



## How to Model WSHP/GSHP Systems Using Carrier's HAP Software

**FAQ #1:** *I'm developing an energy analysis model for a conventional closed loop WSHP system. How do I model this type of system?*

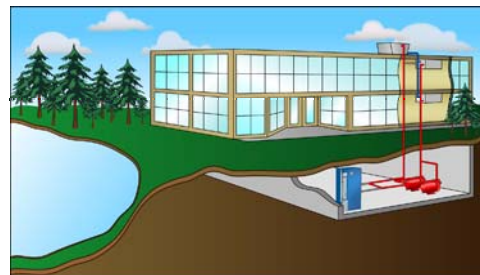
**FAQ #2:** *How do I model an open-loop WSHP system that uses well water?*

**FAQ #3:** *I'm evaluating high-efficiency HVAC systems to support LEED certification. One of the alternatives is a ground-coupled GSHP system where heat is rejected to a buried heat exchanger in the earth. How do I model this type of system with HAP?*

**Answer:** Each of the three WSHP/GSHP systems can be modeled with Carrier's Hourly Analysis Program (HAP) as described below.

### **A. Conventional Closed Loop WSHP System**

This system consists of WSHP units connected in parallel to a common closed water loop. A cooling tower and an auxiliary boiler are also connected to the loop. When the majority of WSHP units are in cooling mode, heat rejection to the water loop will cause the water temperature to rise. The cooling tower will be energized to maintain the loop water temperature below the maximum set point condition. When most of the WSHP units are in the heating mode, heat extraction from the loop will cause the water temperature to fall. At this point, the auxiliary boiler will be energized to maintain the loop temperature above the minimum setpoint condition.



**Conventional Closed Loop WSHP System**

To model this system:

1. Create and save the cooling tower and the hot water boiler before creating the WSHP system.
2. Create a new air system. Use Equipment Type = Terminal Units and System Type = Water Source Heat Pumps.
3. Each zone represents a separate WSHP unit. Therefore, the number of zones must equal the number of heat pumps in the system.
4. Enter data for the WSHP system on the General, Vent System Components, Zone Components and Sizing tabs.
5. On the Equipment Tab, press the "Terminal Cooling Units" button to enter cooling mode performance data from the manufacturer's catalog data for each heat pump.
6. On the Equipment Tab, press the "Terminal Heating Units" button to enter heating mode performance data from the manufacturer's catalog data for each heat pump.
7. On the Equipment Tab, press the "Miscellaneous Components" to describe the system configuration. Specify a "Closed Loop" system. Enter the maximum and minimum loop water set points. Link the cooling tower and boiler created in step #1 to the system.
8. Finally, save the system.



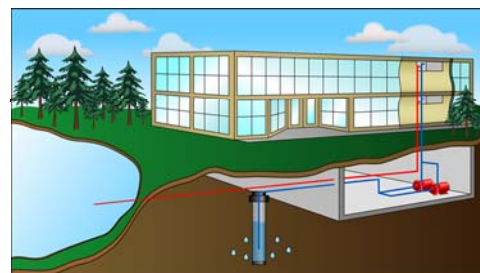
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### B. Open Loop WSHP System

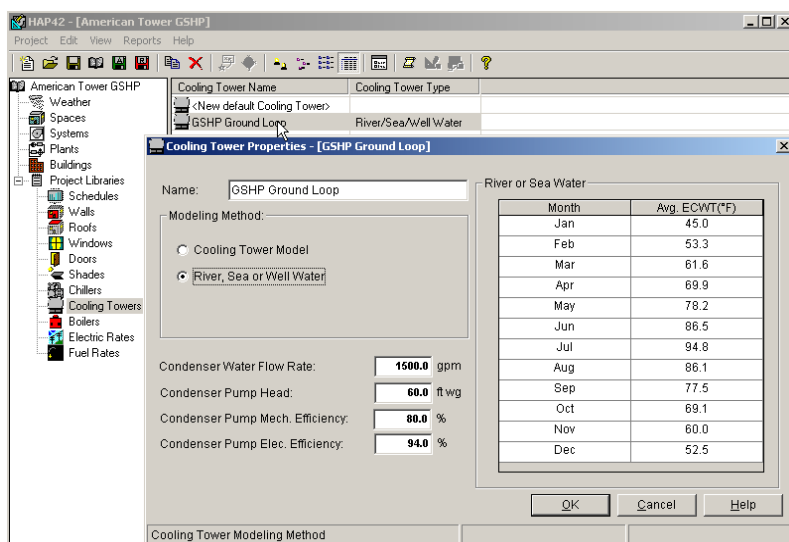
This system consists of WSHP units connected in parallel to an open water source. This water is obtained from a well, river, pond or municipal water supply. If the WSHP unit capacity in heating mode is insufficient to meet a load, an auxiliary electric heater in the WSHP unit is used.

To model this system:

1. Create and save a "cooling tower" before creating the system model. Choose the "River, Sea or Well Water" modeling method for the Cooling Tower Properties shown in Figure 1. Input the average source water temperature (Ave. ECWT) for each month of the year.
2. Create a new air system. Use Equipment Type = Terminal Units and System Type = Water Source Heat Pumps.
3. Each zone represents a separate WSHP unit. Therefore, the number of zones must equal the number of WSHP units in the system.
4. Enter data for the WSHP system on the General, Vent System Components, Zone Components and Sizing tabs.
5. On the Equipment Tab, press the "Terminal Cooling Units" button to enter cooling mode performance data from the manufacturer's catalog data for each heat pump.
6. On the Equipment Tab, press the "Terminal Heating Units" button to enter heating mode performance data from the manufacturer's catalog data for each heat pump.
7. On the Equipment Tab, press the "Miscellaneous Components" to describe the system configuration. Specify an "Open Loop WSHP" system configuration. Link the "cooling tower" created in step #1 to the system. Note that the program assumes electric auxiliary heaters, if auxiliary heating is needed. No inputs are required to define these auxiliary heaters.
8. Finally, save the system.



**Open Loop WSHP System**



**Figure 1**

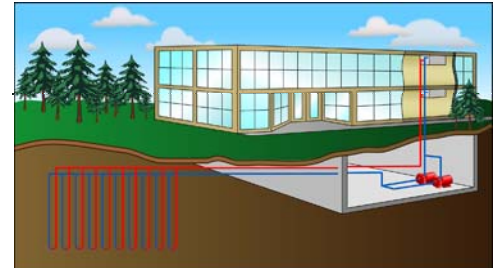


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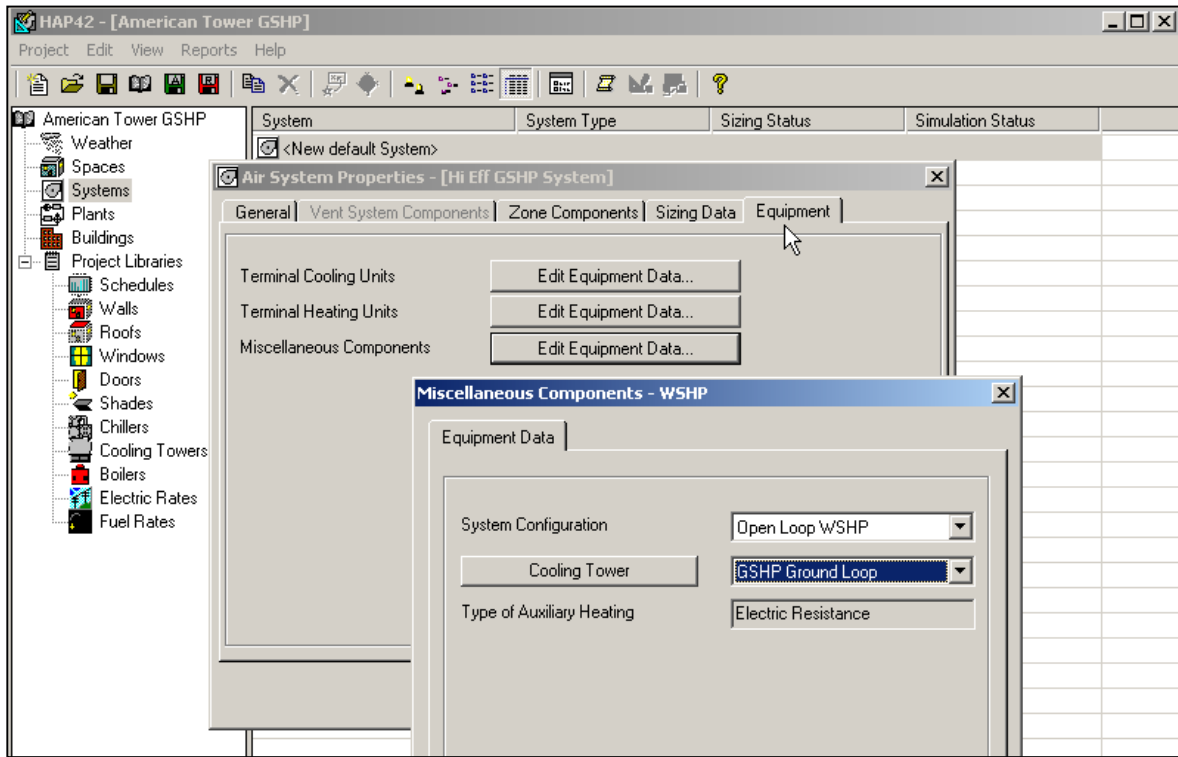
### C. Ground-Coupled WSHP System

A ground-coupled WSHP system (also known as a ground source heat pump system) consists of WSHP units connected in parallel to a closed water loop. Loop water is circulated to each WSHP unit from piping that is buried in the earth known as the ground heat exchanger. This heat exchanger either rejects or extracts heat from the earth. If the capacity of the WSHP units in heating mode is insufficient to meet the load, an auxiliary electric heater in the WSHP unit is energized. Currently, HAP does not provide a performance model for the ground heat exchanger, so the system configuration cannot be directly modeled. However, using an "Open Loop WSHP" system configuration as shown in Figure 2 can approximate performance of this system.

This simulates the loop water temperature for the WSHP units as a function of time of year. An average loop water temperature for each month must be entered for the "Cooling Tower Properties." In the actual system, the loop water temperature for a ground-coupled system is a function both of time of year and the hourly heat rejection or heat extraction. However, using the "Open Loop WSHP" system model shown in Figure 2 allows a general approximation of system performance. See Section B on page 2 for steps to model an "Open Loop WSHP" System.



**Ground-Coupled WSHP System**



**Figure 2**