Appendix C

Appendix C provides a brief description of the ESPAM2 Recharge Tools, which are designed to compile GIS and tabular data into files formatted for input into the MKMOD program (Appendix B). Detailed documentation of the ESPAM2 Recharge Tools is available on the Idaho Department of Water Resources website at: http://www.idwr.idaho.gov/WaterInformation/projects/espam/ESPAM-Web-Documentation/index.html.

The ESPAM2 Recharge Tools use Python code and ArcGIS 10.0 or 10.1 to compile specified flux recharge and discharge data into files formatted for input into the MKMOD program. The Python code can be obtained by downloading the tools from http://www.idwr.idaho.gov/WaterInformation/Projects/espam/ESPAM-Web-Documentation/install.html. The toolbox includes 14 tools. Thirteen of the tools (CEL, CNL, DIV, ENT, ETI, FPT, IAR, NIR, OFF, PCH, PRE, SOL, and TRB) were used to process data for calibration of ESPAM2.1. The Curtailment IAR tool was not used for model calibration and is not discussed in this Appendix. The toolbox also includes four utilities, only the Import PRISM utility was used to process data for calibration of ESPAM2.1.

Input files required for the ESPAM2 Recharge Tools used to process data for model calibration include:

- model grid shapefile (IDTM83) for CEL, CNL, ETI, FPT, IAR, OFF, PCH, PRE, SOL, and TRB tools
- canal line feature shapefile (IDTM83) for CNL tool
- table of canal seepage (fraction of diversions) and adjustment factor (scalar multiplier) by canal line feature for CNL tool
- table of diversions (1,000 x AF) by month and irrigation entity for DIV tool
- table of ET adjustment factors (scalar multiplier) by irrigation practice and irrigation entity or groundwater polygon for ENT tool
- table of sprinkler fraction by irrigation entity or groundwater polygon for ENT tool
- shapefile (IDTM83) of county delineations used to assign ET for ETI tool
- ET (ft/month) by monthly stress period and county for ETI tool
- shapefile (IDTM83) of fixed points representing Snake River, Teton River, and Mud Lake exchange well pumping, municipal pumping, and wetlands for FPT tool
- table of exchange and municipal well discharge (ft^3/month) and wetlands recharge/discharge (ft^3/month), by monthly stress period and fixed point for FPT tool
- irrigated lands raster(s) (IDTM83) for one or more years (1980, 1986, 1992, 2000, 2002, and 2006 for calibration of ESPAM2.1) for IAR tool
- raster (IDTM83) of wetlands and urban areas for IAR tool
- raster (IDTM83) showing fraction of irrigated land with a groundwater source for IAR tool
- raster (IDTM83) of surface water irrigation entities for IAR tool

- raster (IDTM83) of groundwater polygons for IAR tool
- table of non-irrigated recharge (ft/month) by model cell for NIR tool
- shapefile (IDTM83) of points representing offsite wells for OFF tool
- table of offsite well discharge (ft^3/month) by well for OFF tool
- shapefile (IDTM83) of line features representing seepage from non-Snake River sources for PCH tool
- table of seepage (ft^3/month) and adjustment factor (scalar multiplier) by non-Snake River source for PCH tool
- rasters (IDTM83, 500 m x 500 m) of precipitation (ft/month) for each stress period for PRE tool
- shapefile (IDTM83) of soil zones for adjustment of non-irrigated recharge for SOL tool
- shapefile (IDTM83) of line features representing tributary basin underflow for TRB tool
- table of tributary basin underflow (ft^3/month) and adjustment factor (scalar multiplier) by monthly stress period and basin for TRB tool

In general, tools that require spatial data input (CEL, CNL, ETI, FPT, IAR, OFF, PCH, PRE, SOL, and TRB) use ArcGIS10.0 or ArcGIS10.1 tools to assign features or values to model cells. These tools compile spatial and tabular information into lists of model cells and associated values in a format readable by the MKMOD program. Tools that do not require spatial data input apply unit conversions (DIV) and reformat data (DIV, ENT, NIR) into a format readable by the MKMOD program.

The IAR tool performs several processing steps to determine the irrigated area by irrigation entity or groundwater polygon and model cell. These steps are documented in detail at http://www.idwr.idaho.gov/WaterInformation/Projects/espam/ESPAM-Web-Documentation/processing_steps.html#iar-steps.

The Import PRISM utility performs several steps to pre-process PRISM files obtained from the Oregon State University PRISM Climate Group for input into the PRE tool. The pre-processing utility projects and clips the rasters, and converts precipitation values from 100 x mm to feet. These steps are documented in detail at http://www.idwr.idaho.gov/WaterInformation/Projects/espam/ESPAM-Web-Documentation/processing_steps.html#prism-pre-processing-steps.

The files produced by ESPAM2 Recharge Tools for input into the MKMOD program are:

- *.cel contains the area (ft^3) of each model grid cell and its status as active or inactive in the model
- *.cnl contains the locations and seepage rates (fraction of diversions) of leaky canals
- *.div contains volumes of diversions (ft^3/month) from surface-water bodies
- *.ent contains ET adjustment factors and sprinkler fractions for each surface water irrigation entity and groundwater polygon

- *.eti contains the depth of evapotranspiration(ft/month) expected on any irrigated lands that might occur in each model cell
- *.fpt contains locations and recharge/discharge (ft^3/month) associated with exchange wells, municipal wells, and wetlands
- *.iar contains the irrigated land are (ft^2) associated with each irrigation entity, in each model cell.
- *.nir contains the depth of recharge (ft/month) from precipitation that occurs on non-irrigated lands (if any) in each model cell
- *.off file contains the locations and pumping volumes (ft^3/month) of wells that deliver water into streams or canals for use at distant locations, where the diversion volume is not already included in diversions reported in the *.div file
- *.pch contains the locations of non-Snake River seepage sources, and gives the volume of recharge/discharge (ft^3/month) by source.
- *.pre contains the depth of precipitation (ft/month) on each model cell
- *.sol contains a soil zone number for each model cell, for use by parameter-estimation software in adjusting the recharge from precipitation on non-irrigated lands
- *.trb contains the locations and estimated volume (ft^3/month) of subsurface inflow from tributary basins into the eastern Snake Plain aquifer

The MKMOD program requires three other input files which are built by hand and not produced by ESPAM Recharge Tools:

- *.mdl contains comments, the model time discretization, , and factors (scalar multipliers) for adjustment of non-irrigated recharge and wetlands recharge/discharge values contained in the *.nir and *.fpt files
- *.red contains reduction factors for application to the irrigated land areas in the *.iar file areas to correct for non-irrigated inclusions such as roads, haystacks, buildings and farmyards
- *.eff contains maximum On-Farm efficiency, DPin, DPex, and soil parameters used in the On-Farm algorithm to calculate net recharge on irrigated lands.