Part 3. Simulated Effects of Withdrawals on Groundwater Flow (MODFLOW Models)

By John P. Masterson

The groundwater-flow models of the Wood River and eastern Pawcatuck River subbasins (fig. I–1) were developed for this investigation by using MODFLOW (Harbaugh and others, 2000) to analyze the effects of groundwater withdrawals on streamflows, aquifer levels, and pond levels. Simulations were made to compare and contrast the effects of changing hydrologic stresses caused by groundwater withdrawals on rivers with low and high baseflows to determine the responses of these rivers and on the surrounding aquifer. These simulations also included analyses of the effects of constant and varying pumping and recharge conditions and of different well distances from rivers on streamflow.

Streamflows simulated in the MODFLOW models were average monthly flows, except during May to September 2002 when they were average weekly flows. Recharge rates used in MODFLOW models were based on estimates determined from the HSPF modeling effort described in Part 2. Information on the development and calibration of the models as well as the limitations of this analysis are described in Appendix Part 3, "Development of Groundwater-Flow Models."

Effects of Pumping under Constant and Varying Recharge Conditions

Nearly all water that enters the lower Wood River model area (fig. 3–1) as recharge leaves the aquifer as groundwater discharge to streams. The amount of groundwater discharge to streams is controlled primarily by the difference between stream stage and water levels in the surrounding aquifer. As a result, seasonal changes in aquifer recharge result in changes in aquifer levels and therefore changes in the amount of groundwater that discharges to streams. During dry periods, the amount of groundwater discharge to the streams from an aquifer is much lower than during wet periods, when aquifer levels are generally higher relative to stream stage. An example is Meadow Brook (fig. 3–1), which went dry during summer 2002, an extremely dry period. (fig. 3–2).

Groundwater discharge to streams also can be affected by pumping. A pumping well can alter groundwater discharge to downgradient streams (fig. 3–3A) by capturing water that would otherwise discharge to streams (fig. 3–3B); and if the pumping rate is great enough, by reversing the flow direction so that the stream contributes water directly to the pumping well (fig. 3–3C). Two proposed municipal supply sites near rivers in the lower Wood River model area (RIW–481A and RIW–550) (fig. 3–1) were used in this analysis to compare and contrast the effects of pumping on baseflows and water levels in the aquifer under conditions of constant (steady-state) and varying (transient) recharge. These sites were selected to illustrate the contrasting effects of pumping on the stream-aquifer system when streams flow and when they go dry. Model-calculated baseflows and water levels are shown as differences from their respective values under nonpumping conditions.

Simulated pumping of 1.0 Mgal/d (1.5 ft^3/s) from proposed site RIW–481A, about 200 ft from Meadow Brook, resulted in a reduction of baseflow of 1.4 ft^3/s at the HSPF subbasin MEAD2 outlet (RCHRES 48) (sites described in table A2–4) under steady-state conditions (stress period 1 of model simulations shown as "SS" on figures 3–2 and 3–4 through 3–9). About 90 percent of the pumping demand (1.4 ft^3/s) is satisfied by captured baseflow (fig. 3–3B) and induced infiltration from the stream (fig. 3–3C) between the pumping well and MEAD2. The remaining 10 percent of pumped water was derived from captured baseflow captured farther downstream of MEAD2.

In addition to a reduction in baseflow, pumping from RIW–481A also affected water levels in the surrounding aquifer. During the steady-state condition when both pumping and recharge rates were constant, the resulting simulated drawdown was 1.2 ft about 400 ft west of the pumping well at observation well MW–9 (figs. 3–1, 3–5).

The steady-state simulations are based on the assumption that pumping and recharge rates remain constant over time; however, in reality, recharge rates change in response to changes in precipitation and evapotranspiration. Therefore, simulations of the effects of constant pumping with time-varying recharge were made to determine the response of this stream-aquifer system under intermittent-flow conditions in Meadow Brook. The simulation period of this analysis was from January 1, 2000, to September 30, 2004, as discussed in Part 2, "Simulation of Water-Use and Land-Use Changes on Streamflow with a Precipitation-Runoff Model (HSPF)."

Simulation results showed that as baseflow varied in response to the changes in recharge, the amount of baseflow reduction from pumping also varied. During wet periods when simulated baseflow in Meadow Brook was at or above average, the amount of baseflow reduction was similar to the

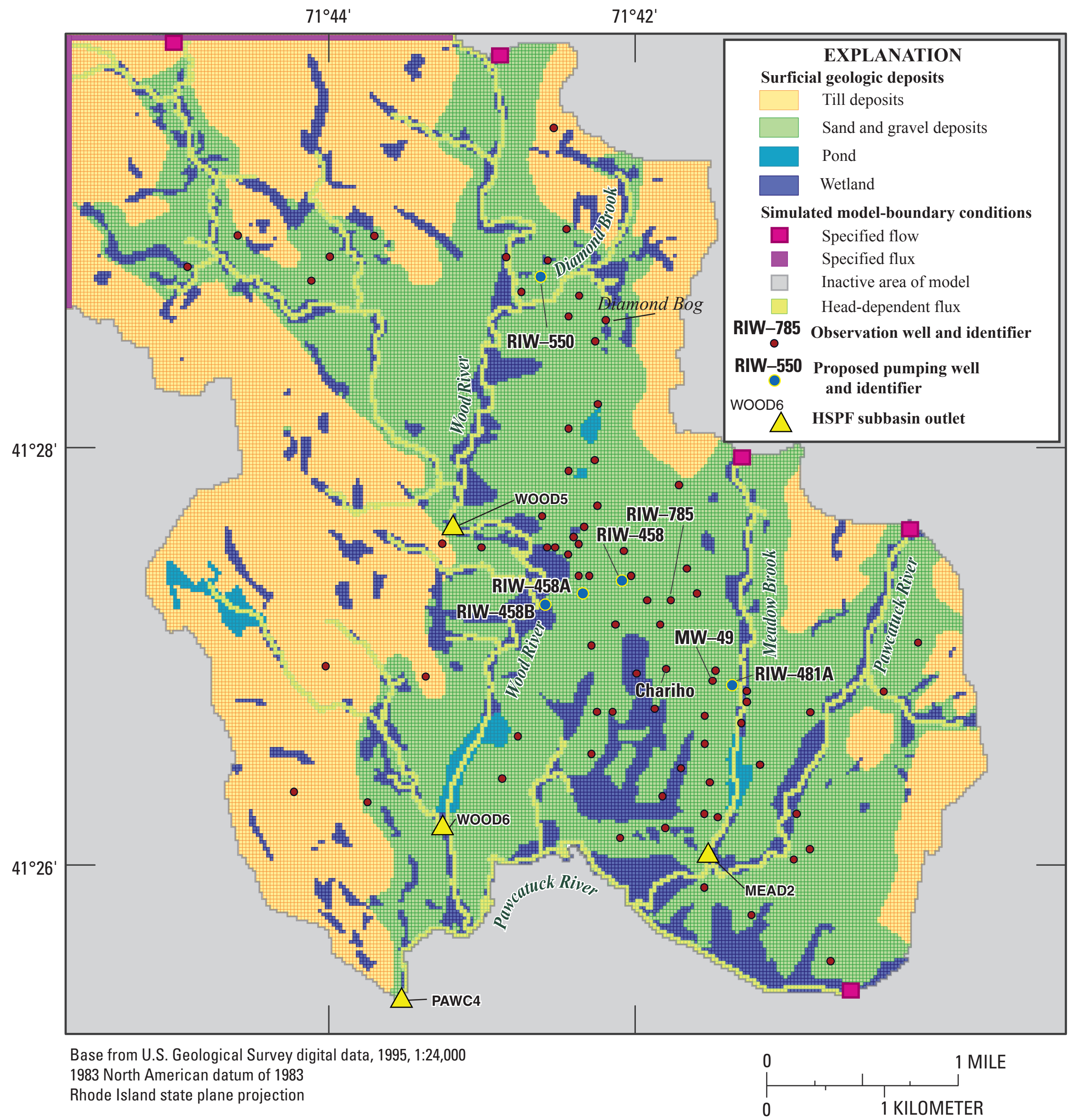


Figure 3–1. Geographic extent, surficial geology, observation wells, proposed withdrawal sites, simulated model boundary conditions, and outflow points from HSPF subbasins for the lower Wood River model in the Pawcatuck River Basin, southwestern Rhode Island.

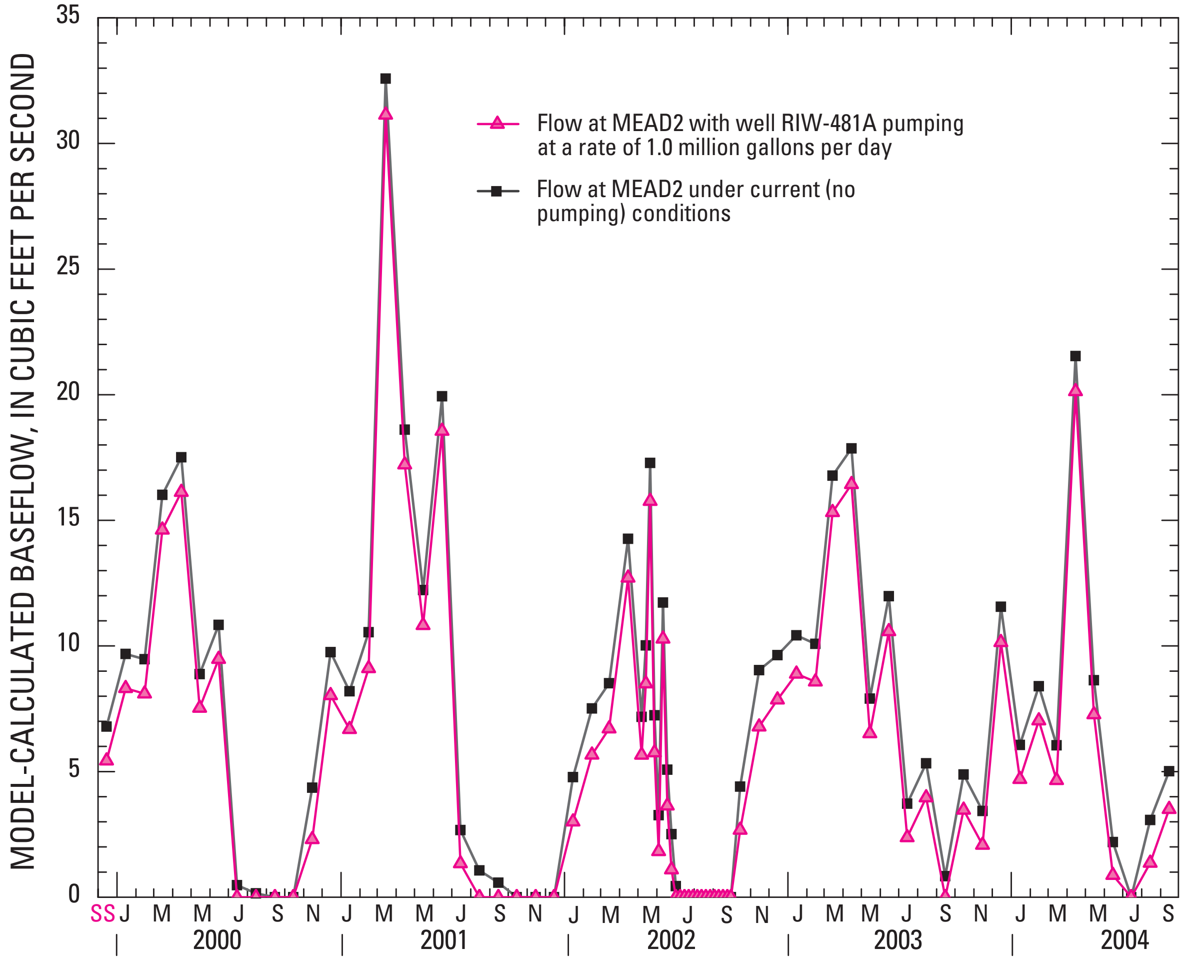


Figure 3–2. Effects of simulated pumping at well RIW–481A on baseflow in Meadow Brook in the lower Wood River model area (MEAD2, RCHRES 48) in the Pawcatuck River Basin, southwestern Rhode Island. Months on x-axis are January, March, May, July, September, and November for years shown. Steady state (SS) represents average steady-state conditions for simulation period. (Site locations shown in figure 3–1.)

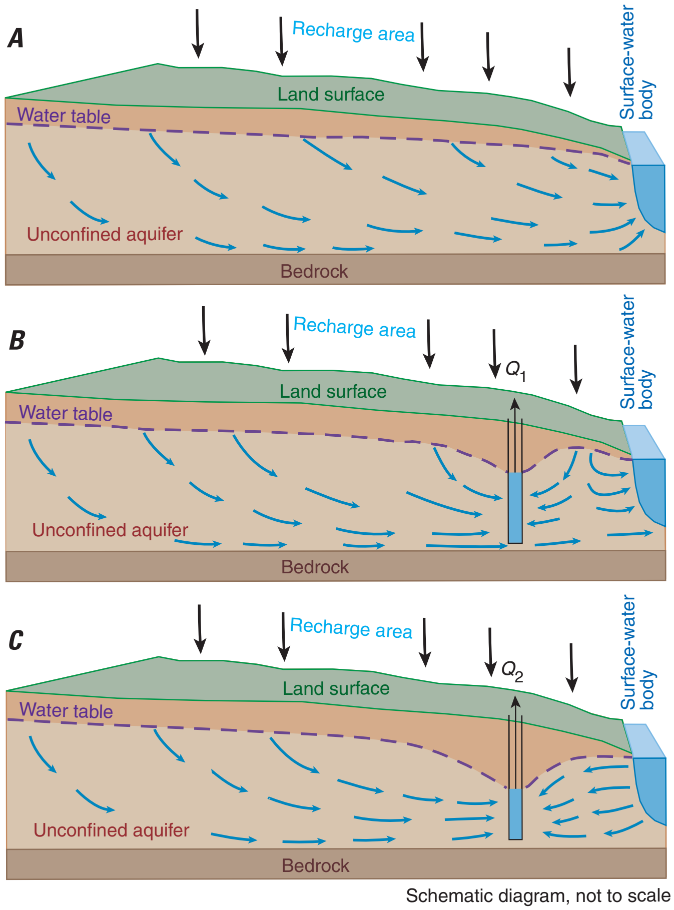


Figure 3–3. Groundwater discharge from a hypothetical aquifer to a stream with *(A)* no pumping; *(B)* pumping at a such a rate (Q1) that the well captures some water that would otherwise discharge to the surface-water body; and *(C)* pumping at a higher rate (Q2) that results in the reversal of groundwater flow direction and in the flow of water out of the surface-water body into the aquifer (induced infiltration).

baseflow reduction predicted by the steady-state simulation in which pumping and recharge rates were constant (about 1.4 ft^3/s, fig. 3–4). During the summer and early fall, however, when simulated baseflow was at or near zero (fig. 3–2), the reduction in baseflow from pumping became progressively less than the 1.4 ft^3/s reduction determined for steady-state conditions. The reason for this decrease in baseflow reduction is that, as the stream went dry, it could no longer be a source of water to the pumped well. When the pumped well could no longer satisfy its demand by depleting streamflow, the demand was met from another source, which is usually aquifer storage.

The shift in the source of water from streamflow to aquifer storage results in much greater drawdowns in the nearby aquifer than if there had been water in the stream. This effect is illustrated in the hydrograph for observation well MW–9 (fig. 3–5) where drawdowns greatly increased during dry periods compared to the drawdowns observed during the steady-state simulation. During the dry period of late summer and early fall 2002, the calculated drawdown at MW–9 was about 2.5 times larger than that calculated in the steady-state simulation (fig. 3–5).

During the first few months that followed extended dry periods, such as the period of November 2000 through February 2001 (fig. 3–4), the simulated reduction in baseflow was about 2.1 ft^3/s, about 50 percent greater than the 1.4 ft^3/s reduction calculated for steady-state conditions. This increase was the result of aquifer recharge replenishing depleted aquifer storage rather than contributing groundwater discharge to the stream. It was not until early spring 2001 that water levels recovered; baseflow reduction decreased to about 1.4 ft^3/s, and the calculated drawdown at MW–9 decreased to about 1.2 ft (fig. 3–5), which are similar to the amounts calculated for the steady-state condition. This pattern of changes in water levels and baseflow reduction rates was repeated during the successive dry and wet periods throughout the simulation period.

A comparison of drawdowns calculated for observation well MW–9 near the proposed RIW–481A well (about 400 ft away) and that of the Chariho observation well (fig. 3–5), about 2,500 ft from the RIW–481A well, was made to determine the effect of distance from the pumping well on changes in aquifer response. This analysis showed that changes in water levels became increasingly delayed and dampened with increasing distance from the pumping well. The model-calculated time lag between changes in water levels for the two observation wells appeared to be about two months. The largest drawdowns at these wells in 2002 occurred at observation well MW–9 in September 2002 and at the Chariho observation well in November 2002 (fig. 3–5). These results also indicate that, because of the distance of the Chariho observation well from the pumping well, the water level at the Chariho observation well did not fully recover from the effects of pumping during summer 2001 before the effects of pumping in summer 2002 became evident (fig. 3–5).

The time-lag effect of pumping observed in the analysis of changing water levels at two observation wells is directly related to distance from the pumping well; as distance from the pumping well increases, the lag effect of pumping increases. This lag effect is the basis of conjunctive-management modeling, which optimizes pumping rate and well location to minimize the effects of pumping on streamflow. Conjunctive-management simulations are discussed in Part 4, “Conjunctive-Management Models as Tools for Water-Resources Planning.”

An assessment of changes in baseflow reduction also was made for the Wood River at HSPF subbasin WOOD5 outlet (RCHRES 63) where baseflow was never lower than 16.0 ft^3/s during the simulation period (fig. 3–6). For the steady-state simulation, the amount of baseflow reduction was equal to the 1.5 ft^3/s (1.0 Mgal/d) of water pumped from RIW–550 about 500 ft from the Wood River (fig. 3–1). During the time-varying recharge simulations, this baseflow reduction ranged from about 1.3 to 2.1 ft^3/s (fig. 3–7), similar to the rates calculated

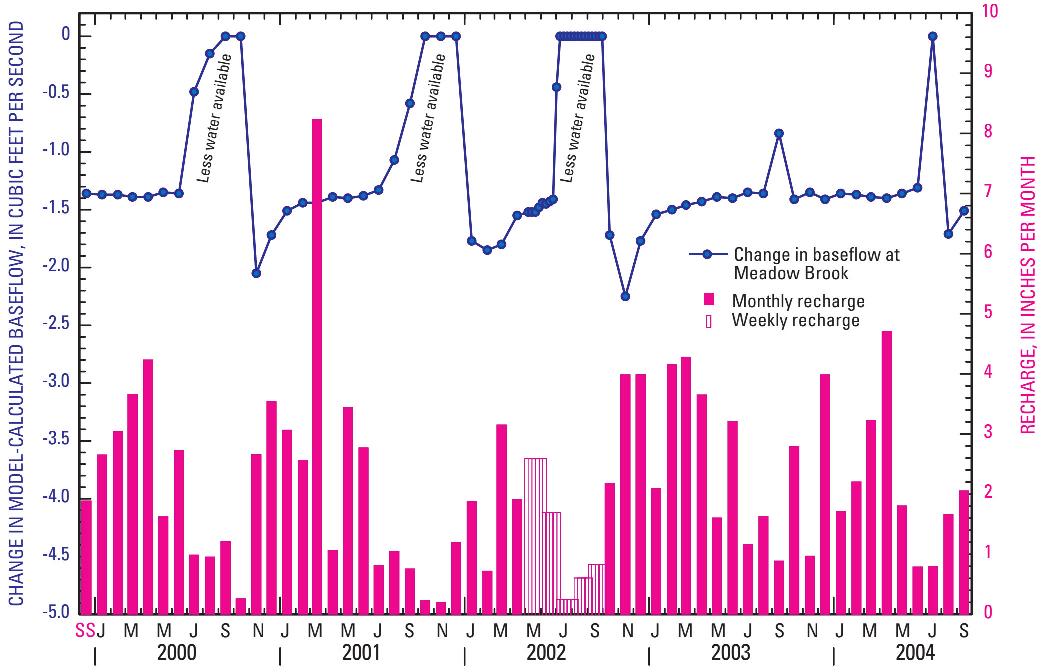


Figure 3–4. Change in baseflow in the Meadow Brook at HSPF subbasin MEAD2 outlet (RCHRES 48) in response to simulated pumping at well RIW–481A in the lower Wood River model area in the Pawcatuck River Basin, southwestern Rhode Island. Months on x-axis are January, March, May, July, September, and November for years shown. Steady state (SS) represents average steady-state conditions for simulation period. (Site locations shown in figure 3–1.)

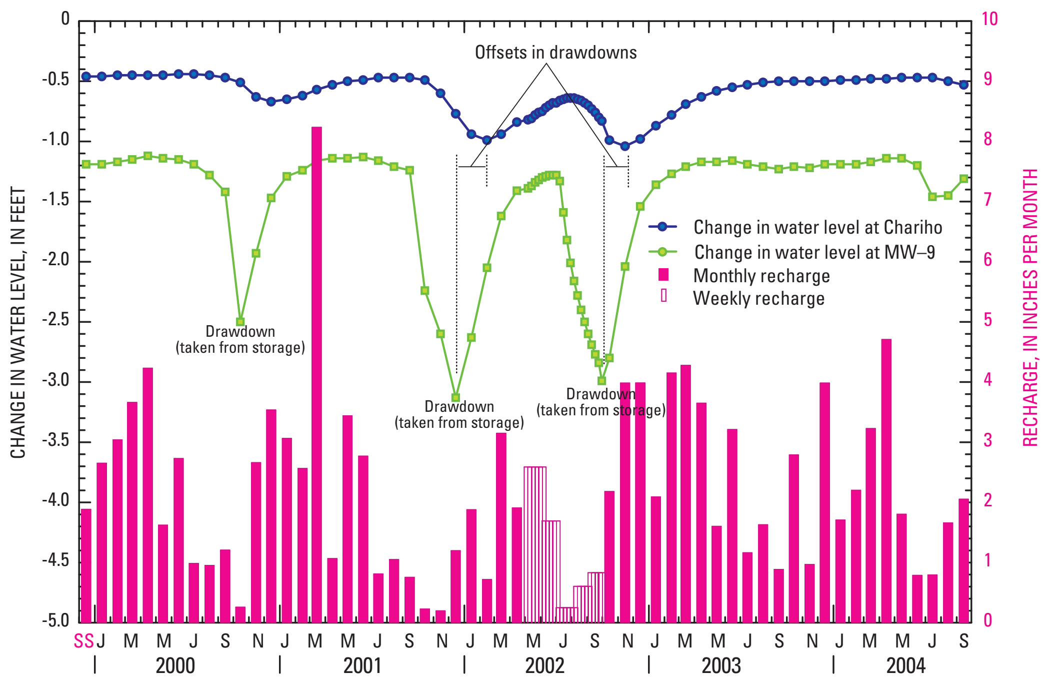


Figure 3–5. Comparison of the changes in water levels at observation wells MW–9 and Chariho in response to simulated pumping at well RIW–481A in the lower Wood River model area in the Pawcatuck River Basin, southwestern Rhode Island. Months on x-axis are January, March, May, July, September, and November for years shown. Steady state (SS) represents average steady-state conditions for simulation period. (Site locations shown in figure 3–1.)

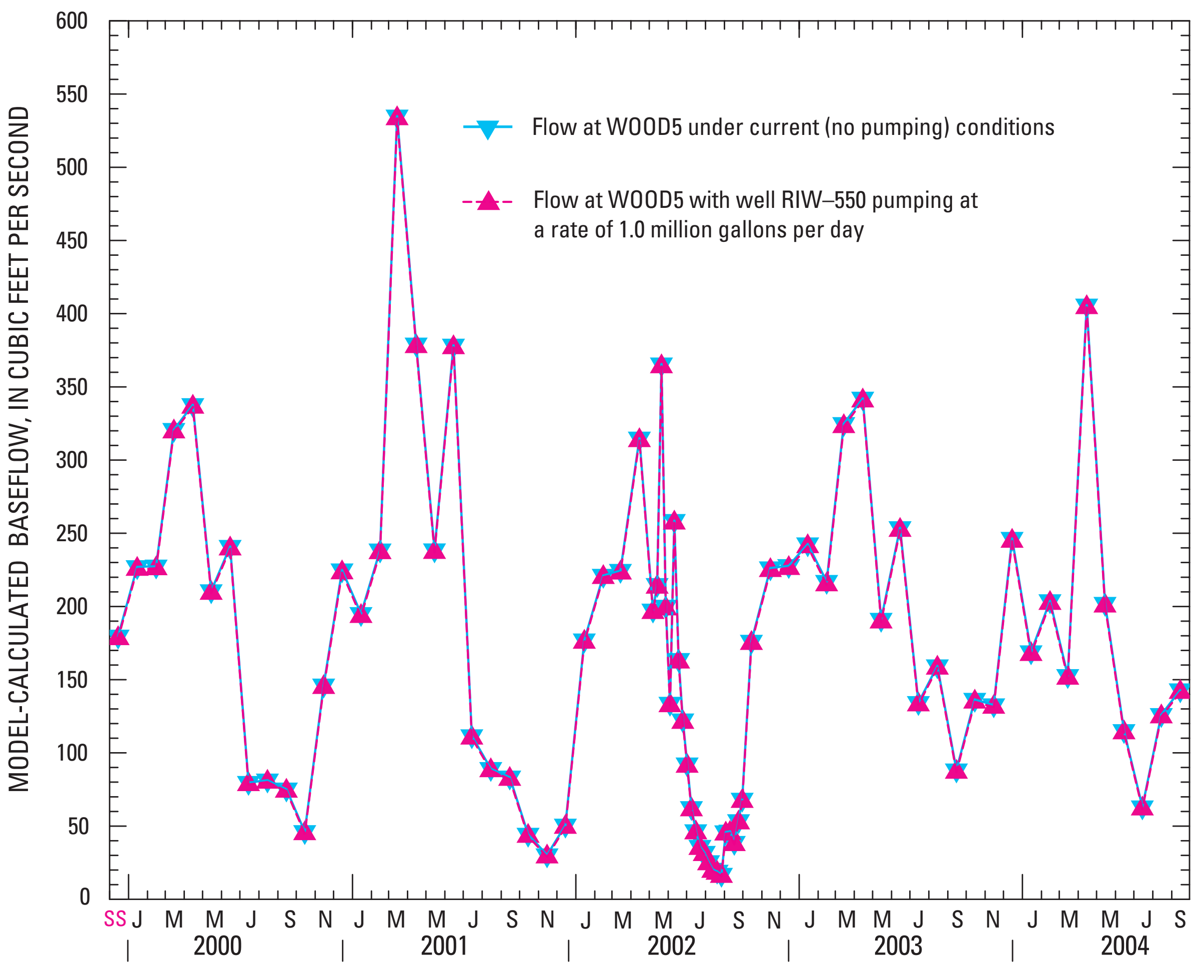


Figure 3–6. Effects of simulated pumping at well RIW–550 on baseflow in the Wood River at HSPF subbasin WOOD5 outlet (RCHRES 63) in the lower Wood River model area in the Pawcatuck River Basin, southwestern Rhode Island. Months on x-axis are January, March, May, July, September, and November for years shown. Steady state (SS) represents average steady-state conditions for simulation period. (Site locations shown in figure 3–1.)

for MEAD2 in Meadow Brook (fig. 3–4). Unlike Meadow Brook, however, the Wood River did not go dry during the simulation period, and therefore the amount of baseflow reduction did not vary with changes in aquifer recharge (Barlow and Dickerman, 2001).

The simulated response of the Wood River at WOOD5 to pumping under varying recharge conditions can be attributed to seasonal changes in baseflow at Diamond Brook, a small tributary to the Wood River between RIW–550 and Diamond Bog (fig. 3–1). This tributary discharges to the Wood River upstream of WOOD5 and, for current average annual conditions, contributes about 0.5 ft^3/s of flow to the Wood River (fig. 3–8). The times during which the reduction in baseflow at WOOD5 was at a minimum of 1.3 ft^3/s coincided with the times during which Diamond Brook was dry under the pumped condition (the red line on fig. 3–8) and therefore unable to contribute water to pumping well RIW–550 (fig. 3–8). As a result, the reduction in baseflow calculated for the Wood River downstream of the confluence with Diamond Brook was derived only from the main branch of the Wood River and aquifer storage rather than from Diamond Brook.

Changes in water levels beneath Diamond Brook in response to simulated pumping at RIW–550 under varying recharge rates can potentially affect the hydroperiod in nearby vernal pools such as Diamond Bog, one of the State's most ecologically sensitive critical habitats (Colin Apse, The Nature Conservancy, written commun., 2005) (figs. 3–1 and 3–9). The drawdown calculated for this area was about 0.2 ft under steady-state conditions (shown as "ss" on fig. 3–9). Water levels in vernal pools are ecologically important during the spring

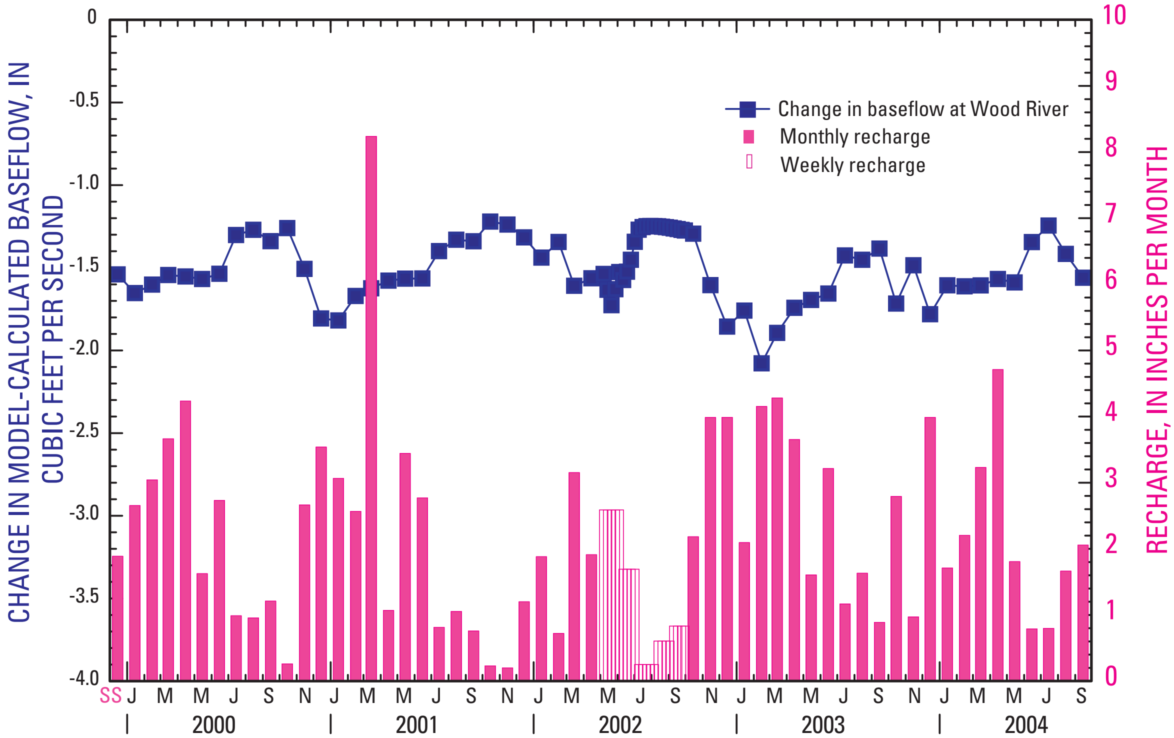


Figure 3–7. Change in baseflow in the Wood River at HSPF subbasin WOOD5 outlet (RCHRES 63) in response to simulated pumping at well RIW–550 in the lower Wood River model area in the Pawcatuck River Basin, southwestern Rhode Island. Months on x-axis are January, March, May, July, September, and November for years shown. Steady state (SS) represents average steady-state conditions for simulation period. (Site locations shown in figure 3–1.)

season, however. The drawdown associated with pumping at RIW–550 for March 2000 was assumed to be representative of average spring conditions, and at 0.2 ft, was nearly the same as that calculated for the steady-state condition. In March 2002, representative of dry spring conditions. the drawdown increased to 0.7 ft (fig. 3–9). Thus, a 14 percent decrease in recharge between March 2000 and March 2002 resulted in a more than threefold decline in water level in the bog; this comparison illustrates the sensitivity of the water level in the bog to changes in recharge.

During March of 2000, the baseflow of 1.0 ft^3/s at the mouth of Diamond Brook was reduced to 0.4 ft^3/s in response to the proposed pumping at well RIW–550. In contrast, under the same pumping conditions, the baseflow in Diamond Brook decreased from 0.3 to 0.0 ft^3/s in March 2002 (fig. 3–8). Because the reduction of 0.3 ft^3/s is only half of the total reduction calculated for March 2000 and because the brook went dry, the remainder of the pumped water was derived from aquifer storage and increased the drawdown calculated for Diamond Bog during March 2002 (fig. 3–9).

A map-view comparison of the drawdown calculated for these two times illustrates the influence of Diamond Brook on the extent of drawdown associated with the simulated pumping at well RIW–550 (figs. 3–10A,B). In March 2000, when there was flow in Diamond Brook, drawdown contours terminated (were zero) at the brook (fig. 3–10A). In March 2002, when Diamond Brook was dry, the drawdown contours extended beyond the brook; this result indicated that the brook was no longer contributing flow to the pumping well and that aquifer storage was being depleted (fig. 3–10B).

The depletion of aquifer storage was much greater during the months with little or no summer recharge because of the effects of streams going dry. This aquifer response was recorded in the simulated change in water levels at observation wells MW–9 and Chariho (fig. 3–5), and at Diamond Bog (fig. 3–9). The greatest reductions in baseflow at Meadow Brook and Wood River occurred after the greatest drawdowns in the aquifer because the increase in aquifer recharge initially replenished the depleted aquifer storage before contributing groundwater discharge to streams.

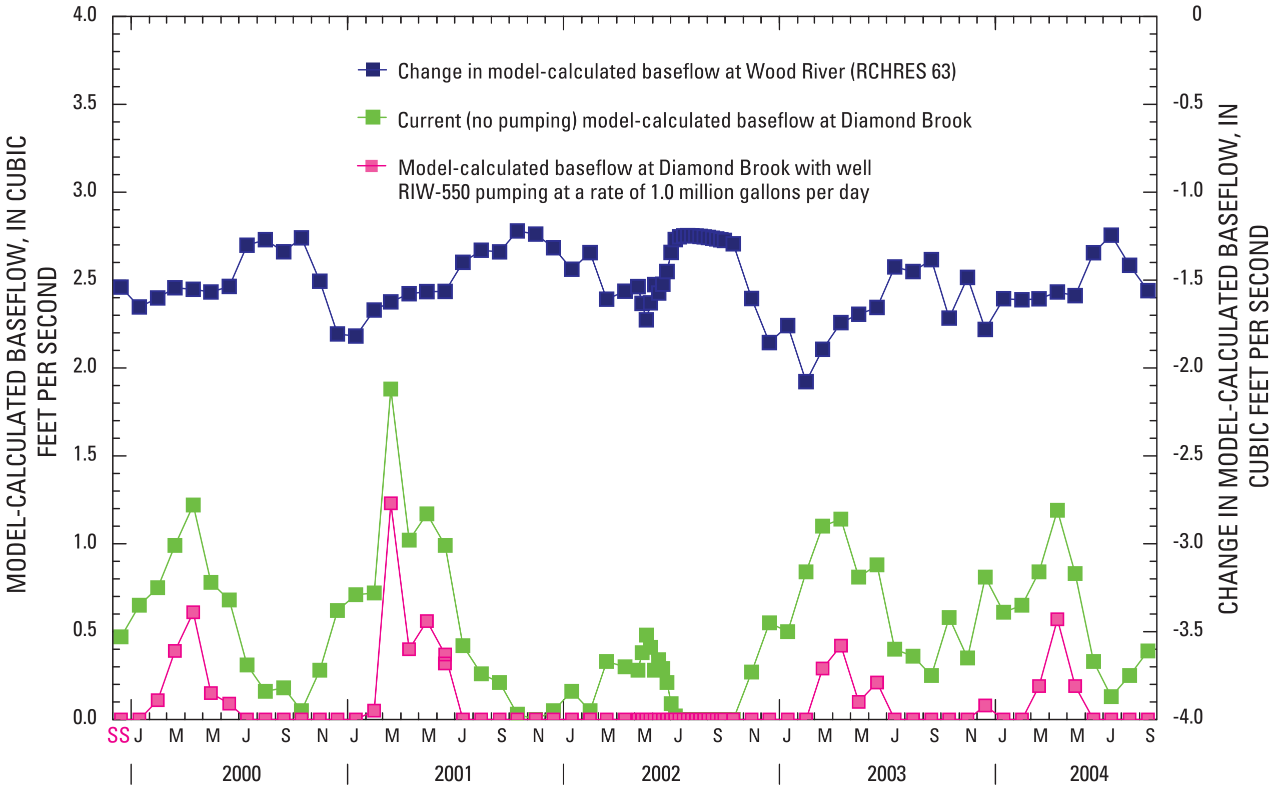


Figure 3–8. Comparison of the changes in baseflows in Diamond Brook and the Wood River at HSPF subbasin WOOD5 outlet (RCHRES 63) in response to simulated pumping at well RIW–550 in the lower Wood River model area in the Pawcatuck River Basin, southwestern Rhode Island. Months on x-axis are January, March, May, July, September, and November for years shown. Steady state (SS) represents average steady-state conditions for simulation period. (Site locations shown in figure 3–1.)

Once the aquifer storage was replenished and water levels rose, the simulated reduction in baseflows were comparable to the streamflows under steady-state rates–about 1.5 ft^3/s for both the Meadow Brook and the Wood River simulations. Nearly all of the pumped water from wells RIW–481A and RIW–550 was derived from baseflow reductions when water was available in the streams. During extended dry periods, however, the magnitudes of baseflow reductions can differ depending on whether the streams or their tributaries go dry.

Effects of Varying Pumping-Well Distance with Constant Pumping Rates

The effects of pumping were simulated for several alternative well locations on streamflow at the HSPF model subbasin WOOD6 and MEAD2 outlets (RCHRES 65 and 48, respectively) in the Wood River and Meadow Brook (fig. 3–1). The proposed well location for RIW–458 was changed in two simulations to two additional sites (Wells RIW–458A and RIW–458B) (fig. 3–1) to determine the effects of pumping-well location on baseflow.

Simulated pumping from well site of RIW–458, about 1,800 ft from the Wood River and 3,500 ft from Meadow Brook, resulted in about 68 percent of the simulated 1.0 Mgal/d of pumping being derived from a reduction of groundwater flow to the Wood River, the remaining 32 percent was from a reduction of groundwater flow to Meadow Brook (fig. 3–11). In the case of the Wood River, a reduction in baseflow of about 1.05 ft^3/s [68 percent of 1.55 ft^3/s (1.0 Mgal/d) of pumping] represents a less than 1-percent decrease in the total average streamflow of 180 ft^3/s. In contrast, a reduction in baseflow of about 0.5 ft^3/s [32 percent of 1.55 ft^3/s (1.0 Mgal/d) of pumping] in the Meadow Brook represents about a 7-percent decrease in the total average streamflow of 7 ft^3/s.

As the pumping well is moved 500 and 1,600 ft closer to the Wood River (Wells RIW–458A and RIW–458B, respectively), the effect of pumping on baseflow changes such that the amount of pumping derived from captured baseflow in the

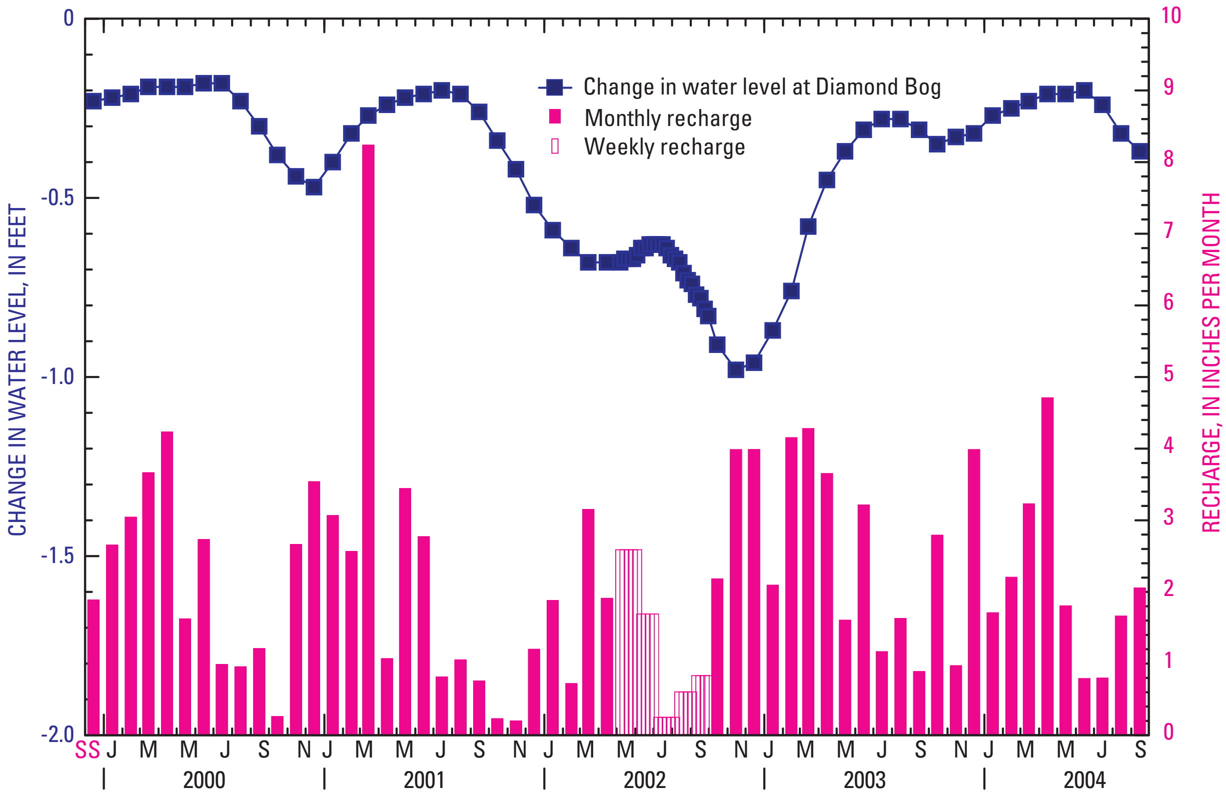


Figure 3–9. Change in water levels at Diamond Bog in response to simulated pumping at well RIW–550 in the lower Wood River model area in the Pawcatuck River Basin, southwestern Rhode Island. Months on x-axis are January, March, May, July, September, and November for years shown. Steady state (SS) represents average steady-state conditions for simulation period. (Site locations shown in figure 3–1.)

Wood River increases from 68 percent at the RIW–458 site to 77 and 88 percent from alternate sites Wells RIW–458A and RIW–458B, respectively (fig. 3–11). With the increase in captured baseflow from the Wood River, the amount of captured baseflow from Meadow Brook is reduced from about 32 to 23 percent to about 12 percent of the total amount of captured baseflow (fig. 3–11); the pumping well is capturing successively less water that otherwise would have discharged to the Meadow Brook as the well is moved closer to the Wood River.

These simulations indicate that the effect of pumping on baseflow depends on well location and that the effect can be managed so streams with higher average flow like the Wood River are affected by pumping more than streams with lower average flow like Meadow Brook. In the case of the RIW–458 simulations, as the well location was moved closer to the Wood River, the baseflow depletion in the Wood River remained less than 1 percent of the total average streamflow while the baseflow depletion in Meadow Brook diminished from about 7 percent to about 2 percent of the total streamflow.

Effects of Varying Pumping-Well Distance with Varying Pumping Rates

The previous examples have focused on the effects of constant pumping rates for municipal supply; however, a vital water use in the Pawcatuck River Basin is that of irrigation for turf farms where pumping rates are highly variable and depend upon ambient weather conditions. Currently, most of the irrigation water used for turf farms in the modeled areas is obtained from withdrawal directly from surface-water bodies. To reduce the effects on surface-water bodies during low-flow periods, which generally coincide with the largest withdrawals for irrigation, the NRCS is considering the potential benefits of utilizing the inherent lag and dampening effect of groundwater withdrawals on surface waters by replacing instream withdrawals with a groundwater well some distance away from surface waters.

The groundwater models developed for this investigation were based on the understanding that groundwater models have certain limitations regarding the simulation of highly

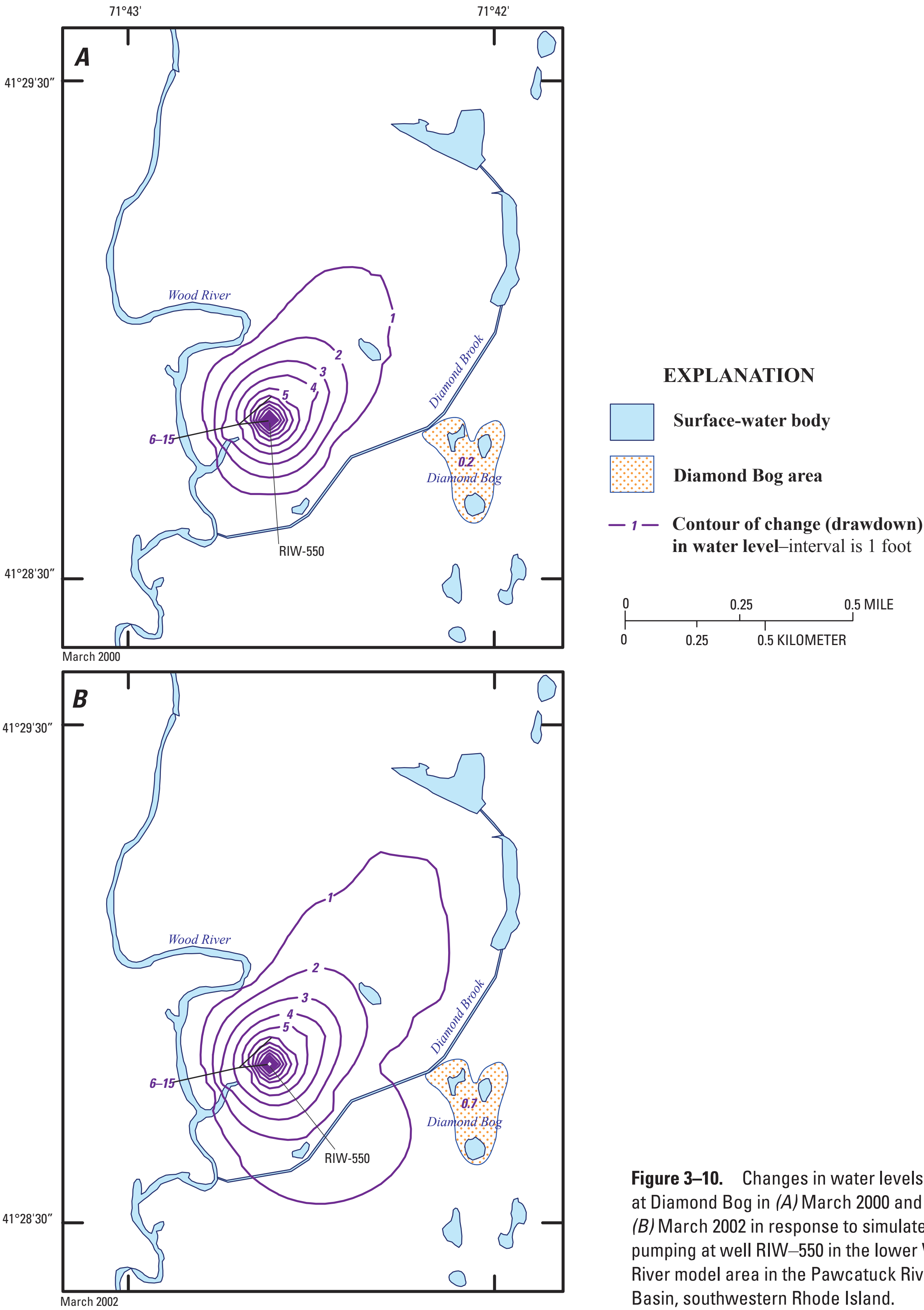


Figure 3–10. Changes in water levels at Diamond Bog in *(A)* March 2000 and *(B)* March 2002 in response to simulated pumping at well RIW–550 in the lower Wood River model area in the Pawcatuck River Basin, southwestern Rhode Island.

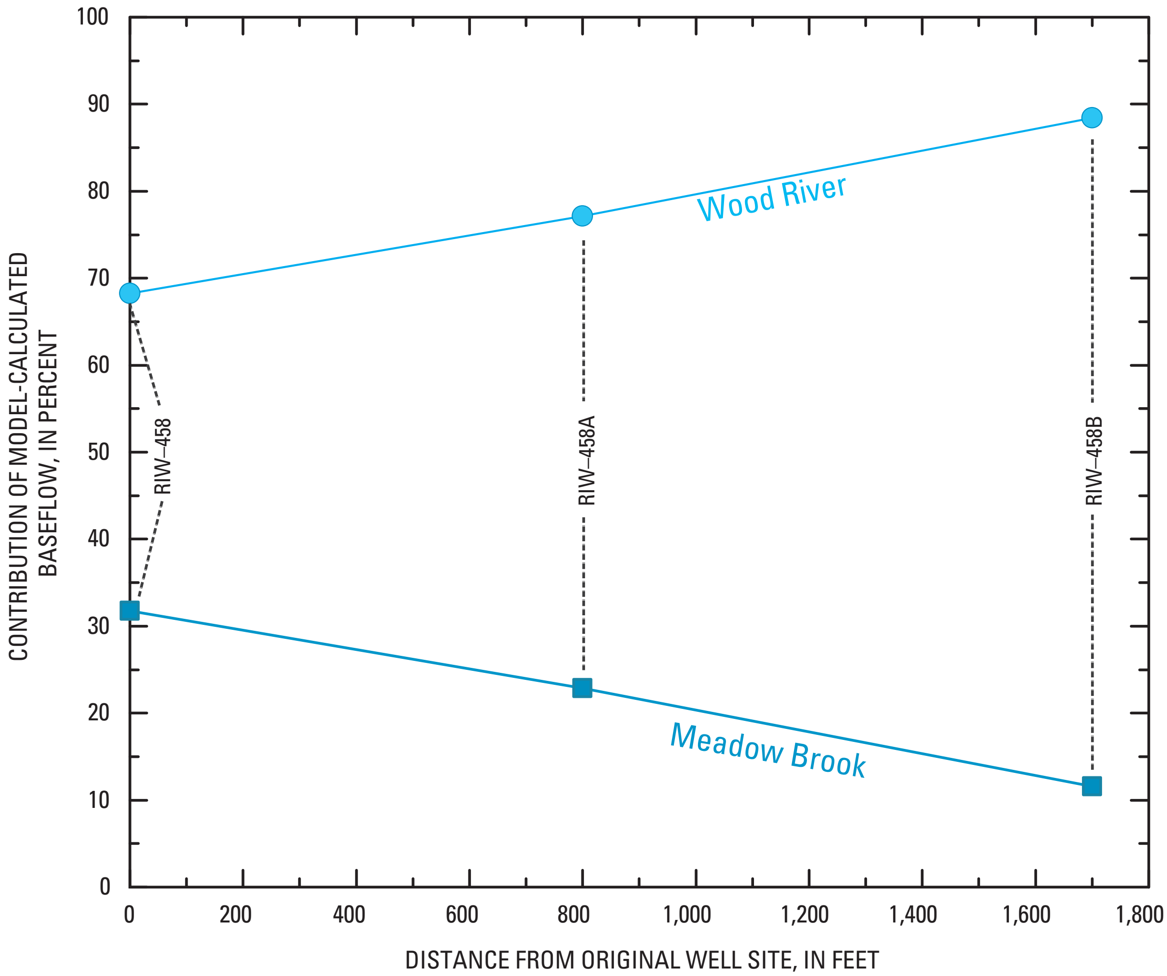


Figure 3–11. Effects of simulated pumping at different well locations RIW–458, RIW–458A, and RIW–458B on baseflow in the Wood River at HSPF subbasin WOOD5 outlet (RCHRES 63) and the Meadow Brook at HSPF subbasin MEAD2 outlet (RCHRES 48) in the lower Wood River model area in the Pawcatuck River Basin, southwestern Rhode Island. (Site locations shown in figure 3–1.)

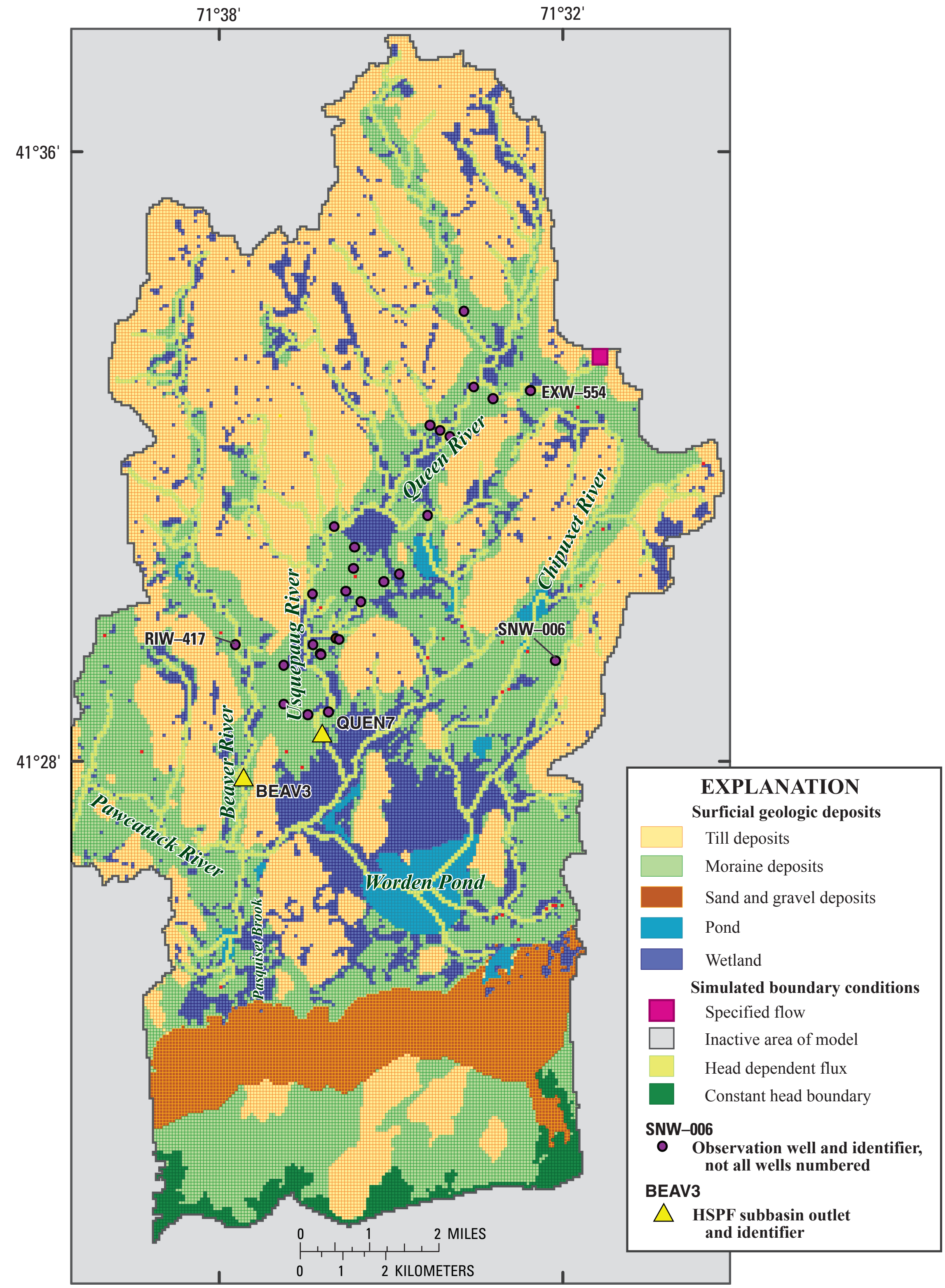
variable short-term withdrawals that are typical of actual irrigation-water demands. Because of the computational limitations on the number of stress periods that would be required to represent extremely short time periods, hourly and daily pumping rates were lumped into weekly and monthly averages, resulting in an underestimate of the short-term hourly or daily effects on the rivers from irrigation withdrawals. As a result, the effects on baseflow of highly variable withdrawals made directly from, or in close proximity to, the stream are not well represented. When highly variable irrigation withdrawals are moved from the stream, however, the response of the stream to this pumping is dampened sufficiently because of the time lag resulting from the increased distance from the stream. As a result, the time discretization of a groundwater model can adequately simulate the effects of groundwater withdrawals on baseflow.

One area for which the relocation of instream withdrawals is under consideration is the lower Beaver and Usquepaug Rivers in the eastern Pawcatuck River subbasin (fig. 3–12). Currently, there are six surface-water withdrawal points along these rivers (five in the Beaver River and one in the Usquepaug River). The NRCS proposed three scenarios in which these surface-water withdrawals are moved to six well locations (scenario A), two well locations (two groups of three, scenario B), and one centralized location between the two rivers (scenario C) (fig. 3–13A–C). The effects of pumping changes on streamflow in the Beaver and Usquepaug Rivers at the HSPF subbasin BEAV3 and QUEN7 outlets (RCHRES 43 and 20, respectively) (fig. 3–12) were assessed in these three scenarios.

Results for simulations of the three aforementioned scenarios indicate that relocating the irrigation withdrawals, which are currently in the rivers, to wells away from the rivers had little effect on baseflow for steady-state conditions (shown as “SS” on figs. 3–14A–C, 3–15A–C), but had a large effect on baseflow under varying pumping and recharge conditions. These results indicate that baseflows increased relative to current baseflows during the summer months and decreased during the fall through early spring months as the distance between the pumping wells and both rivers was increased (figs. 3–14B, 3–15C). The lag in the response of the streams to the pumping stress delayed the effects of summer irrigation pumping on baseflow until later in the fall. This pattern was repeated at BEAV3 and QUEN7 (figs. 3–14B,C, 3–15B,C) throughout the study period.

Although the absolute changes in baseflow in the Beaver and Usquepaug Rivers were similar (for example, about 1.3 ft^3/s for scenario B during summer 2002) (figs. 3–14B, 3–15B), the changes as percentages of the total flow were different because of the large differences in simulated baseflows between the two rivers (figs. 3–14C, 3–15C). In the Beaver River, the simulated baseflow in August 2002 was about 3.0 ft^3/s (fig. 3–14A), whereas the simulated baseflow in the Usquepaug River for the same time was about 14.0 ft^3/s (fig. 3–15A). Therefore, a change in flow of about +1.3 ft^3/s in the Beaver River represents about a 43 percent increase in baseflow for that month, whereas a +1.3 ft^3/s change in flow in the Usquepaug River represented only a 9 percent increase in baseflow (figs. 3–14C, 3–15C). Conversely, as the effects of pumping reached the rivers in September and the streamflow depletion was the greatest (about 0.7 ft^3/s in each river), the percent changes in flow were small (about -8 percent in the Beaver and almost -3 percent in the Usquepaug) (figs. 3–14C, 3–15C) because of the increase in baseflow in these rivers in response to increased aquifer recharge.

These results indicate that relocating instream irrigation withdrawals to groundwater withdrawals away from the rivers resulted in gains in baseflow relative to conditions during summer low-flow periods and losses in baseflow relative to conditions in the early fall when baseflow is typically higher. The benefit of this shift in the effects of pumping on baseflow from the summer to the fall is that, by the fall, streamflows are higher from increased recharge; therefore, the baseflow depletion represents a smaller percentage of the total streamflow than in the summer.



Base from U.S. Geological Survey digital data, 1995, 1:24,000
North American datum of 1983
Rhode Island state plane projection

Figure 3–12. Model extent and boundary conditions used in the eastern Pawcatuck River model area in the Pawcatuck River Basin, southwestern Rhode Island.

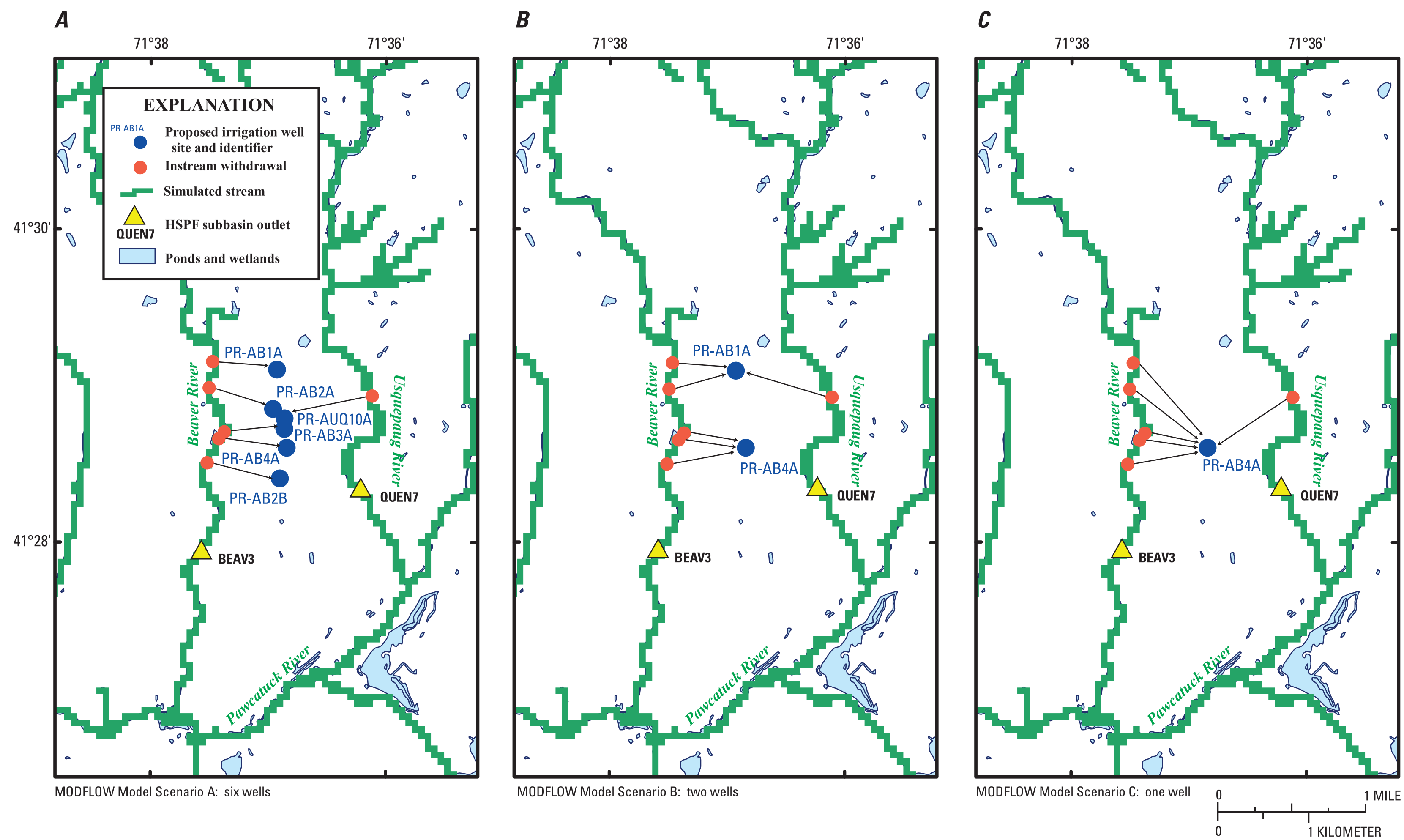


Figure 3–13. Locations of potential groundwater irrigation wells between the Beaver and Usquepaug Rivers in the eastern Pawcatuck River model area, HSPF subbasin outlets BEAV3 (RCHRES 43) and QUEN7 (RCHRES 20), in the Pawcatuck River Basin, southwestern Rhode Island for *(A)* six irrigation wells; *(B)* two irrigation wells; and *(C)* one irrigation well.

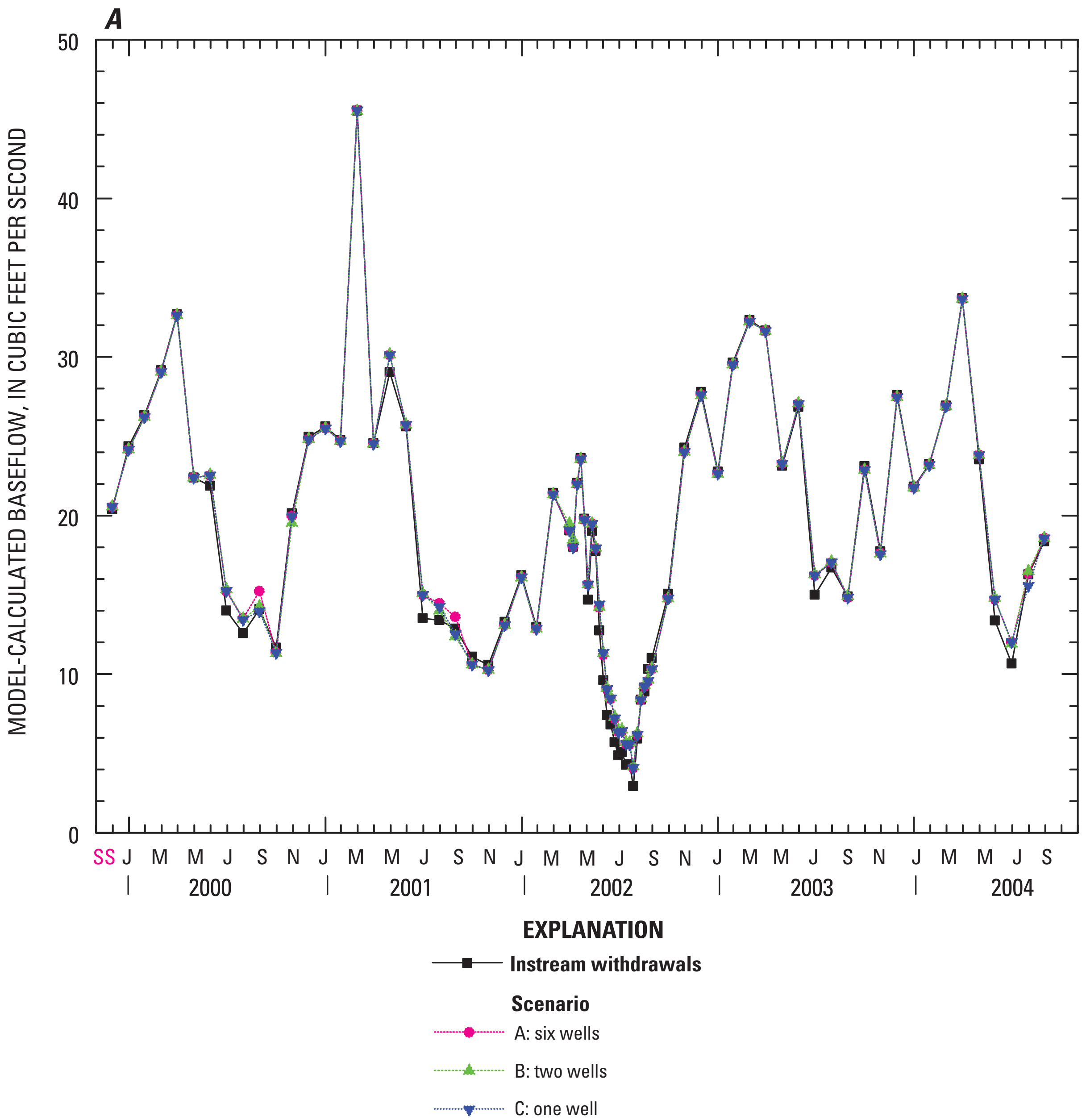
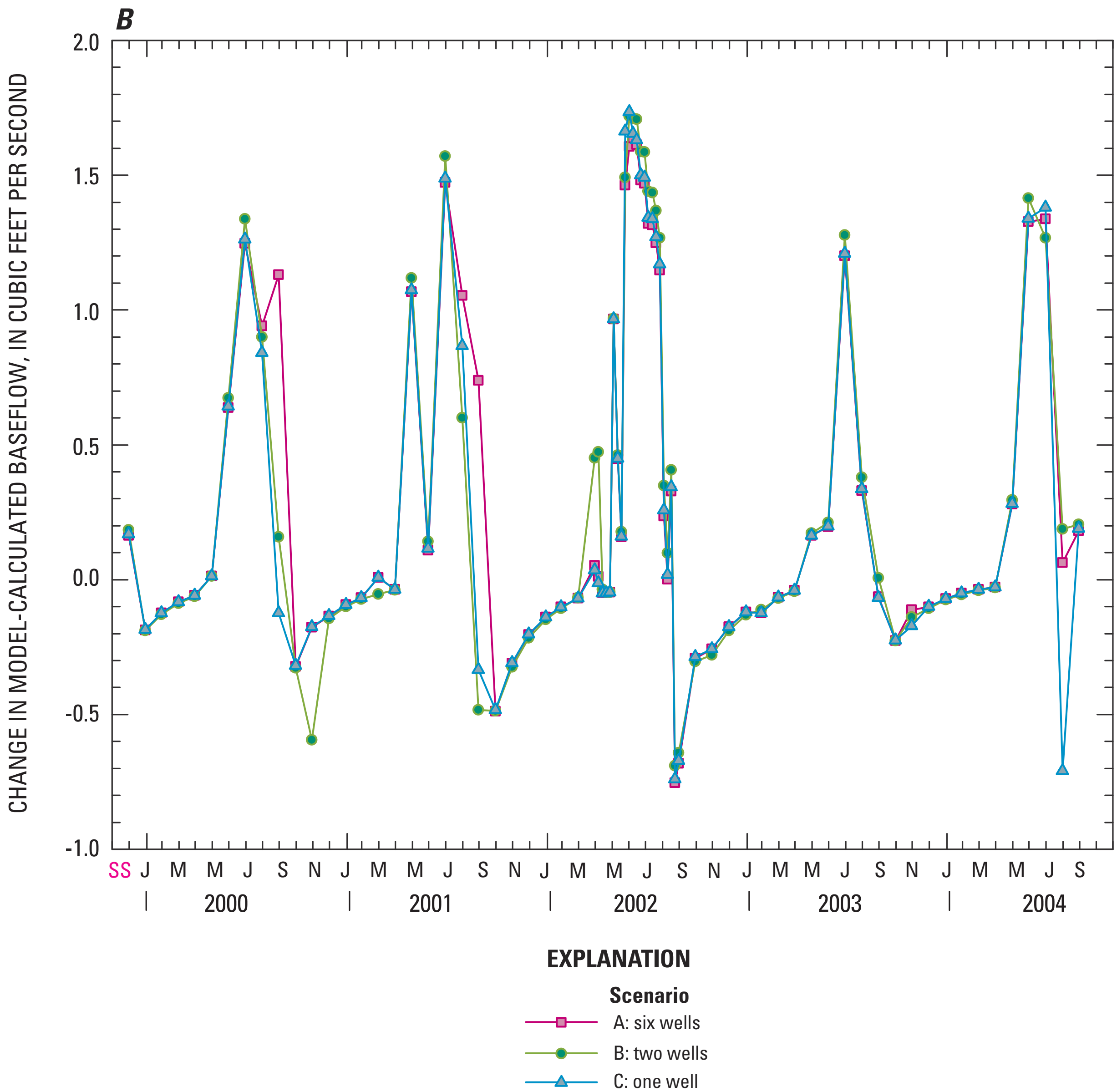


Figure 3–14. Model-calculated baseflow *(A)*, changes in model-calculated baseflow *(B)*, and percent change in model-calculated baseflow *(C)*, in three proposed groundwater irrigation withdrawal scenarios on baseflow in the Beaver River at HSPF subbasin BEAV3 outlet (RCHRES 43) in the eastern Pawcatuck River model area in the Pawcatuck River Basin, southwestern Rhode Island. Months on x-axis are January, March, May, July, September, and November for years shown. Steady state (SS) represents average steady-state conditions for simulation period. (Site locations shown in figure 3–13.)



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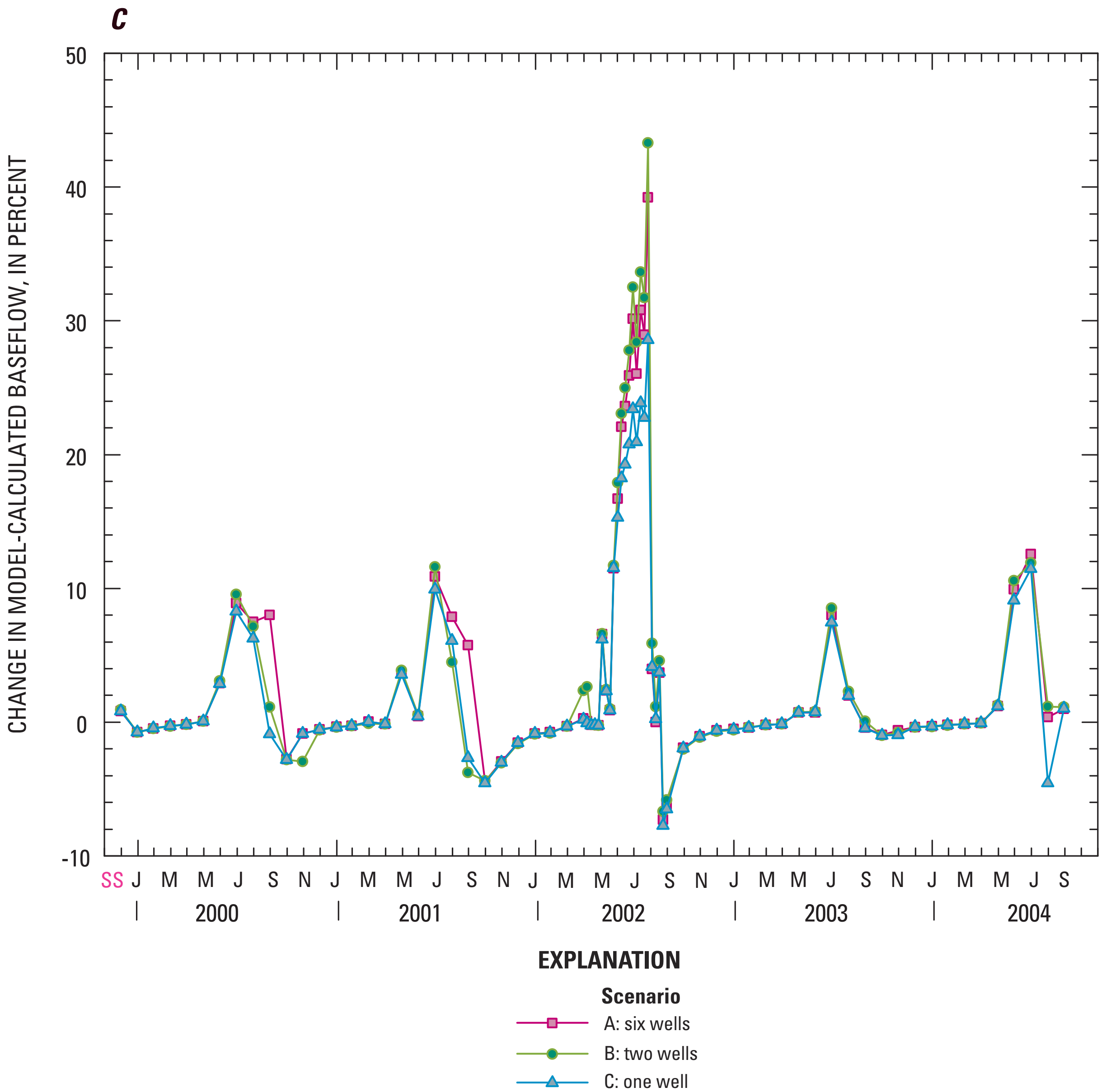

Figure 3–14. —Continued

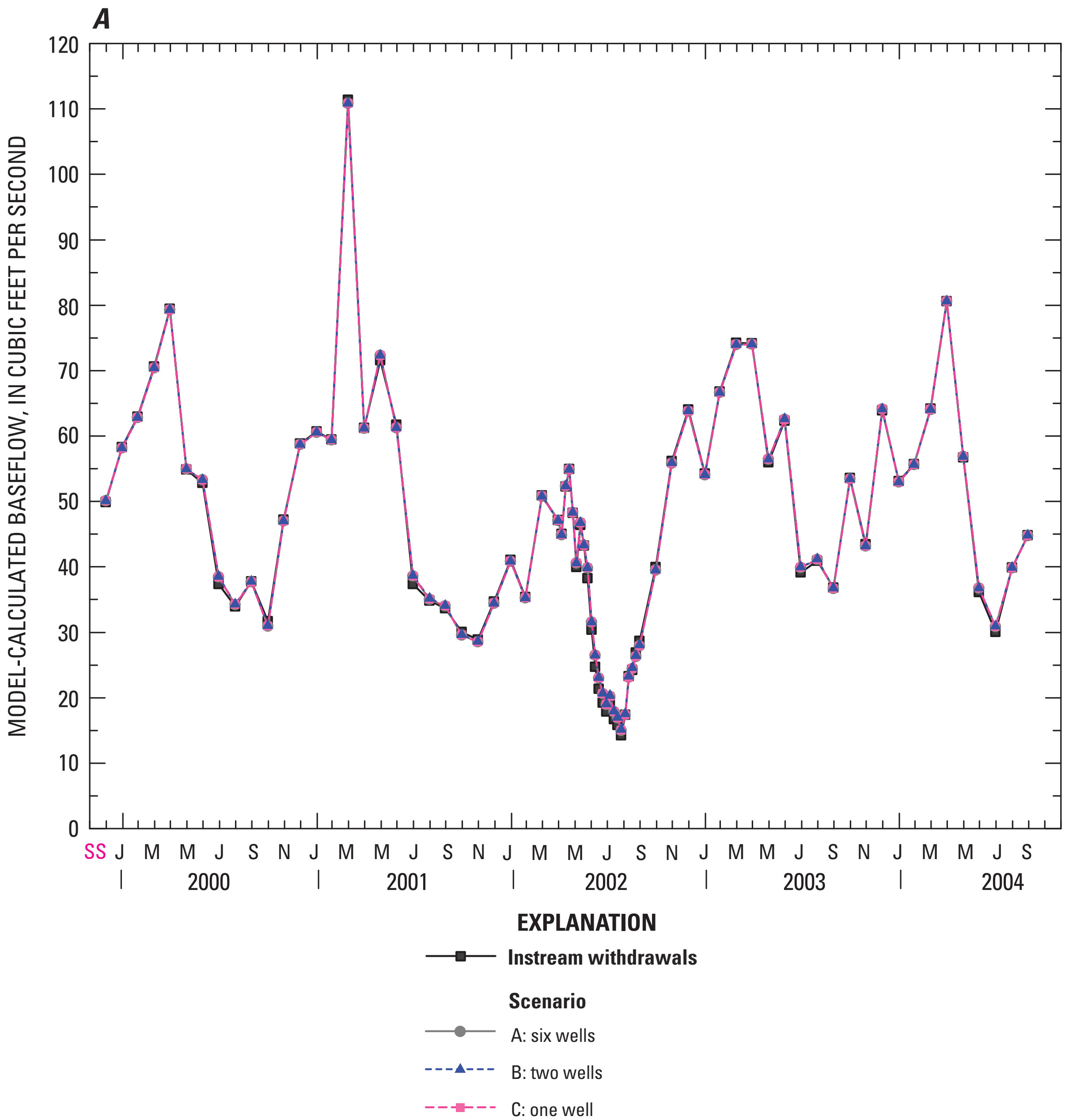

Figure 3–15. Model-calculated baseflow *(A)*, changes in model-calculated baseflow *(B)*, and percent change in model-calculated baseflow in three proposed groundwater irrigation withdrawal scenarios on baseflow *(C)*, in the Beaver River at HSPF subbasin QUEN7 outlet (RCHRES 20) in the eastern Pawcatuck River model area in the Pawcatuck River Basin, southwestern Rhode Island. Months on x-axis are January, March, May, July, September, and November for years shown. Steady state (SS) represents average steady-state conditions for simulation period. (Site locations shown in figure 3–13.)

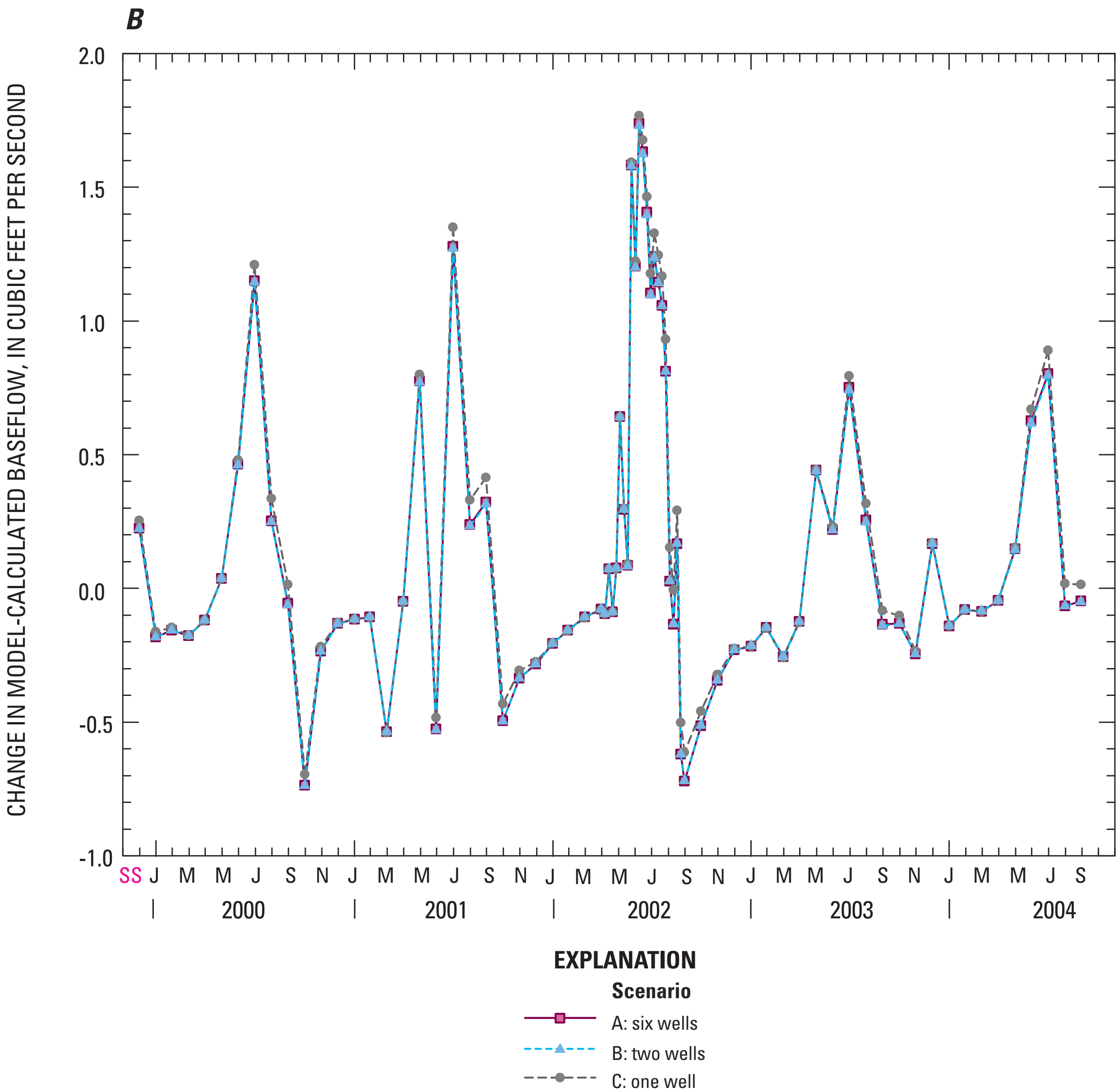

Figure 3–15. —Continued

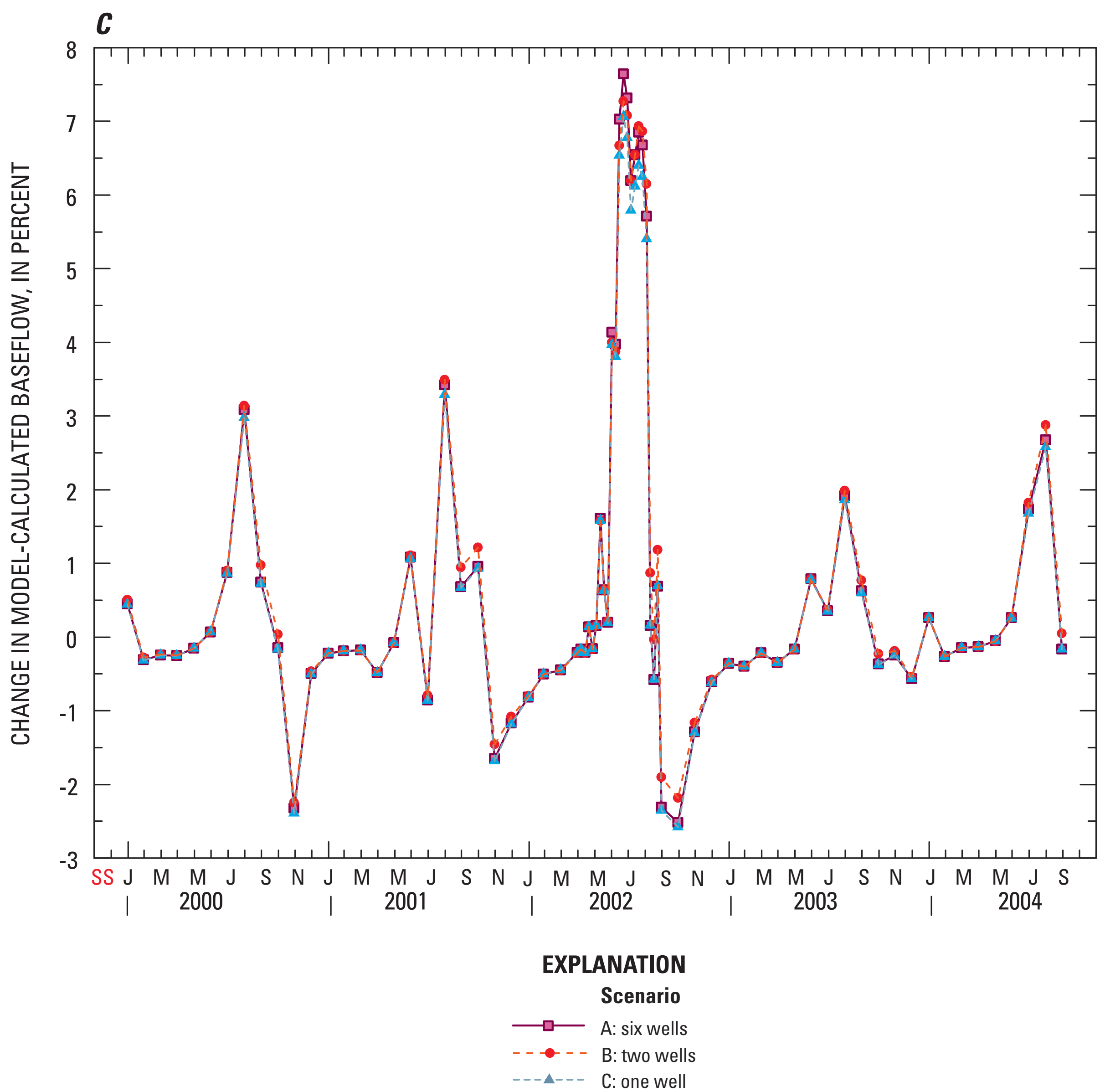

Figure 3–15. —Continued