zone operates as usual. Interflow operates as usual as long as the interflow storage remains above the groundwater elevation. The groundwater starts invading the lower zone and changes in groundwater storage affect lower zone storage. Also, groundwater above the lower zone influence level is subject to evapotranspiration.

Changes in Lower Zone Storage due to Changes in Groundwater Storage

Consider the situation when the water table is rising. In this region, part of the micropore porosity is already occupied by water stored in the lower zone. Since the lower zone represents the micropores in this region, the portion of rising groundwater that enters the micropores is actually increasing the lower zone storage. The groundwater storage is assumed to occupy the macropores. Therefore the algorithms re-distribute the original increase in groundwater storage between AGWS and LZS according to the level of saturation of the lower zone:

$$DLZS = DAGWS*((1 - LZS/(2.5*LZSN))*PCW \tag{35}$$

where:

DLZS = increase in lower zone storage (in)
DAGWS = original increase in active groundwater storage (in)

The increase in AGWS (and TGWS) calculated initially is reduced by DLZS:

$$DAGWS = DAGWS - DLZS \tag{36}$$

DLZS represents the added storage in micropores above the lower zone influence level and below the current groundwater elevation. However, when it is added to LZS, it is distributed throughout the entire depth of the lower zone, increasing its saturation uniformly. This is a necessary approximation, in order to avoid subdividing LZS into several storages as a function of depth below the surface.

This redistribution does not occur when the groundwater table is receding (when DAGWS < 0), because water in micropores will not percolate by gravity. Water that entered the lower zone when the groundwater elevation was rising can only leave as evapotranspiration.

Changes in Interflow due to Changes in Groundwater Storage

Interflow storage increases from the surface down. The interflow storage capacity, IFWSC, represents the maximum space available for interflow in the upper layer of the soil. Increases in interflow storage beyond IFWSC are assumed to occupy macropores in region 2 (between the lower and the upper influence levels). There is only a limited volume in macropores in Region 2:

$$\text{Volume of macropores in Region 2} = (UELV - LELV)*PGW = ULGWS - LLGWS \qquad (37)$$

where:

LLGWS = total groundwater storage below LELV (in)
ULGWS = total groundwater storage below UELV (in)

When the groundwater storage above LELV plus the interflow storage below UELV exceed the macropore space in region 2, water is transferred from interflow storage to groundwater storage:

$$\text{IF } (IFWS - IFWSC) + (TGWS - LLGWS) > ULGWS - LLGWS \text{ THEN} \qquad (38)$$

$$DIFWS = (IFWS - IFWSC) + (TGWS - LLGWS) - (ULGWS - LLGWS)$$
$$IFWS = IFWS - DIFWS$$
$$TGWS = TGWS + DIFWS$$

where:

DIFWS = Transfer from interflow storage to groundwater storage (in)

The model assumes that in this region the interflow path is drowned by the rising groundwater.

Evapotranspiration

Gravitational water above the lower zone influence level is subject to evapotranspiration. In fact, water in macropores will be used up faster than water in micropores. To represent this effect, the way in which PWATER calculates actual evapotranspiration has to be modified.

In the standard PWATER algorithms, evapotranspiration from the groundwater storage occurs only if the parameter AGWETP is greater than zero. AGWETP represents the fraction of remaining potential evapotranspiration that can be sought from groundwater. The algorithms try to satisfy remaining PET from the groundwater storage before using the lower zone storage. This scheme may be valid if the water table is below the lower influence level. However, if the water table is above the lower influence level, additional evapotranspiration from water in macropores should occur. In this model, the algorithms that calculate actual evapotranspiration are modified as follows:

If the groundwater level is below the lower influence level the algorithms operate as before (with the possible addition of surface detention storage evaporation, as discussed later). However, given that the TGWS also represents deep groundwater, a value of AGWETP greater than zero may not be appropriate.

If the groundwater level is above the lower influence level, evapotranspiration from the groundwater storage is still a function of the AGWETP parameter. However, the fraction of remaining potential evapotranspiration (after interception, surface detention and upper zone storages have been used) that can be sought from the total groundwater storage is also proportional to the elevation of the water table above the lower influence level. The equation is:

AGWET = REMPET*(AGWETP + ((1.0 - AGWETP)*(GWEL-LELV)/(SELV-LELV))) (39)

where:

AGWET = evapotranspiration from groundwater (in)
REMPET = remaining potential evapotranspiration (in).
AGWETP = active groundwater ET parameter (-)
GWEL = groundwater elevation (in)
SELV = surface elevation (in)

AGWET cannot exceed the groundwater storage above LELV:

AGWET = MIN(AGWET, (TGWS - LLGWS)) (40)

Any remaining potential evapotranspiration is met from the lower zone storage, as determined by the current PWATER algorithms.

Region 3: Groundwater Elevation Above Upper Influence Level and Below Surface Elevation

In this region the saturated zone affects the upper layers of the soil column. Upper zone and interflow storage share the macropores with the groundwater storage. The interflow path is not assumed to be drowned by the rising groundwater. However the interflow storage is limited to a maximum, the interflow storage capacity, IFWSC. Interflow inflow from the surface is limited accordingly, and any excess is added back to surface detention storage.

Changes in Upper Zone and Interflow Storages due to Changes in Groundwater Storage

Consider a rising water table. As before, in this region, part of the micropore porosity is occupied by water in the lower zone storage. Groundwater that enters the micropores is represented as a transfer to the lower zone storage and is calculated as described in section 3.2. The remaining change in groundwater storage is reassigned between interflow storage, upper zone storage and groundwater storage according to the relative saturation levels as follows: The total contribution to interflow and upper zone is inversely proportional to the combined saturation level of these two storages:

DUZIFS = DAGWS*(1 - (IFWS + UZS)/(4*UZSN + IFWSC)) (41)

where:

DUZIFS = combined addition to upper zone and interflow storage (in)
DAGWS = remaining change in groundwater storage after transfers to LZS (in)

DUZIFS is distributed between upper zone and interflow according to the saturation level of the upper zone and the maximum capacity of the interflow storage. In this model it is done as follows:

Determine addition to interflow storage:

DIFWS = DUZIFS*(1 - UZFRAC) (42)

where:

DIFWS = change in interflow storage (in)
UZFRAC = fraction of potential direct runoff captured by the upper zone, as calculated by the UZINF routines of PWATER

If the addition to the interflow storage is such that the interflow storage exceeds its capacity, IFWSC, then the interflow storage is limited to IFWSC, and DIFWS is reduced.

Determine change in upper zone storage:

DUZS = DUZIFS - DIFWS (43)

where:

DUZS = change in upper zone storage (in)

Notice that if the interflow storage is below its capacity, the addition to upper zone storage will be proportional to UZFRAC. However, if the interflow storage is at capacity, the addition to upper zone storage will be larger.

When the groundwater table is receding (DAGWS < 0), no water percolates from the lower zone (i.e. DLZS = 0). However, water stored in macropores can percolate down. Therefore, the redistribution of water between groundwater storage, upper zone storage and interflow storage also takes place when the water table is receding (DAGWS < 0). In that case, the distribution is proportional to the saturation levels:

$$DUZIFS = DAGWS*(IFWS + UZS)/(4*UZSN + IFWSC) \quad (44)$$
$$DIFWS = DUZIFS*(UZFRAC) \quad (45)$$

The algorithms check to make sure that the storages do not become negative.

Inflow to Interflow and Surface Detention Storage

As mentioned, when the water table is close to the surface, the interflow storage cannot grow without limit in response to inflow from the surface.

In this model, the distribution of water available for infiltration and runoff and the inflow to the upper zone are calculated as before. However, the calculated inflows to surface detention storage and interflow storage are checked and, if necessary, redistributed to limit inflow into interflow storage. If the new interflow storage exceeds its capacity, IFWSC, the interflow storage is limited to IFWSC and the interflow inflow is reduced accordingly. The reduction in interflow inflow is added back to the inflow to surface detention storage (PSUR). This requires a change in the order in which processes are simulated in PWATER: interflow has to be simulated before surface runoff, in case there are additions to PSUR.

Evapotranspiration

The existing evapotranspiration from upper zone represents water drawn from macropores in the upper levels of the soil. Therefore, no further changes to the evapotranspiration procedures are considered necessary when the groundwater level exceeds the upper influence level. Evapotranspiration from groundwater storage continues to be calculated as a function of both the parameter AGWETP and the elevation of the water table above the lower influence level, as described in the previous section.

Groundwater Elevation at the Surface.

When the water table reaches the surface, the groundwater storage interacts with the surface detention storage. In this model, the groundwater elevation cannot exceed the surface elevation. Water depths over the land surface are reflected by the depth of the surface detention storage.

Changes in Storages due to Changes in Groundwater:

The groundwater table reaches the surface when the total macropore space in the upper layer has been saturated. In terms of storages, this occurs when:

$$IFWS + UZS + (TGWS - ULGWS) = 4*UZSN + IFWSC \quad (46)$$

This condition does not guarantee that the upper zone and interflow storages will be completely full when the water table reaches the surface. Similarly, there is no guarantee that the lower zone will be completely saturated, even though transfers to the lower zone are made whenever there is an increase in groundwater storage.

While it may seem wrong to have the water table at the surface when there is still space available in some of the storages, the algorithms tend to correct the problem automatically after a few time steps. While the water table remains at the surface, more water continues to be added to the lower zone storage until it is full. The additions to LZS, are calculated as described in the previous section.

In the case of interflow, upper zone and total groundwater, their combined storage cannot change. However, the distribution changes: if UZS and IFWS were not full when the water reached the surface, water is added to these storages until both are full, and the amount of groundwater storage over UELV is decreased accordingly.

Any remaining changes are assigned to surface detention storage as follows:

After DLZS, DIFWS and DUZS have been subtracted:

$$\text{IF DAGWS} > 0 \qquad \text{DSUS} = \text{DAGWS} \tag{47}$$

where:
DSUS = change in surface detention storage (in)

This interaction with the surface detention storage does not take place when the groundwater is receding, (DAGWS < 0), because in the existing algorithms surface detention storage is already subject to infiltration.

Evaporation from Surface Detention Storage.

In high water table environments, long term surface inundation may be common, except where it is prevented by drainage works. During periods of inundation water can evaporate from the surface at the potential rate. To simulate this environment, it is necessary to allow evaporation from the surface detention storage. In this model, the surface detention storage is the second source from which PET can be met (after interception storage); water will be drawn from this source until the potential evaporation rate is met or until the storage is empty.

Evaporation from the surface detention storage is active even when the water table is well below the surface. Given the low land gradients, water can pond on the surface and remain there long enough to be subject to evaporation.

Surface Runoff Simulation

In the standard PWATER algorithms, surface runoff is dependent on the characteristics of an "overland flow plane" on the land surface. The length, slope, and roughness of this overland flow plane are model parameters.

Surface runoff in a high water table/low gradient environment is complex. When the land surface is inundated, flow will respond to the differences in the elevation of the water surface. Water surface elevations can be altered by local thermal storms. Flows are dependent on the stage in nearby canals, pumping into and out of feeder canals and shallow groundwater, and gate settings in levees.

Two additional methods are available for computing surface outflow in this model. The first one consists of a power function of the following form:

surface runoff = a * (surface storage)^b,

where a and b are parameters and a = (1-SRRC), a Surface Recession Constant similar to IRC, but hourly instead of daily.

SURO = (1 - SRRC*DELT60)*SURS**SREXP (48)

where:

SURO = Surface Outflow (in/interval)
SURS = Surface Detention Storage (in)
SRRC = Hourly recession constant
SREXP = Surface runoff exponent (-)
DELT60 = Hours per interval

Since surface outflow may not always be easily related to the physical characteristics of the land surface, the second option is based on a user-defined function that is provided in tabular form. In this algorithm, the outflow, expressed as a "fraction of the current depth leaving the surface per time interval", is specified in the FTABLES block as a function of the current depth of surface detention storage.

4.4(1).4 PERLND BLOCK -- Section PWATER input

```
****************************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
****************************************************************************************
Layout
******

 [Table-type PWAT-PARM1]
  Table-type PWAT-PARM2
 [Table-type PWAT-PARM3]
  Table-type PWAT-PARM4
 [Table-type PWAT-PARM5]
 [Table-type PWAT-PARM6]
 [Table-type PWAT-PARM7]
 [Table-type MON-INTERCEP]    --
 [Table-type MON-UZSN]         |
 [Table-type MON-MANNING]      | only required if the relevant quantity
 [Table-type MON-INTERFLW]     | varies through the year
 [Table-type MON-IRC]          |
 [Table-type MON-LZETPARM]    --
 [Table-type PWAT-STATE1]

 [Table-type IRRIG-PARM1]     --
 [Table-type IRRIG-PARM2]      |
 [Table-type CROP-DATES]       |
 [Table-type CROP-STAGES]      |
 [Table-type CROP-SEASPM]      |
 [Table-type SOIL-DATA]        | only required if using irrigation
 [Table-type SOIL-DATA2]       | module (IRRGFG > 0 in PWAT-PARM1)
 [Table-type SOIL-DATA3]       |
 [Table-type MON-IRR-CRDP]     |
 [Table-type MON-IRR-AWD]      |
 [Table-type IRRIG-SCHED]      |
 [Table-type IRRIG-SOURCE]     |
 [Table-type IRRIG-TARGET]    --

****************************************************************************************
```

Explanation

The exact format of each of the tables mentioned above is detailed in the documentation which follows.

Tables enclosed in brackets [] above are not always required; for example, because all the values can be defaulted.

4.4(1).4.1 Table-type PWAT-PARM1 -- First group of PWATER parameters (flags)

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  PWAT-PARM1
  <-range><-------------------pwatparm1---------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END PWAT-PARM1

*******
Example
*******

  PWAT-PARM1
    <PLS >                  Flags                                       ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE IFFC  HWT IRRG ***
    1    7    1    1
  END PWAT-PARM1

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max
<pwatparm1>	CSNOFG	I5	0	0	1
	RTOPFG	I5	0	0	3
	UZFG	I5	0	0	1
	VCSFG	I5	0	0	1
	VUZFG	I5	0	0	1
	VNNFG	I5	0	0	1
	VIFWFG	I5	0	0	1
	VIRCFG	I5	0	0	1
	VLEFG	I5	0	0	1
	IFFCFG	I5	1	1	2
	HWTFG	I5	0	0	1
	IRRGFG	I5	0	0	3

Explanation

If CSNOFG is 1, section PWATER assumes that snow accumulation and melt is being considered. It will, therefore, expect that the time series produced by section SNOW are available, either internally (produced in this RUN) or from external sources (e.g., produced in a previous RUN). If CSNOFG is 0, no such time series are expected. See the Functional Description for further information.

RTOPFG is a flag that selects the algorithm for computing overland flow. Four optional methods are provided. If RTOPFG is 1, routing of overland flow is done in the same way as in the predecessor models HSPX, ARM and NPS. A value of 0 results in a different algorithm that is described in the Functional Description. Values of 2 and 3 are designed for use under high water table/low land gradient conditions (HWTFG = 1). A value of 2 results in use of a simple power function method. If a value of 3 is entered, the program uses a table in the FTABLES block to determine surface outflow as a function of surface storage.

UZFG selects the method for computing inflow to the upper zone. If UZFG is 1, upper zone inflow is computed in the same way as in the predecessor models HSPX, ARM and NPS. A value of 0 results in the use of a different algorithm, which is less sensitive to changes in DELT (see functional description).

The flags beginning with "V" indicate whether or not certain parameters will be assumed to vary through the year on a monthly basis: 1 means they do vary, 0 means they do not. The quantities which can vary on a monthly basis are:

VCSFG	interception storage capacity
VUZFG	upper zone nominal storage
VNNFG	Manning's n for the overland flow plane
VIFWFG	interflow inflow parameter
VIRCFG	interflow recession constant
VLEFG	lower zone evapotranspiration (E-T) parameter

If any of these flags are on (1), monthly values for the parameter concerned must be supplied (see Table-types MON-, documented later in this section).

If IFFCFG is 1, then the effect of frozen ground on infiltration rate is computed from the amount of ice in the snow pack (PACKI). CSNOFG must be turned on, and if section SNOW does not compute PACKI (because ICEFG is off or the section is inactive) PACKI must be supplied as an input time series. If IFFCFG is 2, then the infiltration adjustment factor is determined from the soil temperature in the lower layer/groundwater layer, which is either computed in section PSTEMP or must be supplied as a time series. (See Table-type PWAT-PARM5 for more details.)

If HWTFG is 1, then high water table and low land surface gradient conditions (i.e. wetlands) are prevalent on the land segment, and different algorithms are used for some processes. See Functional Description (Part E, Section 4.2(1).3.8 for details. Note: use of monthly values for UZSN is not recommended when using these optional methods.

If IRRGFG is greater than zero, then it selects the method used to determine the method used to determine demands in the irrigation module. If IRRGFG is 1, then the input timeseries IRRDEM will be supplied in the EXT SOURCES block. If IRRGFG is 2, then the demand is calculated based on allowable water depletion in the crop root zone. If IRRGFG is 3, then irrigation occurs according to a schedule defined by the user in Table-type IRRIG-SCHED.

4.4(1).4.2 Table-type PWAT-PARM2 -- Second group of PWATER parameters

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  PWAT-PARM2
  <-range><--------------------------pwatparm2--------------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END PWAT-PARM2

*******
Example
*******

  PWAT-PARM2
    <PLS > ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    1    7       0.2       8.0       0.7      400.      .001                 .98
  END PWAT-PARM2

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<pwatparm2>	FOREST	F10.0	0.0	0.0	1.0	none	Both
	LZSN	F10.0	none	.01	100.	in	Engl
			none	.25	2500.	mm	Metric
	INFILT	F10.0	none	0.0001	100.	in/hr	Engl
			none	0.0025	2500.	mm/hr	Metric
	LSUR	F10.0	none	1.0	none	ft	Engl
			none	0.3	none	m	Metric
	SLSUR	F10.0	none	.000001	10.	none	Both
	KVARY	F10.0	0.0	0.0	none	1/in	Engl
			0.0	0.0	none	1/mm	Metric
	AGWRC	F10.0	none	0.001	0.999	1/day	Both

Explanation

FOREST is the fraction of the PLS which is covered by forest, and which will therefore continue to transpire in winter. This is only relevant if snow is being considered (i.e., CSNOFG = 1).

LZSN is the lower zone nominal storage.

INFILT is an index to the infiltration capacity of the soil.

LSUR is the length of the assumed overland flow plane.

SLSUR is the slope of the overland flow plane.

KVARY is a parameter which affects the behavior of groundwater recession flow, enabling it to be non-exponential in its decay with time.

AGWRC is the basic groundwater recession rate if KVARY is zero and there is no inflow to groundwater; AGWRC is defined as the rate of flow today divided by the rate of flow yesterday.

4.4(1).4.3 Table-type PWAT-PARM3 -- Third group of PWATER parameters

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  PWAT-PARM3
  <-range><------------------------pwatparm3---------------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END PWAT-PARM3

*******
Example
*******
  PWAT-PARM3
    <PLS >***
    # -  #*** PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    1    7
    9             39        33       3.0       1.5
  END PWAT-PARM3

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<pwatparm3>	PETMAX	F10.0	40.	none	none	degF	Engl
			4.4	none	none	degC	Metric
	PETMIN	F10.0	35.	none	none	degF	Engl
			1.7	none	none	degC	Metric
	INFEXP	F10.0	2.0	0.0	10.0	none	Both
	INFILD	F10.0	2.0	1.0	2.0	none	Both
	DEEPFR	F10.0	0.0	0.0	1.0	none	Both
	BASETP	F10.0	0.0	0.0	1.0	none	Both
	AGWETP	F10.0	0.0	0.0	1.0	none	Both

Explanation

PETMAX is the air temperature below which E-T will arbitrarily be reduced below the value obtained from the input time series, and PETMIN is the temperature below which E-T will be zero regardless of the value in the input time series. These values are only used if snow is being considered (CSNOFG= 1).

INFEXP is the exponent in the infiltration equation, and INFILD is the ratio between the maximum and mean infiltration capacities over the PLS.

DEEPFR is the fraction of groundwater inflow which will enter deep (inactive) groundwater, and, thus, be lost from the system as it is defined in HSPF.

BASETP is the fraction of remaining potential E-T which can be satisfied from baseflow (groundwater outflow), if enough is available.

AGWETP is the fraction of remaining potential E-T which can be satisfied from active groundwater storage if enough is available.

4.4(1).4.4 Table-type PWAT-PARM4 -- Fourth group of PWATER parameters

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  PWAT-PARM4
  <-range><--------------------pwatparm4---------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END PWAT-PARM4

Example
*******

  PWAT-PARM4
    <PLS >                                                            ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP***
    1    7       0.1       1.3       0.1        3.       0.5       0.7
  END PWAT-PARM4

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<pwatparm4>	CEPSC	F10.0	0.0	0.0	10.0	in	Engl
			0.0	0.0	250.	mm	Metric
	UZSN	F10.0	none	0.01	10.0	in	Engl
			none	0.25	250.	mm	Metric
	NSUR	F10.0	0.1	0.001	1.0	complex	Both
	INTFW	F10.0	none	0.0	none	none	Both
	IRC	F10.0	none	1.0E-30	0.999	1/day	Both
	LZETP	F10.0	0.0	0.0	2.0	none	Both

Explanation

Values in this table need only be supplied for those parameters which do not vary through the year. If they do vary (as specified in Table-type PWAT-PARM1), monthly values are supplied in the tables documented below (MON-xxx).

CEPSC is the interception storage capacity.

UZSN is the upper zone nominal storage.

NSUR is Manning's n for the assumed overland flow plane.

INTFW is the interflow inflow parameter.

IRC is the interflow recession parameter. Under zero inflow, this is the ratio of today's interflow outflow rate to yesterday's rate.

LZETP is the lower zone E-T parameter. It is an index to the density of deep-rooted vegetation.

4.4(1).4.5 Table-type PWAT-PARM5 -- Fifth group of PWATER parameters

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  PWAT-PARM5
  <-range><---pwatparm5------>
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END PWAT-PARM5

*******
Example
*******
  PWAT-PARM3
    <PLS >***
    # -  #***    FZG      FZGL
    1    7
    9            0.9       0.1
  END PWAT-PARM3

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<pwatparm5>	FZG	F10.0	1.0	0.0001	none	/in	Engl
		F10.0	0.0394	0.0001	none	/mm	Metr
	FZGL	F10.0	0.1	0.0001	1.0	none	Both

Explanation

FZG is the parameter that adjusts for the effect of ice in the snow pack on infiltration when IFFCFG is 1. It is not used if IFFCFG is 2.

FZGL is the lower limit of INFFAC as adjusted by ice in the snow pack when IFFCFG is 1. If IFFCFG is 2, FZGL is the value of INFFAC when the lower layer temperature is at or below freezing.

4.4(1).4.6 Table-type PWAT-PARM6 -- Sixth group of PWATER parameters -
(parameters related to high water table/low gradient conditions)

```
****************************************************************************************
        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
****************************************************************************************
Layout
******

  PWAT-PARM6
  <-range><-----------------pwatparm6------------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END PWAT-PARM6

*******
Example
*******
  PWAT-PARM6
    <PLS >***
    # -  #***  MELEV      BELV    GWDATM       PCW       PGW      UPGW
    1    7     1225.    1205.0    1200.0       0.3       0.2       0.4
  END PWAT-PARM6

****************************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
	MELEV	F10.0	0.0	0.0	30000.0	ft	Engl
			0.0	0.0	10000.0	m	Metric
	BELV	F10.0	none	none	none	ft	Engl
			none	none	none	m	Metric
	GWDATM	F10.0	none	none	none	ft	Engl
			none	none	none	m	Metric
	PCW	F10.0	none	0.01	0.999	none	Both
	PGW	F10.0	none	0.01	0.999	none	Both
	UPGW	F10.0	none	0.01	0.999	none	Both

Explanation

MELEV is the mean surface elevation of the land segment. If the SNOW module section is active, this value is ignored and the program uses the value for MELEV given in Table-type SNOW-PARM1.

BELV is the base elevation for active groundwater. It corresponds to the bottom elevation of nearby channels; therefore, if the groundwater elevation is above BELV, there is outflow into the channels. Groundwater below BELV is considered inactive.

GWDATM is the datum for the groundwater elevation GWEL. Storage below this elevation is considered lost from the system.

PCW is the cohesion water porosity. It is the soil pore space in micropores.

PGW is the gravitational water porosity. It is the soil pore space in macropores in the lower and groundwater layers of the soil column.

UPGW is the upper gravitational water porosity. It is the pore space in macropores in the upper layers of the soil column.

4.4(1).4.7 Table-type PWAT-PARM7 -- Seventh group of PWATER parameters -
(parameters related to high water table/low gradient conditions)

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  PWAT-PARM7
  <-range><--------------pwatparm7------------------------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END PWAT-PARM7

*******
Example
*******
  PWAT-PARM7
    <PLS >***
    # -  #*** STABNO      SRRC     SREXP     IFWSC     DELTA    UELFAC    LELFAC
    1    7                 0.9      1.00       4.8      0.20
  END PWAT-PARM7

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
	STABNO	I10	0	0	999	none	Both
	SRRC	F10.0	none	1.0E-10	0.999	/hr	Both
	SREXP	F10.0	1.0	0.0	none	none	Both
	IFWSC	F10.0	none	0.01	30.0	in	Engl
			none	0.25	750.	mm	Metric
	DELTA	F10.0	0.001	1.0E-6	0.2	in	Engl
			0.025	2.5E-5	5.0	mm	Metric
	UELFAC	F10.0	4.0	3.0	5.0	none	Both
	LELFAC	F10.0	2.5	2.0	3.0	none	Both

Explanation

STABNO is the user's number for the FTABLE in the FTABLES block which contains the outflow properties from the surface storage. This value is used only if RTOPFG = 3 in Table-type PWAT-PARM1.

SRRC is the surface runoff recession constant. It is used to calculate surface runoff as a function of surface storage only. This value is used only if RTOPFG = 2 in Table-type PWAT-PARM1.

SREXP is the surface runoff exponent. This value is used only if RTOPFG = 2 in Table-type PWAT-PARM1.

IFWSC is the maximum interflow storage capacity when the groundwater elevation is greater than the upper influence elevation (UELV).

DELTA is the groundwater tolerance level used to determine transition between regions when high water table conditions are being simulated (HWTFG = 1). It is used to smooth out jumps in groundwater elevation due to changes in "soil region."

UELFAC is the multiplier on UZSN which gives the upper zone capacity. The default value (4.0) should generally be used.

LELFAC is the multiplier on LZSN which gives the lower zone capacity. The default value (2.5) should generally be used.

4.4(1).4.8 Table-type MON-INTERCEP -- Monthly interception storage capacity

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  MON-INTERCEP
  <-range><-----------------mon-icep-------------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END MON-INTERCEP

*******
Example
*******

  MON-INTERCEP
    <PLS >  Interception storage capacity at start of each month      ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC***
    1    7  .02  .03  .03  .04  .05  .08  .12  .15  .12  .05  .03  .01
  END MON-INTERCEP

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<mon-icep>	CEPSCM(12)	12F5.0	0.0	0.0	10.	in	Engl
			0.0	0.0	250.	mm	Metric

Explanation

Monthly values of interception storage. Only required if VCSFG is 1 in Table-type PWAT-PARM1.

Note: The input monthly values apply to the first day of the month, and values for intermediate days are obtained by interpolating between successive monthly values.

4.4(1).4.9 Table-type MON-UZSN -- Monthly upper zone nominal storage

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  MON-UZSN
  <-range><------------------mon-uzsn------------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END MON-UZSN

*******
Example
*******

  MON-UZSN
    <PLS >  Upper zone storage at start of each month                  ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC ***
    1    7  .30  .35  .30  .45  .56  .57  .45  .67  .64  .54  .56  .40
  END MON-UZSN

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<mon-uzsn>	UZSNM(12)	12F5.0	none	.01	10.	in	Engl
			none	.25	250.	mm	Metric

Explanation

Monthly values of upper zone nominal storage. This table is only required if VUZFG is 1 in Table-type PWAT-PARM1.

Note: The input monthly values apply to the first day of the month, and values for intermediate days are obtained by interpolating between successive monthly values.

4.4(1).4.10 Table-type MON-MANNING -- Monthly Manning's n values

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  MON-MANNING
  <-range><----------------mon-Manning------------------------------>
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END MON-MANNING

*******
Example
*******

  MON-MANNING
    <PLS >  Manning's n at start of each month                        ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC ***
    1    7  .23  .34  .34  .35  .28  .35  .37  .35  .28  .29  .30  .30
  END MON-MANNING

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<mon-Manning>	NSURM(12)	12F5.0	.10	.001	1.0	complex	Both

Explanation

Monthly values of Manning's constant for overland flow. This table is only required if VNNFG is 1 in Table-type PWAT-PARM1.

Note: The input monthly values apply to the first day of the month, and values for intermediate days are obtained by interpolating between successive monthly values.

4.4(1).4.11 Table-type MON-INTERFLW -- monthly interflow inflow parameters

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  MON-INTERFLW
  <-range><----------------mon-interflw---------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END MON-INTERFLW

*******
Example
*******

  MON-INTERFLW
    <PLS >  Interflow inflow parameter for start of each month          ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
    1    7  2.0  3.3  3.6  3.8  4.2  5.6  5.6  7.6  7.5  5.6  4.6  3.4
  END MON-INTERFLW

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<mon-interflw>	INTFWM(12)	12F5.0	none	0.0	none	none	Both

Explanation

Monthly values of the interflow inflow parameter. This table is only required if VIFWFG is 1 in Table-type PWAT-PARM1.

Note: The input monthly values apply to the first day of the month, and values for intermediate days are obtained by interpolating between successive monthly values.

4.4(1).4.12 Table-type MON-IRC -- Monthly interflow recession constants

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  MON-IRC
  <-range><--------------mon-irc------------------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END MON-IRC

*******
Example
*******

  MON-IRC
    <PLS >  Interflow recession constant at start of each month       ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC***
    1    7 .35  .40  .40  .40  .40  .43  .45  .45  .50  .45  .45  .40
  END MON-IRC

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<mon-irc>	IRCM(12)	12F5.0	none	1.0E-30	0.999	/day	Both

Explanation

Monthly values of the interflow recession parameter. This table is only required if VIRCFG is 1 in Table-type PWAT-PARM1.

Note: The input monthly values apply to the first day of the month, and values for intermediate days are obtained by interpolating between successive monthly values.

4.4(1).4.13 Table-type MON-LZETPARM -- Monthly lower zone E-T parameter

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  MON-LZETPARM
  <-range><---------------mon-lzetparm------------------------------>
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END MON-LZETPARM

*******
Example
*******

  MON-LZETPARM
    <PLS >  Lower zone evapotranspiration parm at start of each month ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC***
    1    7  .30  .30  .35  .35  .40  .40  .45  .45  .45  .45  .42  .38
  END MON-LZETPARM

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<mon-lzetparm>	LZETPM(12)	12F5.0	0.0	0.0	2.0	none	Both

Explanation

Monthly values of the lower zone ET parameter. This table is only required if VLEFG is 1 in Table-type PWAT-PARM1.

Note: The input monthly values apply to the first day of the month, and values for intermediate days are obtained by interpolating between successive monthly values.

4.4(1).4.14 Table-type PWAT-STATE1 -- PWATER initial state variables

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  PWAT-STATE1
  <-range><--------------pwat-state1----------------------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END PWAT-STATE1

*******
Example
*******

  PWAT-STATE1
    <PLS >  PWATER state variables***
    # -  #***   CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    1    7      0.05      0.10      0.25      0.01       8.2       2.0      .025
  END PWAT-STATE1

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<pwat-state1>	CEPS	7F10.0	0.0	0.0	100	inches	Engl
			0.0	0.0	2500	mm	Metric
	SURS		0.0	0.0	100	inches	Engl
			0.0	0.0	2500	mm	Metric
	UZS		.001	.001	100	inches	Engl
			.025	.025	2500	mm	Metric
	IFWS		0.0	0.0	100	inches	Engl
			0.0	0.0	2500	mm	Metric
	LZS		.001	.001	100	inches	Engl
			.025	.025	2500	mm	Metric
	AGWS		0.0	0.0	100	inches	Engl
			0.0	0.0	2500	mm	Metric
	GWVS		0.0	0.0	100	inches	Engl
			0.0	0.0	2500	mm	Metric

Explanation

This table is used to specify the initial water storages in the soil.

CEPS is the initial interception storage.

SURS is the initial surface (overland flow) storage.

UZS is the initial upper zone storage.

IFWS is the initial interflow storage.

LZS is the initial lower zone storage.

AGWS is the initial active groundwater storage. If high water table/low gradient conditions are being simulated (HWTFG = 1 in table PWAT-PARM1), then AGWS is the storage above the base elevation for active groundwater (BELV). The total groundwater storage (TGWS) is given by (AGWS + BGWS). Under this option, a negative value of AGWS will be interpreted as a groundwater level below the base elevation; however, if TGWS is negative, an error condition occurs.

GWVS is the initial index to groundwater slope; it is a measure of antecedent active groundwater inflow.

4.4(1).4.15 Table-type IRRIG-PARM1 -- First group of irrigation parameters (flags)

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  IRRIG-PARM1
  <-range><-----irrparm1----->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END IRRIG-PARM1

*******
Example
*******

  IRRIG-PARM1
    <PLS >                        ***
    x -  x NSKD SZON VCRD VAWD IROP ***
  102              1    2    2    0
  103         3
  END IRRIG-PARM1

*******************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max
<irrparm1>	NSKED	I5	0	0	20
	SZONFG	I5	0	0	1
	VCRDFG	I5	0	0	2
	VAWDFG	I5	0	0	2
	IROPFG	I5	0	0	1

Explanation

NSKED specifies the number of scheduled applications when IRRGFG=3 in Table-type PWAT-PARM1. The applications are specified in Table-type IRRIG-SCHED.

The remaining flags apply only when IRRGFG=3 in Table-type PWAT-PARM1.

If SZONFG is zero, then field capacity and wilting point are the same for all zones, and are input in Table-type IRRIG-PARM2. If SZONFG is one, then they different for each soil zone, requiring input of Table-types SOIL-DATA2 and SOIL-DATA3.

VCRDFG is used to specify whether crop root depth is: 0 - constant, input in Table-type IRRIG-PARM2; 1 - monthly varying, requiring input of Table-type MON-IRR-CRDP; 2 - varying by stage of growing season, requiring input of Table-types CROP-STAGES and CROP-SEASPM.

VAWDFG is used to specify whether allowable water depletion is: 0 - constant, input in Table-type IRRIG-PARM2; 1 - monthly varying, requiring input of Table-type MON-IRR-AWD; 2 - varying by stage of growing season, requiring input of Table-types CROP-STAGES and CROP-SEASPM.

IROPFG is used to specify whether the irrigation method is: 1 - normal method; or 2 - subirrigation (seepage) method. The latter requires that HWTFG=1 in Table-type PWAT-PARM1.

4.4(1).4.16 Table-type IRRIG-PARM2 -- Second group of irrigation parameters

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  IRRIG-PARM2
  <-range><-------------------------irrparm2------------------------>
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END IRRIG-PARM2

*******
Example
*******

  IRRIG-PARM2
*** <PLS >  IRAREA   IREFF    ARZI   WILTP  FLDCAP   CRDEP   IRAWD  CAPRIS
*** x -  x (acres)                 (in/in) (in/in)    (in)            (in)
  102       1563.5     0.7     0.5    0.01     0.4    36.0     0.6     6.0
  END IRRIG-PARM2

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<irrparm2>	IRAREA	F8.0	0.0	0.0	none	ac	Engl
			0.0	0.0	none	ha	Metric
	IREFF	F8.0	1.0	0.0	1.0	none	Both
	ARZI	F8.0	1.0	0.0	1.0	none	Both
	WILTP	F8.0	0.0	0.0	1.0	in/in	Engl
			0.0	0.0	1.0	mm/mm	Metric
	FLDCAP	F8.0	0.0	0.0	1.0	in/in	Engl
			0.0	0.0	1.0	mm/mm	Metric
	CRDEP	F8.0	0.0	0.0	none	in	Engl
			0.0	0.0	none	cm	Metric
	IRAWD	F8.0	0.0	0.0	1.0	none	Both
	CAPRIS	F8.0	6.0	0.0	none	in	Engl
			15.25	0.0	none	cm	Metr

Explanation

IRAREA is the area being covered by the depth of irrigation application. It should be equal to the total area of the PERLND, so that hydrologic response is uniform. This parameter is used only when withdrawals are made from a RCHRES, i.e. RPRIOR > 0 in Table-type IRRIG-SOURCE.

The remainder of the table is needed only when IRRGFG=2.

IREFF is the irrigation method efficiency. It is used to calculate gross irrigation demand from net irrigation demand.

ARZI is the areal fraction of the root zone that is irrigated.

WILTP and FLDCAP are the the wilting point and field capacity of the soil for all layers when SZONFG = 0 in Table-type IRRIG-PARM1.

CRDEP is the irrigated crop root depth when VAWDFG = 0 in Table-type IRRIG-PARM1.

IRAWD is the allowable water depletion when VCRDFG = 0 in Table-type IRRIG-PARM1.

CAPRIS is the maximum capillary rise when IROPFG = 1 in Table-type IRRIG-PARM1.

4.4(1).4.17 Table-type CROP-DATES -- Planting and harvesting dates

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  CROP-DATES
  <-range><ncr>    <m><d>  <m><d>    <m><d>  <m><d>    <m><d>  <m><d>
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END CROP-DATES

*******
Example
*******

  CROP-DATES
    <PLS >            CROP 1            CROP 2            CROP 3    ***
    # -  # NCRP     PM PD   HM HD     PM PD   HM HD     PM PD   HM HD ***
    1         2      4 15    8 20      9  5    9 29
  END CROP-DATES

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max
<ncr>	NCRP	I5	1	1	3
<m>	CRPDAT(*)	2I3	1	1	12
<d>			1	1	31

Explanation

NCRP is the number of crops per year.

CRPDAT is the month and day of planting and harvesting for each crop. Crop seasons cannot overlap, but a season may wrap around the end of the calendar year.

Cropping dates are required in two cases: 1) the PWATER irrigation module when IRRGFG=2 in Table-type PWAT-PARM1, and VCRDFG and/or VAWDFG = 2 in Table-type IRRIG-PARM1; 2) the yield-based method of plant uptake is being used (NUPTFG = 1 in Table-type NIT-FLAGS and/or PUPTFG = 1 in Table-type PHOS-FLAGS).

This table should only be entered once for the PWATER, NITR, and PHOS sections.

4.4(1).4.18 Table-type CROP-STAGES -- Crop growth stages

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  CROP-STAGES
  <-range><---------------crpstage-------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END CROP-STAGES

*******
Example
*******

  CROP-STAGES
    <PLS >                                 ***
    x -  x    CRPST1    CRPST2    CRPST3    CRPST4 ***
  102           0.20      0.30      0.35      0.15
  END CROP-STAGES

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<crpstage>	CRPSTG(4,*)	4F10.0	0.0	0.0	1.0	none	Both

Explanation

The crop seasons established in Table-type CROP-DATES are divided into four growth stages. CRPSTG is the array of fractions of the length of each crop season which makes up each of the four stages.

This table is required only when IRRGFG = 2 in Table-type PWAT-PARM1, and VCRDFG and/or VAWDFG = 2 in Table-type IRRIG-PARM1. It is repeated NCRP times.

4.4(1).4.19 Table-type CROP-SEASPM -- Crop growth stage parameters

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  CROP-SEASPM
  <-range><------------------------crpseaspm------------------------>
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END CROP-SEASPM

*******
Example
*******

  CROP-SEASPM
    <PLS >    CRAWD1    CRAWD2    CRAWD3    CRAWD4    CRRDPI    CRRDPF ***
    x -  x                                              (in)      (in) ***
  102           0.60      0.60      0.60      0.90       8.0      12.0
  END CROP-SEASPM

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<crpseaspm>	CRPAWD(4)	4F10.0	0.0	0.0	1.0	none	Both
	CRPRDP(2)	2F10.0	0.0	0.0	none	in	Engl
			0.0	0.0	none	cm	Metric

Explanation

CRPAWD(4) is the allowable water depletion for each of the four stages for an annual crop. It is assumed to be constant throughout each stage.

CRPRDP(2) is the initial and final crop root depth for irrigation. The depth of irrigation is assumed to be equal to the initial depth during stage 1, rising linearly during stage 2 to remain at the final level throughout stages 3 and 4.

This table is required only when IRRGFG = 2 in Table-type PWAT-PARM1, and VCRDFG and/or VAWDFG = 2 in Table-type IRRIG-PARM1. It is repeated NCRP times.

4.4(1).4.20 Table-type SOIL-DATA -- Soil layer depths and bulk densities

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  SOIL-DATA
  <-range><------------depths------------><-----------bulkdens----------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END SOIL-DATA

*******
Example
*******

  SOIL-DATA
    <PLS >|          Depths (ins)        |    Bulk density (lb/ft3)      |***
    # -  #|Surface   Upper   Lower Groundw|Surface   Upper   Lower Groundw|***
    1    7     .12     6.0    40.0     80.     80.                    120.
  END SOIL-DATA

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<depths>	none	4F8.0	none	.001	1000	in	Engl
			none	.0025	2500	cm	Metric
<bulkdens>	none	4F8.0	103	50	150	lb/ft3	Engl
			1.65	0.80	2.40	g/cm3	Metric

Explanation

The first four values are the depths (thicknesses) of the surface, upper, lower and groundwater layers, respectively; the second group of four values are the corresponding bulk densities of the soil in those layers. The soil depths are used in the PWATER irrigation algorithm if IRRGFG=2 in Table-type PWAT-PARM2, and all values are used in the PEST, NITR, and PHOS sections. In the latter case, the depth and bulk density are multiplied together by the program to obtain the mass of soil in each layer in order to compute the concentrations of adsorbed chemicals.

4.4(1).4.21 Table-type SOIL-DATA2 -- Wilting points for each soil layer

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  SOIL-DATA2
  <-range><---------------wiltpt--------------->
  . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . .
  END SOIL-DATA2

*******
Example
*******

  SOIL-DATA2
    <PLS > Wilting points for each soil layer       ***
    # -  #    SURFACE     UPPER     LOWER    ACT GW ***
    1    7        .02       .01       .01      .015
  END SOIL-DATA2

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<wiltpt>	WILTPT(4)	4F10.0	0.0	0.0	1.0	none	Both

Explanation

The wilting point, which is input as a fraction (volume-basis), is used to determine when the soil is too dry for plant uptake of water or nutrients to occur.

It is required in two cases: 1) the PWATER irrigation module when IRRGFG=2 in Table-type PWAT-PARM1, and SZONFG = 1 in Table-type IRRIG-PARM1; 2) the yield-based method of plant uptake is being used (NUPTFG = 1 in Table-type NIT-FLAGS and/or PUPTFG = 1 in Table-type PHOS-FLAGS).

This table should only be entered once for the PWATER, NITR, and PHOS sections.

4.4(1).4.22 Table-type SOIL-DATA3 -- Field capacity for each soil layer

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  SOIL-DATA3
  <-range><----------------fdcap---------------->
  . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . .
  END SOIL-DATA3

*******
Example
*******

  SOIL-DATA3
    <PLS >    SFDCAP    UFDCAP    LFDCAP    AFDCAP ***
    x -  x   (in/in)   (in/in)   (in/in)   (in/in) ***
  102           0.40      0.40      0.40      0.40
  END SOIL-DATA3

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<wiltpt>	FDCAP(4)	4F10.0	0.0	0.0	1.0	none	Both

Explanation

The field capacity, which is input as a fraction (volume-basis), is the maximum amount of water that the soil can hold after gravity drainage.

It is required module when IRRGFG=2 in Table-type PWAT-PARM1 and SZONFG=1 in Table-type IRRIG-PARM1.

4.4(1).4.23 Table-type MON-IRR-CRDP -- Monthly crop root depth

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  MON-IRR-CRDP
  <-range><------------------------mon-crdep------------------------>
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END MON-IRR-CRDP

*******
Example
*******

  MON-IRR-CRDP
    <PLS > Monthly crop root depth for irrigation (in)                 ***
    x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC ***
  103        0.   0.   8.  10.  12.  12.  12.  12.  12.   0.   0.   0.
  END MON-IRR-CRDP

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<mon-crdep>	CRDEPM(12)	12F5.0	0.0	0.0	none	in	Engl
			0.0	0.0	none	cm	Metric

Explanation

Monthly values of the crop root depth for irrigation. This table is only required if VCRDFG=1 in Table-type IRRIG-PARM1.

Note: The input monthly values apply to the first day of the month, and values for intermediate days are obtained by interpolating between successive monthly values.

4.4(1).4.24 Table-type MON-IRR-AWD -- Monthly allowable water depletion

```
****************************************************************************************
         1         2         3         4         5         6         7         8
1234567890123456789012345678901234567890123456789012345678901234567890123456789 0
****************************************************************************************
Layout
******

  MON-IRR-AWD
  <-range><-------------------------mon-awd------------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END MON-IRR-AWD

*******
Example
*******

  MON-IRR-AWD
    <PLS > Monthly allowable water depletion as fraction of AWC       ***
    x -  x JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC ***
  103       0.   0.  .40  .45  .50  .50  .65  .65  .40   0.   0.   0.
  END MON-IRR-AWD

****************************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<mon-awd>	IRAWDM(12)	12F5.0	0.0	0.0	none	none	Both

Explanation

Monthly values of the allowable water depletion for irrigation. This table is only required if VAWDFG=1 in Table-type IRRIG-PARM1.

Note: The input monthly values apply to the first day of the month, and values for intermediate days are obtained by interpolating between successive monthly values.

4.4(1).4.25 Table-type IRRIG-SCHED -- Scheduled irrigation applications

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  IRRIG-SCHED
            yr  mo dy hr mn dur    rate         yr  mo dy hr mn dur    rate
  <-range> <--> <> <> <> <><---><-------->     <--> <> <> <> <><---><-------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END IRRIG-SCHED

*******
Example
*******

  IRRIG-SCHED
          <---------Application----------> *** <---------Application---------->
    <PLS ><-----date------> IRDU    IRRATE *** <-----date------> IRDU    IRRATE
    x -  x yyyy mm dd hh mm  min     in/hr ***  yyyy mm dd hh mm  min     in/hr
  101      1989/ 6/15  4:00  240       0.3      1989/ 6/22  4:00  120       0.2
  101      1989/ 6/29  4:00  300       0.3
  END IRRIG-SCHED

*******************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<yr>	IRDATE(5,*)	I4	0	0	none	none	Both
<mo>		I2	1	0	12	none	Both
<dy>		I2	1	0	31	none	Both
<hr>		I2	0	0	24	none	Both
<mn>		I2	0	0	60	none	Both
<dur>	IRDURA(*)	I5	0	0	none	min	Both
<rate>	IRRATE(*)	F10.0	0.0	0.0	none	in/hr	Engl
			0.0	0.0	none	mm/hr	Metric

Explanation

The entries for each PERLND are repeated NSKED times, two to a line. The maximum value of NSKED is 20.

IRDATE(5,*) is the start date for each irrigation event. If the year is blank or zero, the application occurs annually, but in that case, the duration may not extend across a calendar year boundary.

IRDURA(*) is the duration of application in minutes.

IRRATE(*) is the rate of application in depth/hour.

This table is required only if IRRGFG = 3 in Table-type IRRIG-PARM1.

4.4(1).4.26 Table-type IRRIG-SOURCE -- Source priorities for irrigation
               withdrawals

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  IRRIG-SOURCE
  <-range><------------------------------irrsrc------------------------------>
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END IRRIG-SOURCE

*******
Example
*******

  IRRIG-SOURCE
*** <PLS ><-----External-----><---Groundwater----><-----------RCHRES----------->
*** x -  x    XPRIOR     XFRAC    GPRIOR     GFRAC    RPRIOR     RFRAC    IRCHNO
  101  102         2                   1       0.3         1       0.7       100
  103              0                   2                   1                 100
  END IRRIG-SOURCE

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<irrsrc>	XPRIOR	I10	0	0	3	none	Both
	XFRAC	F10.0	1.0	0.0	1.0	none	Both
	GPRIOR	I10	0	0	3	none	Both
	GFRAC	F10.0	1.0	0.0	1.0	none	Both
	RPRIOR	I10	0	0	3	none	Both
	RFRAC	F10.0	1.0	0.0	1.0	none	Both
	IRCHNO	I10	0	0	999	none	Both

Explanation

Irrigation withdrawals may come from any or all of three sources: external sources, TGWS, and RCHRES. Each source is assigned a priority, 1 being the highest, and 3 the lowest. A zero priority means that the source is unused for this PERLND. Two sources, or even all three, may have the same priority, in which case fractions specify how much of the irrigation demand to take from each source.

XPRIOR, GPRIOR, and RPRIOR are the priorities associated with each source, respectively. XFRAC, GFRAC, and RFRAC are the corresponding fractions.

IRCHNO is the ID number of the source RCHRES in the OPN SEQUENCE block.

4.4(1).4.27 Table-type IRRIG-TARGET -- Target fractions for irrigation applications

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  IRRIG-TARGET
  <-range><--------------------irrtgt-------------------->
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  (repeats until all operations of this type are covered)
  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  END IRRIG-TARGET

*******
Example
*******

  IRRIG-TARGET
    <PLS >      Irrigation Application Target Fractions      ***
    x -  x  Intercep   Surface     Upper     Lower Active GW ***
  101  102       0.4       0.6         0         0         0
  103              0         0         0         0       1.0
  END IRRIG-TARGET

********************************************************************************
```

Details

Symbol	Fortran name(s)	Format	Def	Min	Max	Units	Unit system
<irrtgt>	IRRTGT(5)	5F10.0	0.0	0.0	1.0	none	Both

Explanation

IRRTGT(5) is the fraction of the gross irrigation application taht is applied to each of five possible targets: 1) interception storage; 2) soil surface; 3) upper soil zone; 4) lower soil zone; 5) active groundwater storage.

4.5(1) FTABLES for the PERLND Application Module

4.5(1).1 FTABLE for PWATER section

One of the optional methods for computing surface runoff from a PERLND using the High Water Table algorithms is to use a simple FTABLE to define a fraction of the surface storage which runs off in a given interval, depending on the depth of storage. This method is selected by setting RTOPFG=3 in Table-type PWAT-PARM1.

```
********************************************************************************
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
Layout
******

  FTABLE    <t>
<-nr><-nc>
<-depth--><--frac-->
 .........................................................................
The above row repeats until values have been supplied to cover the entire
cross-section at the desired resolution
 .........................................................................
  END FTABLE<t>

*******
Example
*******

  FTABLE     31
 rows cols           ***
    3    2
     depth   outflow ***
      (in)      frac ***
       0.0      0.00
       1.0      0.10
       5.0      0.40
  END FTABLE 31

********************************************************************************
```

Details

Symbol	Name(s)	Format	Comment
<t>	see Sect. 4.5	I3	ID No. of FTABLE
<nr>	NROWS	I5	Number of rows in FTABLE
<nc>	NCOLS	I5	Number of columns in FTABLE. Must be 2
<depth>	Depth	F10.0	Depth of surface storage; Units: English = in; Metric = mm
<frac>	Runoff frac	F10.0	Fraction of storage that runs off per hour.

Explanation

This FTABLE lists depth and outflow rate expressed as a fraction of the surface storage that flows out each hour. HSPF interpolates between the specified values to obtain the flow fraction for intermediate values of depth.

The FTABLE must satisfy the following conditions:

1. (NCOLS*NROWS) must not exceed 100
2. NCOLS must be 2
3. There must be at least one row in the FTABLE
4. The first row must have depth = 0.0
5. No negative values are permitted
6. The depth field may not decrease as the row number increases

4.7(1).4 Group PWATER

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

Time series computed by module section PWATER:

Name	1	2	Kind	Engl	Metr	Description/comment
PERS	1	1	*	in	mm	Total water stored in the PLS
CEPS	1	1	*	in	mm	Interception storage
SURS	1	1	*	in	mm	Surface (overland flow) storage
UZS	1	1	*	in	mm	Upper zone storage
IFWS	1	1	*	in	mm	Interflow storage
LZS	1	1	*	in	mm	Lower zone storage
AGWS	1	1	*	in	mm	Active groundwater storage
TGWS	1	1	*	in	mm	Total groundwater storage (HWTFG=1)
GWEL	1	1	*	ft	m	Groundwater elevation (HWTFG=1)
RZWS	1	1	*	in	mm	Root zone water storage (IRRGFG=2)
RPARM	1	1	-	in/ivld	mm/ivld	Current value of maximum lower zone E-T opportunity
SURO	1	1	-	in/ivld	mm/ivld	Surface outflow
IFWO	1	1	-	in/ivld	mm/ivld	Interflow outflow
AGWO	1	1	-	in/ivld	mm/ivld	Active groundwater outflow
PERO	1	1	-	in/ivld	mm/ivld	Total outflow from PLS
IGWI	1	1	-	in/ivld	mm/ivld	Inflow to inactive (deep) GW
PET	1	1	-	in/ivld	mm/ivld	Potential E-T, adjusted for snow cover and air temperature
SURET	1	1	-	in/ivld	mm/ivld	Evap. from surface storage (HWTFG=1)
CEPE	1	1	-	in/ivld	mm/ivld	Evap. from interception storage
UZET	1	1	-	in/ivld	mm/ivld	E-T from upper zone
LZET	1	1	-	in/ivld	mm/ivld	E-T from lower zone
AGWET	1	1	-	in/ivld	mm/ivld	E-T from active groundwater storage
BASET	1	1	-	in/ivld	mm/ivld	E-T taken from active groundwater outflow (baseflow)
TAET	1	1	-	in/ivld	mm/ivld	Total simulated E-T
IFWI	1	1	-	in/ivld	mm/ivld	Interflow inflow (excluding any lateral inflow)
UZI	1	1	-	in/ivld	mm/ivld	Upper zone inflow
INFIL	1	1	-	in/ivld	mm/ivld	Infiltration to the soil
PERC	1	1	-	in/ivld	mm/ivld	Percolation from upper to lower zone
LZI	1	1	-	in/ivld	mm/ivld	Lower zone inflow
AGWI	1	1	-	in/ivld	mm/ivld	Active groundwater inflow (excluding any lateral inflow)
SURI	1	1	-	in/ivld	mm/ivld	Surface inflow (including any lateral inflow)
IRRDEM	1	1	-	in/ivld	mm/ivld	Irrigation demand (IRRGFG > 0)

IRDRAW	3	1	-	in/ivld	mm/ivld	Withdrawal of irrigation water from: 1) imports; 2) groundwater; 3) RCHRES (IRRGFG > 0)
IRSHRT	1	1	-	in/ivld	mm/ivld	Irrigation shortfall (IRRGFG > 0)
IRRAPP	6	1	-	in/ivld	mm/ivld	Application of irrigation water to: 1) interception storage; 2) soil surface; 3) upper zone; 4) lower zone; 5) groundwater; 6) total

---

Input time series required to compute the above:

Group EXTNL	
PETINP	
IRRINP	only required when IRRGFG=1
PREC	required if snow not considered (CSNOFG= 0)
SURLI	optional
UZLI	optional
IFWLI	optional
LZLI	optional
AGWLI	optional
Group ATEMP	
AIRTMP	only required if section ATEMP is inactive and CSNOFG= 1
Group SNOW	only required if section SNOW is inactive and snow is considered (CSNOFG= 1)
RAINF	
SNOCOV	
WYIELD	
PACKI	only required if ICEFG= 1
Group PSTEMP	only required if section PSTEMP is inactive and IFFCFG= 2
LGTMP	
