National, Holistic, Watershed-Scale Approach to Understand the Sources, Transport, and Fate of Agricultural Chemicals: Supplemental Material Section

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This supplemental material section is an introduction to the series of articles in this issue of *Journal of Environmental Quality* that report on the results of research conducted by the U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program's Agricultural Chemicals: Sources, Transport and Fate study team (Agricultural Chemicals Team, ACT). The section contains information on the environmental settings, study design, field and laboratory methods, modeling methods and quality control for the ACT studies that began in 2002.

Summaries of the Study Areas

Five ACT studies started field activities and data collection in 2002. Each of the five study areas was contained within a NAWQA Study Unit (thousands of km^2). Most of the ACT study activities were within a NAWQA indicator watershed (hundreds of km^2). Many of the process studies were conducted at small scales, such as within a stream segment, an individual field, or a small watershed (about 3-15 km^2). The sections below summaries the environmental settings of each of the study areas based on the reports listed in Table 1.

Sampling sites were established throughout each of the study areas to measure the pathways and rates of water and agricultural chemical movement through and among various environmental compartments, including precipitation, tile drains, overland flow, unsaturated zone, ground water, and streams. There was an attempt to keep the study designs as consistent as possible, but the studies differed due to the differences of the local environmental settings and agricultural management practices. Only the study components that were locally pertinent were included. As examples, the Washington study did not include rain sampling because of paucity of rainfall in that study area, and the Indiana study was the only area that included a tile drain component (Stone and Wilson, 2006). In the sections below, the ACT local study character is presented for each of the five study areas. Figures 1-5 contain maps for each of the areas. Table 2 presents site descriptions and a list of equipment that was used in each ACT study.

California

The Mustang Creek Basin (54.4 km^2) and the lower Merced River Basin (831 km^2) are nested watersheds in central California For the purpose of this study, the Mustang Creek Basin was divided into an upper basin of 17.5 km^2, and a lower basin of the remaining area. A flood control reservoir that holds excess water during severe winter storms separates the upper and lower basins. The lower Merced River Basin has an arid-to-semiarid climate characterized by hot summers and mild winters, with temperatures ranging from a mean of 25°C in July to a mean of 8°C in January. The mean annual precipitation is 31 cm. Eighty percent of the precipitation falls during November through March. Most crop water demands are met with irrigation, primarily in March through September. Evapotranspiration plays a large role in the water budget of these basins. An average of about 140 cm of moisture returns to the atmosphere as a result of evaporation and transpiration (California Department of Water Resources, 1999).

Mustang Creek contributes only about 0.01 m^3/s to the flow of the much larger Merced River (19.4 m^3/s at the mouth). The Merced River is highly engineered and used for agricultural irrigation, and streamflow generally decreases from the upper basin to the mouth. The depth to ground water beneath Mustang Creek is about 45 m, which prevents ground-water seepage into the stream. Mustang Creek is usually dry, except during prolonged winter storms.

Most of the area of both study basins is within the flat structural basin of the San Joaquin Valley, on the east side of the San Joaquin River, with only the upstream sides of the basins extending into the lower foothills of the Sierra Nevada Mountains. The elevation gradients average about 2.5 m/km on the valley floor and 26.7 m/km in the foothills. The San Joaquin Valley is a large, northwest-trending, asymmetric structural trough filled with marine and continental sediments. Alluvial deposits in the eastern part of the valley were derived primarily from the weathering of granitic intrusive rocks of the Sierra Nevada Mountains. These sediments are highly permeable, medium- to coarse-grained sands with low total organic carbon that form broad alluvial fans where the streams enter the valley. These deposits generally are coarsest near the upper parts of the alluvial fans and finest near the valley trough. Dune sand, derived from the alluvial deposits, consists of well-sorted medium-to-fine sand, as much as 43 m thick. This dune sand is predominant in the lower Merced River

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Basin downstream from Mustang Creek, whereas stream-channel deposits along the Merced River consist primarily of coarse sand and gravel. Most of the unconsolidated deposits in the study area are contained within the Turlock, Riverbank, and Modesto Formations. These formations form a sequence of overlapping terrace and alluvial fan systems that indicate cycles of alluviation, soil formation, and channel incision that were influenced by climatic fluctuations and resultant glacial stages in the Sierra Nevada Mountains.

The Corcoran Clay, at the base of the upper Turlock Formation, is a lacustrine deposit that is a key subsurface feature in the San Joaquin Valley. The eastern extent of the Corcoran Clay roughly parallels the San Joaquin River valley axis. The Corcoran Clay within the study area ranges in depth from 28 to 85 m below land surface (BLS), and in thickness from 0 to 57 m. The Mehrten Formation is a key subsurface feature tapped by wells in the eastern part of the study area. The Mehrten Formation reflects a change in lithology and texture from overlying sediments of primarily unconsolidated, coarse-grained sediments of arkosic composition to Mehrten Formation sediments of primarily consolidated sediments of volcanically derived mafic materials.

Ground-water occurs primarily in the unconfined to semiconfined aquifer above and east of the Corcoran Clay and in the confined aquifer beneath the Corcoran Clay. The unconfined to semiconfined aquifer above the Corcoran Clay ranges in thickness from about 40 to 70 m. The unconfined to semi-confined aquifer east of the Corcoran Clay is composed primarily of alluvial sediments, but includes the upper part of the Mehrten Formation. The confined aquifer is composed of alluvial sediments and upper Mehrten Formation sediments from beneath the Corcoran Clay to the deepest extent of fresh water. Ground-water resource development in the basin has changed the ground-water flow regime. Agricultural irrigation pumping and return flows are much greater than natural recharge and discharge, causing an increase in vertical flow in the system. Ground water moving along a horizontal flowpath may be extracted by wells and reapplied at the surface several times before reaching the valley trough. In general, ground-water flow is toward the San Joaquin River to the west.

Soils in the lower Merced River Basin include silt loam, sandy loam, and loam. The finer silt loam soils are located in the upper reaches of the lower Merced River Basin. The coarser sandy loam and loam soils are located in the lower part of the basin, with the loam soils predominantly along the Merced River and Dry Creek stream channels. In the Mustang Creek subbasin, more detailed investigation of the soils revealed the location of a hardpan layer near the surface on the eastern side of the basin.

Approximately 55% of the lower Merced River Basin, predominantly on the valley floor, is covered by agricultural land. The dominant agricultural land use is almond orchards (45% of agricultural land), corn and grain (16%), and vineyards (12%). In 2003, 285 different chemicals were applied to the basin and counties overlapping the Merced River Basin. Pesticides applied for agricultural uses totaled almost 1.0 million kg. Fertilizer applications were estimated at 7.3 million kg for nitrogen and 0.43 million kg for phosphorus. Nutrients from manure were estimated at 5.9 million kg for nitrogen and 1.3 million kg for phosphorus. Within the smaller Mustang Creek watershed, estimated 2003 annual use of nitrogen was 0.65 million kg, and that for phosphorus was 0.03 million kg.

Population in the lower Merced River Basin is estimated at 39,230 from the 2000 Census, a 19% increase since the 1990 Census. The areas of highest population density are around the communities of Delhi, Livingston, and Winton, on the valley floor. The Sierra Nevada foothills adjacent to the valley are sparsely populated.

Water availability in the San Joaquin Basin is characterized by a water-year index used by the State of California for water allocation and regulation. On the basis of this index, there were 6 years of above-normal conditions (wet) from 1995 through 2000 and 4 years of below-normal conditions (dry) from 2001 through 2004. Annual mean streamflow in the Merced River for water years (October 1 through Spetember 30) 2003 and 2004 was low compared to the long-term mean annual streamflow. A storm on February 23, 2004, produced a peak streamflow of 5.9 m^3/s in Mustang Creek, which has strong response to storms.

The ACT study area is the lower Merced River watershed, located on the eastern side of the San Joaquin River (Figure 1). Within the Merced River watershed, two areas were studied intensively from 2003 to 2005—the Mustang Creek watershed and an area surrounding a ground-water flowpath from an agricultural setting to the Merced River.

Two precipitation sites (site designators in Figure 1.c: C47, C48) within the Mustang Creek watershed were sampled and analyzed for targeted pesticides, their transformation products, and nutrients. A third precipitation site (Figure 1.d: C49) was located in an almond orchard at the head of the ground-water flowpath near the Merced River. Meteorological data, including rainfall, wind speed and direction, solar radiation, air temperature, and relative humidity, collected at these three sites were used to estimate the areal distribution of chemicals to the watershed from rainfall.

A surface-water site along Mustang Creek (Figure 1.c:C13) and a site near the mouth of the Merced River (Figure 1.b:10) were sampled and analyzed for nutrients, pesticides, major ions, organic carbon, and suspended sediment. An overland flow site (Figure 1.c:C41) was also sampled for the same constituents. Streamflow was recorded at one site along Mustang Creek. The California Department of Water Resources measured streamflow on the Merced River. Dye studies were conducted during the rainy season to determine travel times along the Mustang Creek. The primary goal of the surface-water sampling was to identify temporal

patterns in the concentrations of selected pesticides and nutrients and to relate these patterns to surface-water transport processes.

Multi-depth monitoring wells were installed along a ground-water flowpath (Figure 1.d:C20-22) from an agricultural setting to the Merced River. Water sampled from these 15 monitoring wells in April, June, and October 2004 was analyzed for field parameters, nutrients, major ions, and isotopes. The same type of sampling was done at a monitoring well located in the Mustang Creek watershed (Figure 1.c:C31). During the June sampling, the water from the monitoring wells was also analyzed for pesticides, SF_6 age dates, and dissolved gases. At this site, 10 core samples were collected from the saturated zone and analyzed for bulk density, particle-size distribution, iron/sulfide minerals, pesticides and carbon, and mineralogy. Ground-water level measurements and water samples (for chemical and age-dating analyses) collected from the multi-depth monitoring wells provide information about movement of water and chemicals through the aquifer system beneath the water table.

An unsaturated-zone sampling site was located in an almond orchard near the head of the ground-water flowpath and the meteorological station (Figure 1.d:C20). Two 30-cm by 30-cm pan lysimeters were installed at about 1 m depth in addition to suction lysimeters at 1 m, 3.4 m, 4.6 m, and 6.1 m depths. These lysimeters were sampled in April, June, and October 2004 (and after some storms and irrigation events) for analysis of pesticides, nutrients, major ions, and isotopes. Potassium bromide was applied to the soil surface above the lysimeters twice during the study to monitor the conservative transport of bromide through the soil. Five heat dissipation probes and three soil moisture probes were also installed at the unsaturated zone site to collect data every 4 hours to measure water flux. The soil moisture probes were installed at depths of 0.3, 0.6, and 1 m below land surface (BLS). The heat dissipation probes were co-located with the suction lysimeters.

These sampling activities in the unsaturated and saturated zones helped characterize the movement of water and chemicals from the land surface through the unsaturated and saturated zones, and between surface water and ground water. Two transects were set up across the Merced River and its raparian zone at the toe of the ground-water flowpath (Figure 1.f:C61-C69, C81-C89). Five sets of paired monitoring wells were installed at each transect, three in the river and one on each bank. The transects were installed about 100 m apart. The paired monitoring wells were screened at about 0.5 m and between 2 to 3 m depth below the streambed. A subset of the monitoring wells was equipped with pressure transducers, temperature probes, and water-quality monitors for continuous data collection of hydraulic gradient, temperature, pH, specific conductance, and dissolved oxygen. The temperature probes inside the monitoring wells were located at depths of 0.5, 1, and 2 m below the streambed. Small hand-driven sampling ports (drive points, screen length 0.91 cm): were installed next to the monitoring wells at depths of about 0.3, 0.5, and 3 m below the streambed. These 30 drive points had Teflon tubing (0.635 cm OD) attached, which was routed to the banks. The 30 ports were sampled by peristaltic pump for water-quality constituents. They were sampled in April, June, and October 2004 for analysis of nutrients, major ions, and isotopes, and in June only for analysis of pesticides, SF_6 age dates, and dissolved gases. Synoptics surveys of the streambed using temporary drive points were conducted in April and October at about 30 sites upstream, between, and downstream of the 2 fixed transects (Figure 1.f:C51-95). A manometer board was used to record the hydraulic gradients between the river and at specified depths below the streambed at each site. Temperature was recorded in the river and at depths of 0.3, 0.5, and 1 m below the streambed at each site. A temporary drive point was used to measure dissolved oxygen, pH, and specific conductance, and to collect samples for analysis of water-quality constituents with colormetric field tests (including sulfide, nitrate, iron, and orthophosphate). The continuous temperature measurements at the two fixed transects were used to estimate ground-water/surface-water interaction by simulating heat transport. Eight core samples were collected from the streambed and analyzed for bulk density, particle-size distribution, and iron/sulfide minerals. Estimates of hydraulic conductivity were calculated from the results of the particle-size analysis and slug tests conducted in 18 of the 20 monitoring wells. Seepage meters were deployed near the transects to directly measure ground-water flux (Figure 1.e:C61-C66, C81-C86). These data collection activities will be used to characterize the movement of ground water and chemicals into the Merced River and assess the chemical transformations that occur as the water moves through the different zones.

Indiana

Leary Weber Ditch Basin (7.23 km^2) and Sugar Creek Basin (239.8 km^2) are nested watersheds located in central Indiana within the White River Basin. The area has moderate temperatures ranging from a mean of 23.8°C in July to a mean of -3.8°C in January. Mean annual precipitation is 100.3 cm. Normally, precipitation is evenly distributed throughout the year, with total amounts in spring and early summer exceeding that of winter. Rain in spring is considered reliable but decreases throughout the summer. Occasionally, heavy spring rains delay crop planting. Evapotranspiration plays a large role in the water budget of both basins. In Indiana, an average of 65 to 75 cm of moisture returns to the atmosphere as a result of evaporation and transpiration.

Leary Weber Ditch contributes only about 0.09 m^3/s to the flow of the much larger Sugar Creek (2.9 m^3/s at the mouth). At baseflow, there is little to no ground-water seepage into Leary Weber Ditch. Sugar Creek's baseflow is mainly

from ground water; however, Sugar Creek receives small amounts of ground-water input compared to other nearby streams. Leary Weber Ditch has periods of very low flow. Periods of complete dryness have been documented. There were 97 days of no recorded flow in 2003 and 73 days in 2004. Leary Weber Ditch is primarily a tile-drain fed stream, and the tributaries of Sugar Creek are mostly tile-drain fed.

Physiographically, both basins are completely contained within the New Castle Till Plains and Drainageways, an area that was glaciated, leaving behind a till plain and major glacial drainageways. The valley grades of Leary Weber Ditch (2.07 m/km) and Sugar Creek (1.10 m/km) differ substantially. Most of the Sugar Creek Basin and the entire Leary Weber Ditch Basin overlie a combination of Devonian limestone and dolomite bedrock. Unconsolidated materials (sand and gravel) overlie much of the bedrock in the basins.

Four major types of aquifers underlie the Sugar Creek and Leary Weber Ditch basins. The two types most prominently used for water supply are surficial sand and gravel aquifers, which are located adjacent to major drainages, and buried sand and gravel aquifers, which are found at different horizons in the drift.

Soil types in the Sugar Creek and Leary Weber Ditch basins are broadly identified as either loam or silt loam. Soils are generally deep, very poorly to somewhat poorly drained, fine to medium granular textured, and nearly level. Chances of surface erosion are negligible as runoff is slow. Available water capacity is high; organic matter is high to moderate. These soils are naturally suited to row crops such as corn and soybeans. Successful farming requires lowering the water table, removing ponded water, improving fertility, and insuring good soil tilth.

Agriculture is the principal land use in the Leary Weber Ditch and Sugar Creek basins. Respectively, 87% and 75% of the total land area in these basins are used for row crops. Crops grown in the basins are split nearly equally between corn and soybeans. Growers in the area employ a broad variety of fertilizers, herbicides, and pesticides. Irrigation and manure application in the study area are minimal.

The study area is sparsely populated in small communities and rural areas, and neither basin has a large city. The population of Hancock County is approximately 61,000. Water use is about 24,000 m^3/d. Drinking water comes entirely from ground water (21,690 m^3/d).

Floods in the Sugar Creek and Leary Weber Ditch are caused by spring rains on frozen or saturated soils, by heavy summer thunderstorms, and by fall rains after harvest. The worst flood in the study basin, with an estimated occurrence interval exceeding 100 years, occurred in 1913. Periodic droughts in central Indiana have lasted from weeks to years. The lack of water negatively affects the population, livestock, and agriculture. The worst drought ever recorded extended from 1933 through 1936, with a recurrence interval of 25 to 60 years. The record 7-day minimum streamflow recorded at the Sugar Creek gaging station was 0.007 m^3/s, during September 16-22, 1999.

Three major modifications have been made to the natural hydrology of the Sugar Creek Basin. First, substantial amounts of subsurface drainage have been installed in the form of tile drains. Tile drains permit better timing of seasonal cultivation, lower the cost of cultivation, and improve seed germination, but they may also facilitate the transport of water and chemicals into streams. Second, several major roads cross Sugar Creek as it flows south, possibly affecting the hydrology and water quality. Finally, outflow from a water treatment plant is located just upstream from the gaging station on Sugar Creek, adding an estimated 0.014 m^3/s of flow. Water-quality samples are collected nearly 1.8 km upstream from the gaging station, where the creek is unaffected by treatment plant outflows. The basin contains other small wastewater-treatment plants as well.

Eight study sites were established in the ACT study area (Figure 2): north (Figure 2.c:I32, 33, I47, I49), south (Figure 2.c:I30, I31, I48), overland flow (Figure 2.c:I41), Leary-Weber Ditch gage (Figure 2.b:I13), ground-water/surface-water interaction study area (Figure 2.e:I51-I99), Sugar Creek water-sampling site (Figure 2.b:I10), and Sugar Creek gage (Figure 2.b:I11).

The Sugar Creek Basin (239.8 km^2) is located in the White River Basin. The water-sampling site on Sugar Creek is located 15.9 km downstream from the confluence of Leary Weber Ditch and Sugar Creek (Figure 2.b:I10). At this site, water-quality samples were taken for comparison with samples from Leary Weber Ditch. Similarly to the Leary Weber Ditch, samples were taken during baseflow and storms. Baseflow samples were taken manually. Storm samples were collected by an autosampler triggered by rising water levels. A continuous water-quality monitor measured temperature, specific conductance, pH, and dissolved oxygen. The Sugar Creek gaging station is 1.8 km downstream from the Sugar Creek water sampling site and records gage height and discharge (Figure 2.b:I11).

The Leary Weber Ditch Basin has an area of 7.23 km^2 (Figure 2.b:I13). The gaging station, which continuously records stage, is 0.51 km upstream from the confluence with Sugar Creek. This site integrates a mixture of water from precipitation, tile drains, overland flows, and ground-water inflows. Surface-water samples were collected at baseflow and during heightened flows caused by storms. A continuous water-quality monitor measured temperature, specific conductance, pH, and dissolved oxygen.

The purpose of the north site (Figure 2.c:I32, I33, I47, I49) is to assess the water quantity (Figure 2.c:I49) and quality of precipitation (Figure 2.c:I47), to monitor important weather parameters to provide a calculation of potential evapotranspiration (Figure 2.c:I49), and to study the transfer of water and chemicals through the unsaturated zone and into the ground water (Figure 2.c:I32, I33). Suction lysimeters

were placed at 0.9, 1.2, 1.5, and 1.8 m BLS to collect water samples in the unsaturated zone. Two pan lysimeters were placed at 0.7 m depth to monitor macropore flow from the surface. Wells were located at 1.2, 1.8, 2.4, and 3.0 m BLS to monitor the saturated zone (Figure 2.c:I2:32, I33). Time Domain Reflectometers (TDR) were located at 0.6, 0.9, and 1.2 m BLS to measure soil moisture.

The purpose of the south site (Figure 2.c:I30, I31, I48) is to assess variability in precipitation amounts in the basin and to establish unsaturated-zone and ground-water quality. The south site is located in the southern portion of the Leary Weber Ditch Basin. Here, as with the north site, the amount of precipitation is quantified, but no water-quality analyses were performed on precipitation samples from this site (Figure 2.c:I48). Suction lysimeters (Figure 2.c:I30) were placed at 0.9, 1.2, 1.5, and 1.8 m BLS to collect water samples in the unsaturated zone. Wells (Figure 2.c:I31) were located at 1.2, 1.8, 2.4, and 3.0 m BLS to monitor ground-water quality and ground-water movement. No pan lysimeters or TDRs were installed at this site.

The tile-drain site (Figure 2.c:I40) was established to monitor flows and water quality from a tile drain. The outflow is located on the south side of Leary Weber Ditch 3.80 km upstream from the gaging station (Figure 2.b:I13). This particular tile drain was selected due to its medium level of flow compared to other tile drains. This tile drains approximately 4.2 hectares of nearby fields. The purpose of collecting data at this site is to document the tile drain flows and to collect water-quality samples from a representative tile in the basin. Comparisons will show if infiltration carries with it any constituents of interest.

The overland-flow site (Figure 2.c:I41) is approximately in the middle of Leary Weber Ditch Basin, 2.33 km upstream from the Leary Weber Ditch gaging station (Figure 2.b:I13). This site is situated at the bottom of a small decline directly adjacent to a field. The site is positioned so that all surficial runoff from the adjoining area, approximately 1.4 hectares, must pass through the instrumentation. With the use of a calibrated flume, observation of overland flow rates and calculation of discharge were possible. Additionally, water samples were collected from runoff flows.

The ground-water/surface-water interaction study area (Figure 2.e:I35-I38, I51-I99) is approximately 0.35 km downstream from the Leary Weber Ditch gaging station and just upstream from the confluence of Leary Weber Ditch with Sugar Creek. The main purpose of this site is to measure the movement and interaction of water and chemicals between stream water and ground water in Leary Weber Ditch. Five transects were used in and near the stream to collect subsurface water samples and measure the hydraulic gradient between the stream and the subsurface by use of drive-point samplers, piezometers, and temporary piezometers. Samples were collected from three depths (0.3 m, 0.5 m, and 1.0 m below the sediment-water interface) in the channel and at two depths (0.5 m and 1.0 m BLS) on the right bank during a seasonal low-flow period and a seasonal high-flow period in 2004. Within this set of five transects, two transects of fixed piezometers are used to monitor water level and temperature (Figure 2.e:I71-I74, I91-I94). In the fixed network, water was collected at two depths (0.5 m and 2 m) in four locations across two of the stream transects. Fixed network wells were sampled during April, June, and October 2004. Water level and temperature were recorded continuously in four of the locations within this fixed network—two depths at two locations along each of the fixed transects. Seepage meters were employed at six locations at this site to provide a water flux measurement (Figure 2.e:I52, I71, I73, I83, I92, I93). Streamflow was measured at each end of the study reach during the seasonal low-flow and high-flow sampling to provide measurements of streambed flux along the study reach. Surface-water levels and temperature were monitored at the two fixed transects (Figure 2.e: I73, I93). A continuous water-quality monitor at the gaging station measured temperature, specific conductance, pH, and dissolved oxygen of the surface water (Figure 2.b:I13). Continuous water-quality monitoring probes were placed in streambed piezometers at depths of 0.5 and 2.0 m at the upstream fixed transect (Figure 2.e:I73).

Maryland

The Morgan Creek Basin is a 31-km^2 watershed in Kent County, Maryland, on the Delmarva Peninsula, which covers about 15,500 km^2 and includes most of the State of Delaware and parts of Maryland and Virginia east of the Chesapeake Bay. The area has moderate temperatures that range from a mean of 25.2^{o}C in July to a mean of 0.67^{o}C in January. The mean annual precipitation is 112 cm. Precipitation is relatively evenly distributed throughout the year, from 7.6 to 10.1 cm per month; spring and summer (March–September), however, tend to be slightly wetter than autumn and winter (October–February). Anomalously high precipitation can occur in summer to early autumn due to occasional hurricanes and tropical storms. Thunderstorms can also produce relatively high localized precipitation, which occurs over the Morgan Creek Basin during the summer months. Evapotranspiration has a large role in the water budget. In the study area, an annual average of 78.4 cm of moisture moves into the atmosphere as a result of evaporation and transpiration, predominantly during the growing season from April to September.

Mean daily streamflows for Morgan Creek at Kennedyville, Maryland (Figure 3.c:M13) are highly variable, and somewhat flashy due to the relatively small area of the basin. Frequent storms, which maintain saturated conditions in the basin, help to sustain a stream that was greater than the long-term average for this site. The long-term median baseflow for Morgan Creek is 59% of total flow, indicating

that total streamflow is most often dominated by sustained ground-water contribution. Surface runoff accounts for the other 41% of total streamflow and dominates during and just after precipitation events. Low flows are considered to be discharges less than 0.09 m^3/s (90-percent exceedance), and high flows are discharges greater than 0.85 m^3/s (5-percent exceedance).

The study area lies within the Coastal Plain Physiographic Province, which generally is a flat, seaward-sloping lowland with areas of moderate topographic relief. The Morgan Creek Basin lies within a well-drained upland region, which includes permeable soils and sediments that are incised by stream valleys.

The surficial aquifer in the study area consists of permeable quartz sand and gravel underlain by less permeable marine sand, silt, and clay. The depth to the water table ranges from less than 0.4 m BLS in the floodplain to 12 m in upland areas. Ground water generally flows from uplands toward the Morgan Creek floodplain at a variety of depths and velocities. Because the soils and sediments are permeable and porous, some fraction of the chemicals applied to the land surface moves downward to the water table, from which they migrate to discharge areas near Morgan Creek.

Soil types in the Morgan Creek Basin are predominantly silt loams that have some clay but a higher proportion of silts and sands. These soils are commonly found in the upland regions and in sloped areas away from drainages in the study area. More than half of the soils in the study area are classified as either well drained or moderately well drained. Available water capacity is moderate to high. In cultivated areas, the potential for soil erosion is mostly moderate. The soil is strongly to extremely acidic in un-limed areas. These soils are classified as prime farmland and are well suited to most crops, including row crops, pasture, hay, and specialty crops such as nursery stock.

Agriculture is the principal land use in the Morgan Creek Basin, as well as throughout the entire Delmarva Peninsula. Most agricultural land is used for row crops such as corn, soybeans, and small grains, and slightly less is used for pasture and hay production involving alfalfa, clover, and various perennial grasses. The study area also has several dairy operations. Farm management includes fertilizer and herbicide applications, different tillage practices, liming, forested riparian buffers, grassed waterways, and sediment retention ponds. Irrigation in the study area is minimal.

The ACT study area is in a rural part of central Kent County, about 15 km northeast of Chestertown, Maryland. There are at least 327 people per km^2 throughout the study area, except in the village of Kennedyville, where population density is greater. The population in Kent County, Maryland, increased approximately 10% from 1990 to 2004.

Both surface- and ground-water use is permitted in the Morgan Creek Basin by the Maryland Department of the Environment. Within Kent County, permitted ground-water withdrawals range from 0.38 to 30 m^3/day for small users and 30 to 2,678 m^3/day for large users. Small-scale uses include livestock watering, seasonal pond filling, and irrigation of lawns, gardens, recreational complexes, small businesses and restaurants. Large-scale ground-water uses include farm irrigation, livestock watering, and sanitation. Surface-water withdrawals are limited, and used for farm irrigation. There are no known or permitted surface-water withdrawals for use as drinking water.

Flooding in the Morgan Creek Basin occurs occasionally when precipitation is of great intensity and/or long duration. High flows are almost always attributed to storms, and stormflows will infrequently inundate parts of the floodplain. The greatest instantaneous discharge, measured at Morgan Creek at Kennedyville (Figure 3.c:M13), was 317 m^3/s, during Hurricane Floyd, on September 16, 1999. Most extreme flood events are related to hurricanes passing near the area. During the study period, low-flow conditions existed only during early October of water year 2003, a remnant of drought conditions during the summer of 2002. The smallest discharge ever recorded for the period of record was 0.017 m^3/s on August 28-29, 1966, during the summer drought of 1966.

Natural hydrologic processes dominate water movement in the basin; however, some non-natural modifications affect streamflow and water quality. These features include grassed waterways that direct overland runoff, and small (less than 0.04 ha) sediment retention ponds, which are common on many farms. Other human perturbations to the basin's hydrology include limited ground-water withdrawals for agricultural and municipal uses and a few permitted surface discharges to Morgan Creek.

In this study, sampling locations were established to study the movement of water and associated chemicals in a flow system from a recharge area in the upland area of an agricultural field to Morgan Creek (Figure 3). Three locations were established in the upland field (corn/soybean/small grain rotation)—an uphill recharge area (Figure 3.c:M22), a mid-field location (Figure 3.c:M21) adjacent to the meteorological station (Figure 3.c:M48), and a lower field location (Figure 3.c:M20). The field was just upstream from the Morgan Creek gage (Figure 3.c:M13) and the ground-water/surface-water interaction study area (Figure 3.e:M51-85). A meteorological station (Figure 3.c:M48) was deployed in roughly the middle of the intensive-study field site. A rain sampler was deployed on property maintained by an organic dairy operation, 0.72 km east of the intensive-study field site (Figure 3.b:M47), to collect samples for chemical analysis. The agricultural management practices of the organic dairy do not permit use of herbicides on any properties used for animal grazing, hay, or silage crop growth. This location allowed collection of rain without concern of the effects of local pesticide applications.

At the intensive-study field site, a variety of equipment was installed below ground to collect water samples at various

locations and depths within the flow system and to track the movement of water and chemicals from the unsaturated to saturated zone. Unsaturated-zone lysimeters, ground-water wells, and riparian-zone piezometers are deployed in the ground at differing points in the substrate and along the flow system. The lysimeters and wells are located at three sites within the intensive-study-site agricultural field: the uphill recharge area, mid-field at the meteorological station, and the lower field bordering the wooded riparian zone. At the uphill recharge area (Figure 3.d:M22), four suction lysimeters are located at 0.6, 1.2, 4.4, 9.1 m BLS and three ground-water wells are located at 11.9, 15.2, 18.8 m BLS. At the mid-field location (Figure 3.d:M21), adjacent to the meteorological station (Figure 3.c:M48), TDRs are located at 0.5, 0.8, 1.1, 1.4 m BLS to measure soil moisture. Heat dissipation probes are located at 0.4, 1.1, 2.3, 4.1 m BLS to measure soil-water matric potential. Two pan lysimeters at 0.5 and 1.2 m BLS, five suction lysimeters at 0.6, 1.3, 2.4, 4.3, 5.5 m BLS, and three ground-water wells at 8.2, 10.7, 14.0 m BLS are used to obtain water samples. At the lower field site (Figure 3.d:M20), three suction lysimeters are at 0.6, 1.2, 4.3 m BLS and three ground-water wells at 5.8, 11.6, 15.3 m BLS.

Also connected with the ground-water flow system at the intensive-study field site are piezometers in the riparian zone of Morgan Creek. These piezometers allowed sampling the shallow ground water, at various depths, within a discharging seep along the base of a steep slope leading from the flowpath system to the floodplain of Morgan Creek (Figure 3.65). The piezometers at the end of the flow system are also part of the larger network of samplers that constitute the ground-water/surface-water interaction study area. The ground-water/surface-water interaction study area (Figure 3.c:M14-16, Figure 3.e:M51-85) consists of instruments and samplers to measure and monitor stream water and discharging ground water in the stream and riparian zone along the intensive-study field site. There are 22 piezometers in three transects across the floodplain and in discrete and wide seepage faces along the hillslope. Also included in the ground-water/surface-water interaction study area are six surface-water sites (Figure 3.c:M14-M16, Figure 3.e:M67-M69), which include locations in the overland flow areas in the seepage faces, channels formed from overland flow, and within the main stream channel that bracket the upstream and downstream ends of the piezometer transects. The downstream and upstream piezometer transects are located approximately 0.51 and 0.72 km, respectively, from the Morgan Creek streamflow-gaging station (Figure 3.c:M13).

In addition to the ground-water wells within the flow system at the intensive-study field site, six other wells located throughout the Morgan Creek Basin were used to monitor water level and chemistry (Figure 3.b:M30-M35). These wells were completed in different aquifers or at differing points within a single aquifer. Two new wells were installed during the ACT study at one site at depths of 4.42 and 10.05 m BLS (Figure 3.b:M30-M31). Four existing wells, installed and sampled by Bachman and others (2002), were used to collect additional water samples in this study (Figure 3.b:M32-M35). These four wells include two at the same site at depths of 9.45 and 18.29 m BLS and two at other sites at 13.26 and 16.31m BLS.

The Morgan Creek streamflow-gaging station (Figure 3.c:M13) is located between 0.51 and 0.72 km downstream from the intensive-study field site and ground-water/surface-water site. The Morgan Creek streamflow-gaging station records gage height and discharge. Water-quality samples were collected during baseflow and storm events. Baseflow samples were normally collected manually, and storm event samples were collected by autosampler triggered by rising water levels. A continuous water-quality monitor was installed to measure temperature, specific conductance, pH, and dissolved oxygen.

Nebraska

The small watershed (unnamed tributary to the South Fork of Dry Creek) (1.5 km^2) and the Maple Creek watershed (955 km^2) are nested watersheds, located in eastern Nebraska within the Platte River basin. Temperatures in the area range from a mean of 24.8°C in July to a mean of 5.7°C in January. The mean annual precipitation is 72.3 cm. Precipitation normally occurs throughout the year, but with total amounts in spring and early summer exceeding that in winter. Rain in spring is considered reliable but becomes intermittent as summer progresses. Occasionally, heavy spring rains delay crop planting. Evapotranspiration has a large role in the water budget of both basins. In Nebraska, an average of 50 to 110 cm of moisture returns to the atmosphere as a result of evaporation and transpiration.

The unnamed tributary to the South Fork of Dry Creek contributes only intermittently to Maple Creek (2.27 m^3/s at the mouth). At baseflow, ground-water seeps into both the unnamed tributary to the South Fork of Dry Creek and into Maple Creek. Much of the drainage network is incised, resembling a narrow, meandering ditch in tributary channels, with stream banks up to 5 m high enclosing a 20-m-wide main channel near the mouth. Springs are common along stream channels throughout the basin, flowing primarily during the early to mid-growing season in tributary channels and perennially in main channel reaches. Physiographically, both basins are completely contained within the Dissected Till Plains Section of the Central Lowland Province. The Maple Creek watershed can be divided into two distinctly different topographic regions on the basis of relative relief and topographic diversity. The upper and western part of the watershed, where the smaller watershed is located, is characterized by rolling hills of loess-mantled glacial till. The lower and eastern part of the watershed lies mostly within the Maple Creek Valley and has markedly less topographic relief than the upper part of the watershed.

Unconsolidated materials (sand and gravel) overlay much of the bedrock in the basins. Soil types are either loam or silt loam. Parent material of the upland soil is eolian sand, silt, and loess, which results in mostly fine-grained soils throughout the watershed. Soils are generally deep, somewhat poorly drained, medium textured, and nearly level. Available water capacity is high. Natural fertility and organic matter are moderate. Soils are naturally suited to row crops such as corn and soybeans. Two major aquifers, the High Plains and the Maha (Dakota) aquifer systems, underlie the Maple Creek and small watersheds. In the western part of the watershed, some wells obtain water from Quaternary deposits of the High Plains aquifer system.

Agriculture is the principal land use in the Maple Creek watershed and the smaller study basin. Respectively, 95 and 97% of the total land area in these basins are used for row crops. The crops grown in the basins are split nearly equally between corn and soybeans. Farming practices in the area employ a broad variety of tools to promote growth and to inhibit competition, including the use of fertilizers, herbicides, and pesticides.

The population of the study area is widespread. There are no large cities in either basin. Most residents live in small communities or rural areas. Colfax County, Nebraska, had a population of approximately 10,000 in 2000, although the majority of those residents live outside of the Maple Creek basin.

The mean annual discharge of Maple Creek was 2.27 m^3/s for water years 1952 through 2004. The lowest daily mean discharge for water years 1952–2004 was 0.003 m^3/s, recorded on January 15, 1956. The highest daily mean discharge for water years 1952–2004 was a discharge of 295 m^3/s, recorded on August 6, 1996.

There are two main modifications to the natural hydrology. First, lakes and ponds in the Maple Creek watershed are the result of impoundments. These lakes and ponds can attenuate flood peaks and act as sinks for contaminants that are associated with sediment in surface runoff. Most ponds are poorly lined and tend to leak, which creates points of recharge to the ground water that would otherwise be bypassed by overland flow. Ponds also are sources of surface water that are used commonly for watering livestock or occasionally for other uses. Second, straightened stream channels in agricultural areas slow or reduce lateral channel migration to subsequently reduce the loss of cropland. Straightening removes natural features associated with stream channels such as meanders, pools, and riffles that decrease flow velocities and dissipate energy. Straightened channels provide a more direct conveyance for surface-water runoff than drainage networks that have developed naturally.

In the ACT study, two study areas were established in Nebraska (Figure 4): the small watershed, an unnamed tributary to the South Fork of Dry Creek (Figure 4.c), and the flowpath and ground-water/surface-water interaction study area near the gage on Maple Creek (Figures 4.d-f).

The purpose of the small watershed study area was to assess the water quantity and quality of precipitation (Figure 4c:N47), to monitor relevant weather parameters to provide a calculation of evapotranspiration rates (Figure 4c:N47), to study the transport of water and chemicals through the unsaturated zone (Figure 4c:N30), and to assess the water quantity and quality in the ephemeral unnamed tributary to the South Fork of Dry Creek (Figure 4.c:N13). Suction lysimeters were placed at 1.5, 2.4, 4.0, and 7.6 m below land surface (BLS) to collect water samples in the unsaturated zone (Figure 4c:N30). One pan lysimeter was placed at this same location at 1.2 m BLS to monitor macropore flow from the surface. The watershed drained by the unnamed tributary to the South Fork of Dry Creek has an area of 1.5 km^2 (Figure 4.c:N13). The gaging station recorded stream stage intermittently from June 2003 through December 2004. This site integrates a mixture of water from the precipitation, overland flows, and ground-water inflows. Surface-water samples were collected at baseflow and during higher flows caused by storms. Baseflow samples were collected manually. Storm samples were collected by an autosampler triggered by rising water levels.

The flowpath and ground-water/surface-water interaction study area is approximately 10 km upstream from the confluence of Maple Creek with the Elkhorn River. The purpose of this study area is to monitor the transport of water and chemicals in the unsaturated and saturated zones (Figure 4.d:N20-23), to measure the movement and interaction of water and chemicals between stream water and ground water in Maple Creek (Figure 4.f:N51-84), and to assess the water quantity and quality in Maple Creek (Figure 4.b:N10). At the ground-water/surface-water interaction site, five transects were used in and near the stream to collect subsurface water samples and measure the hydraulic gradient between the stream and the subsurface by use of drive-point samplers, piezometers, and temporary piezometers. At all five transects, samples were collected from three or four depths (0.3, 0.5, 1.0, and 2.0 m below the sediment-water interface) in the channel during a seasonal low-flow period (October) and a seasonal high-flow period (May) in 2004. Within this set of five transects, two transects had permanent piezometers in the streambed (Figure 4.f: N61-65, N81-85) and one of the transects had piezometer screened in the stream. At the permanent piezometers, water was collected at three depths (0.5, 1.0, and 2 m) in four locations across the stream. Nearby wells were also sampled during April and August 2004. Continuous temperature and water level were recorded at 13 locations (Table 2) and 6 locations (Table 2, Figure 4.f: N63c, N63d, N65c, N65d, N82c, N82d) within this fixed network, respectively. A storm during the last week of May caused high flows that washed out the piezometers and associated equipment in part of one permanent transect (Figure 4.f: N82-N85). Thus, long-term records are available only intermittently at these locations in Maple Creek. Continuous water-quality monitors measuring specific conductance, dissolved oxygen,

and pH were deployed at three of the sites in the fixed network (Figure 4.f: N63c,N63d, and N85).

Washington

The DR2 Drain basin (5.5 km^2) and the Granger Drain basin (160 km^2) are nested watersheds, located in south-central Washington within the Yakima River basin. The area has moderate temperatures, which range from a mean of 22.7°C in July to a mean of 0.2°C in January. The mean annual precipitation is 17.6 cm with most of it falling during the winter.

Streamflow in DR2 Drain and Granger Drain is largest during the summer irrigation season. In DR2 Drain, monthly average flows during the irrigation season ranged from 0.12 to 0.22 m^3/s, and non-irrigation season flows ranged from 0.076 to 0.11 m^3/s. In Granger Drain, monthly average flows ranged from 0.96 to 1.5 m^3/s during the irrigation season, and from 0.52 to 0.59 m^3/s during the nonirrigation season. Flooding in the Granger Drain and DR2 Drain basins is rare.

Physiographically, both basins are completely contained within the Yakima Fold Belt, which is between the Cascade Mountains to the west and the Columbia Plateau to the east. Bedrock in the Granger Drain and DR2 Drain basins consists of a thick sequence of Columbia River Basalt. Bedrock outcrops are limited to elevations above about 350 m. Unconsolidated materials (silt to gravel) overlay much of the bedrock in the basins. The predominant soil type is silt loam. Soils are generally deep, well drained, and have a high water-storage capacity. The slope in cultivated areas ranges from nearly level to more than 8%.

In the Granger Drain and DR2 Drain basins, the unconsolidated materials form a single unconfined aquifer. Depth to water varies from less than 1 m to more than 75 m.

Agriculture is the principal land use in the Granger Drain and DR2 Drain basins. Respectively, 52 and 89% of the total land area in these basins is used for crops. Within the Granger Drain basin, more than 50% of the cultivated land is devoted to tree fruit orchards and corn. Alfalfa, grapes, and pasture compose another 25%, and the remaining land is devoted to a variety of row crops. Within the DR2 Drain basin, most land is planted in corn or grapes. Farming practices in the area employ a broad variety of tools to promote growth and to inhibit competition, including the use of commercial and manure fertilizers, herbicides, and pesticides. Irrigation is required for all crops in the study area and is usually applied by running water down furrows cut into the field or with sprinkler systems. Drip irrigation systems are used, but are not widespread. Granger (population 2,500) is the only city in the Granger Drain basin. Most residents live in rural areas.

In the ACT study area, six study areas were established (Figure 5): Granger Drain gage (Figure 5.b:W10), DR2 Drain gage (Figure 5.c:W13), ground-water/surface-water interaction study area (Figure 5.e:W51-W64), unsaturated zone study (Figure 5.c:W22), ground-water flow system study (Figure 5.b:W20-W25), and overland flow study (Figure 5.c:W14, W41, W42).

The Granger Drain gage site is 1.35 km upstream from the confluence of Granger Drain with the Yakima River and 4.25 km downstream from the confluence of DR2 Drain with Granger Drain (Figure 5.b:W10). At this site, continuous stage and discrete water-quality samples were collected for comparison with the DR2 Drain. Samples were collected at regular intervals throughout the year. A continuous water-quality monitor measured temperature, specific conductance, pH, and dissolved oxygen.

The DR2 Drain gage site is 125 m upstream from the confluence with Granger Drain and records continuous discharge (Figure 5.c:W13). This site integrates a mixture of water from irrigation tailwater, ground-water discharge, tile-drain discharge, and operational spill from irrigation water deliveries. Surface-water samples were taken at regular intervals. A continuous water-quality monitor measured temperature, specific conductance, pH, and dissolved oxygen.

The two ground-water/surface-water interaction transects are located 85 and 150 m upstream from the DR2 Drain gage (Figure 5.e:W51-W55 and W61-W64, respectively). This site was used to study the movement and interaction of water and chemicals between stream water and ground water in the DR2 Drain. Transects of permanently installed drive-point piezometers were used to collect subsurface water samples and measure the heads in and near the stream. Samples were collected from two depths in March, May, July, and October of 2004. Continuous water level, temperature, specific conductance, pH, and dissolved oxygen were collected at two depths at one location within this network (Figure 5.e:W53), continuous water-level and temperature data were recorded at an additional site (Figure 5.e:W63), and continuous temperature data was collected at two additional sites (Figure 5.e:W51, W62). A stilling well placed in the stream was monitored for water level; a continuous water-quality monitor in the well measured temperature, specific conductance, pH, and dissolved oxygen (Figure 5.e:W53). A nearby well was monitored for water quality, temperature and water level (Figure 5.c:W20p).

The unsaturated zone study (Figure 5.b:W22, Figure 5.c:W48) was situated on the edge of an upgradient parcel of a flood-irrigated corn field. The purpose of this site was to estimate local evapotranspiration and to study the transfer of water and chemicals through the unsaturated zone and into the ground water. The instrumentation at the site consisted of two pan lysimeters (both 0.61 m BLS) and four ceramic cup suction lysimeters (1.22 m, 1.83 m, 2.74 m, and 3.66 m BLS) for sample collection, four heat dissipation probes (1.07 m, 1.68 m, 2.56 m, 3.51 m BLS) to measure matric potentials, and four time domain reflectometers (0.61 m, 0.91 m, 1.22 m, and 1.48 m BLS) to monitor soil water content. Suction lysimeters were paired with a heat dissipation probe. In addition to this

instrumentation, the site was equipped with a weather station (Figure 5.b:W48) and a shallow ground-water monitoring well (Figure 5.c:W22) equipped with a data logger to continuously record water level.

The ground-water flow system study was conducted at seven locations (Figure 5.b:W23-W25, Figure 5.c:W20-22) located along a transect aligned with the general flow direction in the DR2 Drain basin. Two of these sites (Figure 5.c:W20, W22) were already noted as part of other study components. The purpose of this study was to evaluate the movement and transformation of nutrients and pesticides in the shallow aquifer underlying the study area. These sites were sampled in March, May, July, and October of 2004 for common ions, nutrients, and pesticides. Most wells were equipped with pressure transducers to record continuous water level and temperature.

The overland flow study area consisted of three sites (Figure 5.c:W14, W41, W42) along the lower reaches of the DR2 Drain. The sites were monitored to evaluate temporal changes in water chemistry and flow in response to irrigation events and seasonality. Discharge, temperature, pH, specific conductance, dissolved oxygen, common ions, nutrients, and pesticides were collected at these sites.

Strategy and Methods of Field Activities

The sample design and field instrumentation were similar, given local constraints, among all five study areas. The sample collection and processing methods in the field and laboratory methods were identical for all five study areas. This consistency allows a direct comparison among the results of the various locations.

The water samples were collected differently from each environmental compartment. The collection methods are described below. Once the water was obtained, it was handled, filtered, bottled, and shipped following the USGS National Field Manual for the Collection of Water quality Data (U.S. Geological Survey, variously dated). All samples for dissolved inorganic chemicals and dissolved organic carbon (DOC) analyses were filtered through a membrane filter (Pall Supor hydrophilic polyethersulfone membrane, 0.45 μm pore openings), whereas all samples for dissolved pesticides and pesticide transformation products were filtered through a glass-fiber filter (Whatman GF/F, 0.7 μm nominal pore openings). Samples for inorganic chemical analyses were placed in clean plastic bottles and samples for pesticide and DOC analyses were placed in clean, amber glass bottles. Unfiltered water samples were placed directly into appropriate bottles. Once the samples were collected, they were put on ice (except for suspended sediment samples, which were stored at room temperature) and shipped overnight to a USGS laboratory. Table 3 describes the types of analyses that were done for each environmental compartment and the laboratory that performed the analysis.

Atmosphere

Precipitation

Pesticides and nutrients enter the atmosphere during and after their application. They are returned to the Earth's surface through wet and dry depositional processes (Majewski and Capel, 1995). Pesticides, and to a lesser extent, nutrients, were measured in rainfall to determine their concentrations, seasonal deposition patterns and load to the watershed. Pesticides were quantified in rain in all of the study areas except in Washington, where rainfall is minimal and generally occurs during the nongrowing season. The rainfall was collected as weekly integrated samples in the three eastern study areas (Indiana, Maryland, and Nebraska). The rainfall was collected on an event basis in California because of the infrequent rainfall in this area.

National Atmospheric Deposition Program (NADP) guidelines (NADP, 2001) were followed in choosing the exact locations for sampling precipitation. A modified AeroChemetrics rain sampler (Miami, Florida) was used at all of the study locations to collect the sample. The sampler was modified by drilling a hole through the bottom and beneath the collection bucket. The inside of the collection bucket was lined with a clean Teflon pouch with a rigid Teflon opening. The outlet of the pouch was attached to a Teflon tube that went through the bottom of the rain sampler and into a 10-L carboy contained in a refrigerator. Similar modifications of the AeroChemetrics sampler were made by Capel et al. (1998). The rain water was collected every Tuesday during the growing season (about May though September) in the three eastern ACT study areas. In California, the rain was collected during November through March. The rain was analyzed for the target pesticides (Table 4) and pesticide metabolites (Table 5) and dissolved organic carbon (Table 6). The data for nutrient concentrations and loads in rain were obtained from the National Atmospheric Deposition Program (NADP) (NADP, 2004) for the three eastern watersheds. The rain from California was analyzed for nutrients (Table 7) by this study because there were no NADP sites near the ACT watersheds.

Weather parameters

At least one weather station was located in each ACT study area to continuously monitor the weather parameters and provide the data needed to calculate potential evapotranspiration. The weather stations were co-located with the intensive unsaturated zone study area. The rain sampler, used to collect water for chemical analysis, was co-located with the weather station in the Indiana, Nebraska, and California. In Maryland, the weather station and rain collector were about 0.7 km apart.

The weather station (Table 8) consisted of an air temperature and relative humidity sensor (Vaisala, HMP45C),

an anemometer for wind speed and direction (RM Young 03001), a pyranometer for solar radiation (LiCor Li200x), an 8-inch tipping bucket rain gage (Texas Electronics TE525WS, 15.25 cm diameter), and a net radiometer for net radiation (REBS Q7-1) mounted on a 2-m tripod. All of the weather instruments were factory calibrated and wired to a datalogger and memory module (Campbell CR10). The instruments were set to obtain readings every 15 minutes. The weather station also contained instrumentation to measure the surficial soil temperature and heat flux. These are described below in section 3c.

Streams

The stream network was sampled at two scales in all of the study areas except for Maryland, where there was not a larger stream to sample.

Large and intermediate streams

The large and intermediate streams have been sampled by the NAWQA Program since the early 1990s, and most of them have long discharge records (Table 9). The basins of these large streams (14,540 to 35,060 km^2) are referred to as "integrator" watersheds in the NAWQA Program. These basins contain a variety of land uses, including urban, agriculture and forest. The intermediate streams are referred to as "agricultural indicator" watersheds in the NAWQA Program because agriculture is the dominant land use and the water-quality conditions of the streams are indicative of the impacts of agricultural activities specific to that part of the Nation. The areas of these watersheds range from 160 to 3,297 km^2. Only the lower portion (831 km^2) of the Merced River watershed is used for intensive agriculture, the rest is mostly forested. More information on the watersheds and their discharge data is available (U.S. Geological Survey, 2006a). There was not a large stream in the Maryland study.

Water for chemical analysis was sampled at the same location used for discharge measurements or at a nearby bridge. For the large-size streams, the water samples were collected manually. For the intermediate-size streams, the water samples were collected manually in California and Washington and both manually and with an autosampler in Indiana and Nebraska. The autosampler was used for sampling after storm events where the increase in discharge was of short duration. For the manual samples, the depth- and width-integrated subsamples were composited and split with a churn splitter into the appropriate bottles for each analysis. For both the large- and intermediate-size streams, water samples were processed using standard NAWQA protocols (Shelton, 1994; U.S. Geological Survey, variously dated). The water was analyzed for nutrients (Table 7), pesticides and pesticide transformation products (Tables 4 and 5), and major ions, dissolved organic carbon, field parameters and suspended sediment (Table 6).

Small streams

The small stream watersheds were chosen specifically for this study. Only the Maryland stream (Morgan Creek, Figure 3) had an existing gaging station and discharge record. Temporary USGS stream gaging stations were established at the other four sites.

In California, the Mustang Creek site (Figure 1.b) was outfitted with a Model 5000 KPSI pressure transducer and CR10 data logger for continuous stage measurement. Discharge measurements were made with current meters or a 3-inch Parshall flume during flow events. A stage-discharge relation (rating table) and a record of continuous flow were established at this site. Initially, a sharp-crested rectangular weir with a 90-degree V-notch was installed as a control structure, but was washed out in a flood. During the short period when the weir was operable, weir equations were used to estimate continuous flow from recorded stage data and discharge measurements.

In Indiana, the streamflow-gaging station Leary Weber Ditch at Mohawk, Indiana (Figure 2.b) was established in July 2002 specifically for this study. Water-quality samples were collected both manually and with an autosampler at the same location where streamflow was measured. An autosampler was used for sampling during storms; manual samples were collected during stable flows.

In Nebraska, stage measurements were measured with a triple-orifice bubbler (MetOne Instruments, Inc., Grants Pass, Oregon) at the un-named tributary (Figure 4.c). Depending on flow rate, discharge was determined one of two ways. For flows $\leq$ 0.04 m^3/s, the cone equation and a conversion factor was used to calculate discharge based on depth of water over the 90-degree V-notch weir (U.S. Bureau of Reclamation, 2001). When the flow rate was greater than 0.04 m^3/s, a conversion table created with the Culvert Analysis Program (Fulford, 1998) for the 1.98 m corrugated culvert was used to convert head in the culvert to discharge.

In Washington, stage measurements were measured on DR2 (Figure 5.b) with an AquaRod pressure transducer (Stevens Water Quality Monitoring, Inc., Beaverton, Oregon) installed in a flume. Water discharge in the flume was measured every 1 to 2 months with a pygmy meter. Standard USGS methods were used to establish a relation between stage and discharge.

Water for chemical analysis was sampled at the same location where discharge measurements were made. Water was collected and processed according to standard NAWQA protocols (Shelton, 1994; U.S. Geological Survey, variously dated). The water samples were collected manually in Washington and both manually (during periods of stable flow) and with an autosampler (during periods of changing flows) at the other sites. The sample processing and sample analytes are the same as in section 3b1.

Soils

In this study, the movement of water and the transport and reactions of target chemicals were investigated to better understand the processes that govern their environmental storage, fate and transport. Soil samples were collected for physical characterization and measurement of selected chemicals.

Soil solids

Soil samples were collected at every location a lysimeter was installed and at every major geologic horizon during either well drilling or lysimeter installation. Some solid soil samples were also obtained with a hand auger throughout the duration of the study.

Soil samples were obtained inside a plastic core barrel either during the well drilling process or using a hand coring device. The core barrel was capped at both ends with plastic caps and secured with tape. The core was described as to its appearance and then transported on ice to the laboratory. The soil samples were stored in a refrigerator until subsampled. In the laboratory, the cores were subsampled and analyzed for the physical and chemical parameters listed in Table 10. In some cases, the bulk density sampled was obtained in the field and capped and stored along with the rest of the soil samples. The soil core was cut with a hacksaw and capped for the bulk density sample. Aliquots of the remaining soil sample were placed into separate zippered plastic bags with a stainless steel spoon for analyses for particle size distribution, mineralogy, soil moisture, organic matter content and chloride. Particle size distributions (2,000 to <0.5 μm) were determined by optical diffraction with a Coulter LS-230 particle-size analyzer (Gee and Or, 2002). Particles greater than 2 mm were separated with ASTM sieves ranging from >2 to >128 mm and later integrated into the particle-size distribution. Bulk density was determined by the core method (Grossman and Reinsch, 2002), and soil moisture content was determined gravimetrically (Topp and Ferre, 2002). Organic matter content was estimated from the loss on ignition (Lim and Jackson, 1982). Chloride concentrations were determined in pore water by drying the sediment cores, mixing the sediment with water at a 1:10 ratio and measuring the chloride in the extract solution by ion chromatography. Many of the soil samples that came from the locations where lysimeters were installed were also analyzed for the target pesticides listed in Tables 4 and 5. A few selected, intact soil cores from each study area were also analyzed for their hydraulic conductivity (Nimmo et al., 2002).

Soil water

At one to four locations in each study area (Table 2), lysimeters were installed at various depths to quantify the movement of water and chemicals through the soil over time. At any given location, two to five lysimeters were located at various depths. In all cases the shallowest lysimeters were located just below the plow zone so as not to interfere with normal agricultural practices. Two types of lysimeters were installed. At all depths, ceramic porous-cup suction lysimeters were installed to collect water that was analyzed for chemical constituents. At one depth, pan lysimeters were installed to collect free draining water.

The shallow lysimeters (both suction and pan) were installed by digging a trench in the soil with a backhoe, pushing the lysimeters into the intact wall of soil of the trench, and then backfilling the hole with the native material. Deeper suction lysimeters were installed through boreholes made by a drill rig. All of the lysimeters had two nylon tubes attached to them; one to apply a vacuum and the other to obtain the water sample. The suction lysimeters were constructed of a 5-cm-long by 5-cm-diameter porous cup. The open end was glued with epoxy to a 25-cm-long polyvinyl chloride (PVC) tube. The PVC tube was closed with a nylon plug that had two ¼-inch Swagelock fittings for tubing. A piece of nylon tubing long enough to reach the soil surface was attached to each fitting—one for vacuum and the other for suction. The pan lysimeters were constructed of stainless steel and measured 30 cm by 30 cm. They were drained via a nylon tube to a 6-quart stainless steel pot. In some cases, the stainless steel pot had a 4-L glass bottle in series as an overflow.

The lysimeters were placed under vacuum for 3 to 24 hours prior to sampling. The vacuum was removed and the water was pressurized out of the suction lysimeter or pan lysimeter reservoir and collected into a clean glass bottle. The pH and specific conductance of the water was obtained. Depending on the total volume of water, subsamples were collected in the order shown in Table 11. The subsamples that needed to be filtered (nutrients, pesticides, DOC, major ions and alkalinity) were filtered though an in-line syringe filter (Pall Supor hydrophilic polyethersulfone membrane, 0.45 μm pore openings).

Soil moisture, matric potential and temperature

One of the unsaturated zone sites (Table 2) in each of the study areas was instrumented to measure surficial soil temperature, soil heat flux, soil-water matric potential, and soil moisture at depth in order to estimate the fluxes of water out of the soil and the reservoir of water in the soil. The weather stations were co-located with the instrumented unsaturated zone sites.

Four types of soil instrumentation were installed. In the upper few centimeters of soil, temperature-averaging thermocouples (Campbell TCAV) and soil heat flux plates (REBS HFT3) were installed. At five depths, with the shallowest just below the plow zone, soil water content reflectometers (Campbell CS616) were installed into the intact wall of the trench. Factory calibration curves were corrected to site specific conditions based on gravimetric soil moisture analysis of soil samples obtained at the depth of each sensor at a nearby location. Also, laboratory-calibrated heat dissipation matric water potential sensors (Campbell 229) were installed at three to five depths depending on the depth of the

unsaturated zone. These were installed in boreholes adjacent to the trench area. All of the soil sensors were wired to a relay multiplexer (Campbell AM16/32) that was connected to a datalogger (Campbell CR10) and memory module. The sensors were set to obtain readings every 15 minutes.

Tile Drains

Tile drains are installed beneath agricultural fields to facilitate the transport of water from the root zone. Oftentimes agricultural chemicals, particularly those that are dissolved, are transported with this water. The only area that had extensive tile drains in this study was Indiana. Stone and Wilson (2006) have shown that preferential transport is more important than matrix transport in moving water and chemicals through the soil to the tile drains.

An autosampler equipped with fluorinated plastic bottles was used to collect water samples during periods of increased tile-drain flow related to storms. The autosampler was triggered by a datalogger connected to a pressure transducer that measured water depth in the tile drain. A predetermined rise in water level inside the tile drain initiated the autosampler to collect samples on an hourly basis through the rise and peak of the storm hydrograph. During the recession of the hydrograph, the sampling interval was lengthened to every 2 or 4 hours. Additionally, between storms and during periods of low flow, grab samples were collected manually from the tile-drain effluent. The tile-drain water was analyzed for the target pesticides (Table 4) and pesticide metabolites (Table 5), major ions and dissolved organic carbon (Table 6), and filtered nutrients (Table 7).

Tile-drain flow was estimated from stage-discharge relations and data from a modified circular flume. Numerous stage and discharge measurements under varying flow conditions were made onsite at the tile-drain outlet to calibrate the flume. Partial and full submergence greater than 80% of the flume outlet, however, complicated the accuracy and reliability of the flume calibration. Therefore, onsite direct measurements of tile-drain flow under partial and full tile-outlet submergence were used in conjunction with the circular flume estimates to obtain a continuous record of flow. A specific conductance and temperature probe (Campbell CS547A) was placed in the tile drain approximately 3 m from the outlet. Instrument drift was minimized through the regular calibration of the specific conductance probe against standard solutions. Tile-drain-flow, specific conductance and temperature data were collected in 15-minute intervals.

Overland flow

Overland flow can move water and agricultural chemicals directly from fields to the surface-water system. The importance of overland flow for any given field is a function of topography, soil type, amount and intensity of rainfall/irrigation, and agricultural management practices. In this study, overland flow samples were collected only in California, Indiana, and Washington. In California, a portable V-notch weir was installed in a ditch that intercepted runoff from an orchard (Table 2:C41). Water samples were collected from the weir and processed as for other types of surface-water samples. In Indiana, an autosampler collected overland flow samples from an overland flow site that intercepted the runoff before entering the agricultural ditch (Table 2:I41). These samples were collected throughout the storm hydrograph from a flume installed at the edge of the field. In Washington, the three overland flow sites flowed intermittently year-round when they received episodic pulses of irrigation return flow (Table 2:W14, W41, W42). Two overland flow sites integrated water from multiple fields and were sampled approximately once per month to characterize water quality during the irrigation season. They were sampled three times during the non-irrigation season—immediately before irrigation began, immediately after irrigation ended, and during stable, winter low flow. The smallest site (W42) was a tile drain that received runoff from a single field. This site was sampled approximately twice per month during the irrigation season—once at the same time as the two larger ones and once by itself when it was sampled twice in a single day.

The water samples were processed using standard NAWQA protocols (Shelton, 1994; U.S. Geological Survey, variously dated) and analyzed for nutrients (Table 7), pesticides and pesticide transformation products (Tables 4 and 5), and major ions, dissolved organic carbon, field parameters and suspended sediment (Table 6).

Aquifers

Some fraction of the water and chemicals that are applied to land surface can move through the soil and find its way to ground water. Once in the ground water, the chemicals can undergo transport and transformations. The ground-water investigations in this study had two components. One was a characterization of water chemistry and water levels of shallow wells across the watershed to provide an areal context for the study. The other component was a process-orientated flow system study in which a number of well nests were installed at locations along a 1- to 2-km transect with the objective of investigating the transport of water and changes in the water chemistry over the past half-century.

Aquifer solids

Samples of aquifer solids were collected inside a plastic core barrel, when possible, at locations where a well screen was installed plus other major geologic horizon during well drilling. The core barrel was capped at both ends with plastic caps, and the caps were secured with tape. The core was described as to its appearance and then shipped to the laboratory. The core samples were stored in a refrigerator until they were subsampled. In the laboratory, the cores were cut with a hacksaw inside of a sealed glove box that had been

purged to remove oxygen. An aliquot of the solid material was obtained for redox-sensitive iron minerals and transferred to a glass jar, capped and taped. The remaining cores were removed from the glove box and subsampled for particle size, mineralogy, bulk density, and organic matter (Table 10), and selected samples were analyzed for the target pesticides (Tables 4 and 5). The analytical methods were the same as those given in the section above on soil samples.

Areal characterization

The wells used in the areal characterization portion of the study were a combination of existing monitoring wells and new wells installed for this study. See Figures 1-5 for the well locations. The installation of all new wells followed the NAWQA well installation protocols (Lapham, et al., 1995). All of the wells had polyvinyl chloride (PVC) casings and screens. The location, well drilling technique, screen length, and screen depth for each of the sampled wells are listed in Table 2.

The wells were purged and sampled using standard NAWQA well sampling protocols (Koterba et al., 1995) on a quarterly schedule (pre-plant, post-plant, mid growing season, post-harvest). The water level in the well was measured with an electrical tape before the well was sampled. A few of the areal wells were equipped with recorders that continuously measured water level and temperature at 15 minute intervals (LeveLoggers, Solinst Canada Ltd, Georgetown, Ontario). The water was processed onsite, and subsamples were collected to be analyzed for nutrients (Table 7), pesticides and pesticide transformation products (Tables 4 and 5), and major ions, dissolved organic carbon, and field parameters (Table 6). In addition, selected samples were collected and analyzed for chemical species to calculate the age of the water, and to determine the content of dissolved gases and selected isotopes of nitrogen and oxygen (Table 12, Green et al., 2007).

Flow system investigations

The wells used in the flow system investigations were all new. The locations and depth of the wells were decided on the basis of geology, topography, location relative to the stream, and access to the land. Each of the flow system studies terminated in the ground-water/surface-water interaction study area. At least one of the flow system well nests was co-located with an unsaturated zone study site. See Figures 1-5 for the well locations. The installation of all new wells followed the NAWQA well installation protocols (Lapham et al., 1995). All of the wells had PVC casings and screens. The location, well drilling technique, screen length, and screen depth for each of the sampled wells are listed in Table 2. Well sampling, sample processing and target analytes were the same as for the areal wells. Water levels were measured either with steel or electrical tapes and/or pressure transducers equipped with a datalogger.

Ground-water/surface-water interface

In many types of landscapes, ground water and the chemicals it contains, discharges to the surface-water network. These discharge areas commonly exhibit sharp gradients in chemistry and hydrology and are potentially important regimes for chemical transformations and stream loadings. Each of the study areas included one location at which the interactions between ground water and surface water were studied extensively. Each of these studies was located at the terminus of the flow system. In California and Nebraska, the study areas were in the intermediate streams, whereas in Indiana, Maryland and Washington the study areas were in the small streams. The locations were chosen on the basis of hydrology and access to private land.

After the general area of the ground-water/surface-water (GW/SW) interaction study was identified, a temperature survey of the bed sediment of the stream reach ($\leq$500 m) was conducted either in the summer or winter, when the difference between the ground-water and surface-water temperatures were near a maximum. On a grid of sampling points, a 1-m-long temperature probe (Type K thermocouple wire embedded in a ¼-inch stainless steel rod, Cole-Parmer) was used to obtain the stream-water temperature, then inserted into the sediment to 0.5 and 1 m (or as far as it could go). This three-dimensional assessment of sediment temperature compared to surface-water temperature showed areas of upwelling ground water and areas where surface water was infiltrating, which provided insights to where the fixed sampling sites should be located. This type of survey was repeated twice, once during a period of relatively high flow and once during a period of relatively low flow. During these surveys, the head was also measured with a temporary minipiezometer (Winter et al., 1988), and water was collected and screened in the field for nitrate and iron concentrations (AccuVac, Hach Company).

Two transects of fixed sites were established at each of the study locations, except for Maryland. In Maryland, the bed sediment texture did not allow for any water exchange at the GW/SW interface, so a different sample design was needed at this site (Puckett et al., 2007). At the other locations, each of the two transects had three to five piezometer nests. Water sampling points were installed as drivepoint tips with 1-cm screen lengths and ¼”-inch nylon tubing (AMS Inc.). Three drivepoints were installed in each piezometer nest at depths of 0.5, 1.0, and 2 to 3 m below the sediment-water interface. In addition, a PVC well was installed at selected piezometer nests (three–five per study location) and equipped with continuous water-level (LeveLoggers, Solinst) and water temperature (Stowaway Tidbit, Onset Computer) instruments. Data were obtained at 15-minute intervals. At one location in each of the study areas, a 2-inch (outer diameter) PVC well was installed and continuous water-quality monitors were deployed (0.5 and 2 m

below the sediment-water interface) to record pH, specific conductance, and temperature at 15-minute intervals.

Water was collected from each of the fixed piezometers three or four times over the growing season, generally pre-plant, post-plant, mid-growing season, and post-harvest. The water was sampled by attaching the nylon tubing from the piezometer to a short piece of cleaned, Viton tubing that was in the pump head of a peristaltic pump. The water was monitored for temperature, pH, specific conductance, and dissolved oxygen in a flow-through cell that had a volume of < 50 mL. After the pH, specific conductance, and temperature were stable, water was collected for chemical analysis of nutrients (Table 7), pesticides and pesticide transformation products (Tables 4 and 5), and major ions, dissolved organic carbon, and field parameters (Table 6). In addition, selected samples were analyzed for chemical species to calculate the age of the water, and to determine the content of dissolved gases and selected isotopes of nitrogen and oxygen (Table 12, Green et al., 2007)

Irrigation water quantity

Three of the ACT study areas are in arid or semiarid environments, where irrigation is a standard part of agricultural activities. In order to get the needed input parameters on water, and perhaps chemical fluxes from irrigation activities, the quantity of water was tracked and the quality of the water was measured.

In the California and Nebraska study areas, irrigation water came from wells and in some locations, from imported canal water. Samples of the irrigation well water were obtained and analyzed for the same suite of target compounds as the other wells in the study. In the detailed ACT study area, the quantity of water that is piped to each field was obtained by installing a flow meter on the producer's irrigation pump (Nebraska) or through power consumption records of the irrigation pump (California), or by pumpage information supplied by the individual landowners.

In the Washington study area, irrigation water came from a canal that diverts flow from the Yakima River. Surface grab samples of the irrigation canal water were analyzed for the same suite of target compounds as the streams in the study. The quantity of water that is piped to each field was obtained from the Sunnyside Valley Irrigation District, Washington.

Methods for Modeling Activities

Watershed models

The watershed modeling goals were (1) to provide mass balance information to be used as input to the unsaturated-zone and ground-water models, (2) to examine processes that could be responsible for agricultural chemical transport to streams and the unsaturated and saturated zones, (3) to examine how geographic location, climate, hydrogeology, and farming practices affect the flow of water through a watershed, (4) to predict the fate of agricultural chemicals that are not well characterized or measured at the study sites, and (5) to evaluate the performance of two models. The soil and water assessment tool (SWAT) (Neitsch et al., 2002a) and the water, energy, and biogeochemical model (WEBMOD) (Webb et al., 2006) were selected to simulate the hydrologic and chemical processes occurring in each watershed. The SWAT model (version SWAT2000) was chosen because of its widespread use in the agricultural research community (U.S. Department of Agriculture, 2006a). WEBMOD was selected because of its ability to simulate more physically based hydrologic processes and its inherent adaptability because it was developed in-house. Each model was able to account for the spatial variability of hydrologic and chemical processes occurring on the land surface and in the unsaturated and saturated zones.

Preprocessors, associated with each framework, were used to create the default parameter files necessary for initial simulations. The SWAT model was run within the U.S. Environmental Protection Agency's Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) software (USEPA, 2004), whereas the GIS WEASEL (Viger et al., 1998) was used to parameterize WEBMOD. SWAT and WEBMOD both require the same spatial data inputs: a digital elevation model (DEM), a land-use grid, and a grid of soil map units. Thirty-meter resolution DEMs (U.S. Geological Survey, 2006b) were hydrologically corrected using high-resolution stream coverages from the National Hydrography dataset (U.S. Geological Survey, 1999) and USGS (CA and MD-DE-DC) Water Science Centers. For the Nebraska study site, a 33-m resolution DEM was used because of software limitations. The AcrINFO GRID function COMBINE (ESRI Inc.) is used in the creation of parameters for WEBMOD by combining rasters of subbasins with slope, land use, elevation, etc. The size of the Nebraska study site creates combinations greater than 10 million, especially with rasters that have continuous surfaces such as elevation or slope. The spatial representation of land use was a 30-m resolution grid of the enhanced National Land Cover Database (Vogelmann et al., 2001). The map-unit grid corresponding to the State Soil Geographic (STATSGO) database (Schwarz and Alexander, 1995) had a 30-m-resolution. Each model was run at a daily time-step with temporal data composed, at least, of minimum and maximum temperatures and precipitation. Although a weather generator is available within BASINS, temporal data were gathered for a 20-year period from October 1, 1985 through September 30, 2005, for each study site to ensure consistency between model inputs.

The models were manually calibrated using an 8-year period, as recommended by Yapo et al. (1996), for the Maryland, Indiana, and Nebraska study sites. The Washington and California study sites were calibrated using data observed during the data collection period of the ACT study. Consistent with suggestions by Neitsch et al. (2002a), the

models were calibrated by subjectively adjusting parameters to (1) match simulated and observed discharge peaks, then (2) match simulated and observed baseflow conditions, and (3) refine the model parameter set using small parameter adjustments to achieve the highest model efficiency possible. Model efficiency was evaluated by comparing observed and simulated discharge using the r-squared and Nash-Sutcliffe efficiency (Nash and Sutcliffe, 1970) statistical measures. Similar to the criteria used by Neitsch et al. (2002b), models were considered calibrated when the r-squared value exceeded 0.6 and the Nash-Sutcliffe efficiency measure exceeded 0.5. Additionally, the conceptual understanding of hydrologic processes was weighted strongly, such that contributions to streamflow in calibrated models conformed to the conceptual understanding, similar to the ideals expressed by Refsgaard and Storm (1996) and Refsgaard and Knudsen (1996). At some study sites, climate data (potential evapotranspiration and solar radiation) and hillslope hydrologic data (soil moisture content and depth to water) were used to facilitate calibration. Following each simulation, the mass balance was checked by comparing simulated mean annual streamflow and evapotranspiration values with long-term mean annual values reported in the literature. Once calibrated, the models developed for Maryland, Indiana, and Nebraska were validated using an 8-year time period different from that used for calibration.

Soil-Water Assessment Tool (SWAT)

Detailed documentation of the equations governing water and solute transport within the SWAT model are described by Neitsch et al. (2002a). In general, hydrologic and chemical processes in the SWAT model were based on the Chemicals, Runoff, and Erosion from Agricultural Management Systems (CREAMS) model (Knisel, 1980) and the Groundwater Loading Effects on Agricultural Management Systems (GLEAMS) model (Knisel, 1993). Crop growth was controlled using components from the Erosion Productivity Impact Calculator (EPIC) (Williams, 1995). Although several options are available for determining evapotranspiration, the Penman-Monteith equation (Monteith, 1965) was used for all SWAT models. The contributions to flow generated by SWAT were direct runoff, lateral flow through an anisotropic soil profile, and ground-water flow from a shallow aquifer. Water received by the stream channel was routed using variable storage methods similar to those described by Williams (1969).

Each watershed was delineated from a point in the watershed co-located with a stream gage. The watershed then was subdivided into subbasins of approximately the same size, consistent with recommendations by Jha et al. (2004). The subbasins were then further divided into Hydrologic Response Units (HRUs). Multiple HRUs within a subbasin were defined if a land-use category occupied more than 20% of the subbasin area and a soil class consisted of at least 10% of the subbasin area.

Water, Energy, and Biogeochemical Model (WEBMOD)

The WEBMOD model is composed of modules that are available in the Modular Modeling System (MMS) (Leavesley et al., 1998). Rain, snowfall, canopy interception, and potential evapotranspiration were simulated with the use of the modules from the existing Precipitation Runoff Modeling System (PRMS) model (Leavesley et al., 1998). Evapotranspiration was calculated according to the Hamon method (Hamon, 1961). Snowpack processes were simulated with the National Weather Service Hydro-17 model (Anderson, 1973). Infiltration and subsurface flow processes were simulated by using a multi-catchment version of the statistical-dynamical Topmodel algorithm (Beven, 1979), which allows for a spatially distributed runoff response. Runoff is explicitly derived as Hortonian and Dunnian overland flow, preferential flow, exfiltrating flow from a shallow aquifer, and baseflow directly to the stream. Water discharged to the stream from the hillslopes is routed to the basin outlet with the use of unit hydrographs (Clark, 1945).

Watersheds and subbasins for the WEBMOD were created according to the same criteria as those used for the SWAT. Subbasins were further divided into right and left banks, which were then divided again based on the topographic wetness index (TWI) value given to each grid cell. The TWI is based on the TOPMODEL algorithm (Beven, 1979) and assumes that the likelihood of a point to generate runoff increases with increased contributing area and slope. The TWI value for each grid cell is defined by the equation:

$$TWI = \ln (a/\tan h)$$

where a is the area contributing to a given point and h is the angle of the hillslope. A high TWI value indicates a greater likelihood of generating runoff. TWI values, ranging from 1 to 30, were computed for each 30-m^2 grid cell within each right or left bank.

Unsaturated-zone models

The purposes of the unsaturated-zone transport modeling are (1) to provide mass-balance information to be used as input to ground-water models, (2) to simulate the transport, dissipation and leaching of nutrients and pesticides with a wide range of physical and chemical properties, (3) to examine how geographic location, climate, hydrogeology, and farming practices affect the quantity and quality of water recharging the ground water, (4) to predict the fate of agricultural chemicals not yet well characterized or measured at the study sites, and (5) to examine pesticide loading to the saturated zone from the date of chemical registration to present. The Root Zone Water Quality Model (RZWQM) was selected for the ACT process-based modeling efforts at the intensively studied unsaturated zone sites. The Leaching Estimation and Chemistry Model (LEACHM; (Hutson and Wagenet, 1992)

was selected to carry out simulations for a longer period of time and for a greater area than the scope of RZWQM applications. These models were chosen following side-by-side comparisons with other unsaturated-zone transport codes (Nolan *et al.*, 2005). RZWQM contains features desirable to the ACT study that include fully integrated macropore flow and extensive farming-simulation modules. RZWQM is fully documented in Ahuja *et al.* (2000) and was extensively tested during the 1990s at the USDA Management Systems Evaluation sites (Farahani *et al.*, 1999; Ghidey, *et al.*, 1999; Jaynes and Miller, 1999; Martin and Watts, 1999; Wu *et al.*, 1999).

Process Modeling: Root Zone Water Quality Model (RZWQM)

Root Zone Water Quality models were parameterized for only the intensive unsaturated-zone study sites (Table 2: C22, I32, M21, W22) with data collected on-site where possible and supplemented with data collected nearby, with values that appear in the literature, with estimates from on-site data, or with computations from on-site data (Table 13). Data were collected from sediment cores and from a single vertical profile instrumented to monitor the physical and chemical characteristics of the unsaturated zone. Although farm-management practices, climate, and hydrogeologic settings are similar at some sites, each site has unique features.

Simulated scenarios, run on an hourly time step, are one-dimensional vertical profiles. Sediment-core analyses were used to discretize the profile to include no more than 10 soil horizons that totaled less than 30 m of depth. Model stability and accuracy are facilitated by internal routines that rediscretize the profile into layers with thicknesses less than 5 cm. An additional internal rediscretization creates model layers near land surface that are 1 cm thick and are activated during infiltration. The upper boundaries of the RZWQM models are land surface and are controlled by the geology, climate, and land-use practices. The basal boundary usually is several meters below the mean water-table elevation; this boundary is treated as a constant flux.

The RZWQM scenarios simulated 2002-2004 during calibration. In most cases, measured data are available only for 2004; years 2002 and 2003 are considered model warm-up years. Prior to the 3-year simulations, the nutrient and organic-matter modules are equilibrated internally for a period of 35 years. The short-term (3 years) simulations are used for calibrating parameters and examining the processes affecting chemical degradation and dissipation. Additional "long-term" (more than 3 years) simulations examine long-term loading of pesticides to the saturated zone. The long-term model uses the calibrated short-term model parameters but simulates the period from the pesticide registry through 2004. It is assumed the past land use is identical to that of the present time, except where significant changes in farming practice (e.g., conversion from conventional to no-till tillage) have been documented.

A subjective calibration process is used to obtain reasonable agreement between simulated and measured values. This approach is similar to that used to calibrate models tested previous studies (Hanson et al., 1999). Calibration targets for simulations include moisture content, water-table depth, recharge, and tracer and chemical concentrations at various times and depths within the unsaturated zone. Calibration steps for the NAWQA ACT RZWQM models include:

Step 1. Compare simulated and measured bromide breakthrough curves; potassium bromide tracer tests were done at some unsaturated-zone study sites. Improve agreement by adjusting soil-layer and soil-crust hydraulic conductivity and macropore and transport parameters.

Step 2. Compare simulated and measured soil-moisture profiles, water-table elevations, and recharge rates. Improve comparison by adjusting soil hydraulic properties and initial soil-tension conditions. Compare RZWQM-simulated recharge with values estimated by other methods.

Step 3. Compare simulated and measured aqueous nitrate breakthrough curves. Improve results by adjusting relevant farming-practice parameters, soil organic-matter distribution and reactivity, and microbiological populations.

Step 4. Compare simulated and measured pesticide- and degradation-compound breakthrough curves. Improve calibration by adjusting relevant farming-practice parameters and chemical properties.

Some parameters and initial conditions are adjusted in most steps of the calibration process. Adjustments to complex models, however, can be numerous. Adjusted values are usually within the range of values reported in the literature. The highly transient nature of unsaturated-zone processes and the variability inherent to unsaturated-zone measurement techniques imply that exact matching of measured and simulated data is unlikely. Differences between pesticide- and degradation-compound parameter values that are described for laboratory studies and the values required for simulations of field studies are unintentional but noteworthy findings of the study.

Users of these RZWQM results are cautioned that (1) the calibrated solutions are non-unique and subjectively calibrated, (2) modeled profiles may be relevant only to the immediate study area, (3) many model parameters are estimated, computed, or taken from the literature, and (4) occasional instrument failure and site accessibility produce data gaps that require acquisition of representative substitute data from other sources.

Spatial Modeling: Leaching Estimation and Chemistry Model (LEACHM)

LEACHM (Hutson and Wagenet, 1992), which was selected to simulate processes at the watershed scale, runs at daily time steps and has less stringent data requirements than RZWQM. LEACHM has two available methods for

simulating water and pesticide fluxes: (1) Richard's equation combined with the convection dispersion equation and (2) a tipping-bucket algorithm (CALculated Flow, or CALF) with solute concentrations computed according to mobile/immobile water concept. The spatial modeling of recharge and pesticide leaching described below used Richard's equation. The CALF model is a more simple representation and has much greater computational efficiency.

LEACHM, run on a daily time step, was used to estimate the flux of water and pesticides leaching to ground water beneath the corn/soybean field at the intensive-study site in Maryland for the period 1995-2004. Wherever possible, soil and chemical properties used for the RZWQM run at the same site were duplicated. Daily precipitation totals, minimum and maximum temperatures, potential evapotranspiration, and the water demands of vegetation drive hydrological simulations within LEACHM. For the period 2002-2003, precipitation and temperature values were summarized from the hourly data compiled for RZWQM. For the period 1995-2001, the daily precipitation and temperatures compiled for surface-water models were used. Potential evapotranspiration was computed using the Hamon method. The planting of crops and the timing and loads of pesticides observed during the 2004-2005 soybean-winter wheat-corn crop rotation at the intensive-study site was assumed to be typical for other soybean-corn areas in the Maryland watershed. The water demand for corn-soy fields in the watershed simulated for the period 1995-2004 used this analog.

Recharge and pesticide leaching for the Maryland watershed were estimated using results of 15 LEACHM models representing three possible crop rotations and five depths. The crop rotations vary according to whether corn or soy is planted on even versus odd years. The field surrounding the intensive-study site represented a third, unique, rotation that had only four corn crops in the 10 modeled years; the farmer double cropped soy in 2003 and 2004. Although double cropping may have occurred elsewhere in the basin during the simulation period, strict alternating corn-soy rotations are used for all other fields. The rotation of any specific field is determined from the 2004 field by field crop survey. The thickness of the unsaturated zone for each hectare was computed by subtracting the piezometric head of a steady-state ground-water model from the topographic elevation determined from Light-Imaging Detection And Ranging (LIDAR) surveys. Ground-water heads exceeded land-surface elevations in 16% of the watershed. This condition describes ground-water discharge into wetlands, riparian areas, and streams. However, only 5.7% of the watershed was classified as wetland and riparian area by the enhanced version of the 1992 National Land Cover Data (NLCDe, Vodelman, 2001). Therefore, the datum for the ground-water model heads was lowered by 1.65 m to reduce the area predicted as wetland and riparian area (heads less than or equal to zero) to 5.7% of the watershed. With this modification, an average thickness of 7.5 m is predicted for the intensively studied field area, consistent with observations. Thus derived, approximately 80% of the watershed has a unsaturated-zone thickness within the modeled range of 1 to 10 m.

All LEACHM profiles were discretized into 10-cm layers with a free-draining bottom boundary condition (zero tension). The silty loams and sandy loams in the soil horizons observed at the intensive-study site located nearest the meteorological station were assumed to be typical of the watershed. The top meter was a medium density silty loam with 0.7% organic matter. The second meter contained a low density sandy loam with similar organic content. Below 2 m, a medium-density silty loam with 1.4% organic content was found.

Hydrological parameters of the Maryland LEACHM model were calibrated to fit observed soil moisture variations and bromide breakthrough using Parameter ESTimation (PEST) routines (Doherty, 2001). Optimal parameter values describing soil moisture retention properties were constrained to the ranges reported by Meyer and others (1997). Bulk densities were estimated during modeling because the dry bulk density of soil sample from the site exceeded 2 g/cm^3, resulting in anomalously low estimates of porosity. These high densities may have resulted from soil compaction during sampling or because of significant fractions of dense minerals (porosity is computed using a particle density for quartz 2.65 g/cm^3). The bulk density of the middle layer was estimated at 1.15 g/cm^3 during the calibration of the model to match observed variations in soil moisture at 0.7 m and 1.4 m and bromide concentrations at 0.7 m. Model convergence during calibration was possible only by fixing the values estimated for the bulk densities of the first and third layers. These medium density loams were fixed at 1.3 g/cm^3, an average value for medium density sandy loams (U.S. Department of Agriculture, 2006b). Observations included measurements of soil moisture with TDRs installed at 0.7 and 1.4 m and bromide concentrations measured in the pan lysimeter at 0.7 m. The bromide concentrations provided additional constraints for the soil moisture retention and the estimated dispersivity. Dispersivity in LEACHM is restricted to the range of half to twice the node spacing. Even with a node spacing of 10 cm, the calibrated value is at the minimum value of 5 cm. This is in agreement with recent reviews of dispersivity reported in the literature (Beven, 2006).

Parameters affecting the fate and transport of seven parent pesticides and seven metabolites were from Table 14 with the following exceptions. Transformation half-lives for atrazine, metolachlor, and their metabolites were modified such that time series of relative and absolute concentrations of the parent and daughter products predicted by an analytical branched serial first-order decay model would match observations made at the Maryland and Nebraska study sites.

Total recharge and leaching of pesticides to the ground water were estimated for each hectare of corn-soy crops for the period 1995-2004 in the Maryland watershed. Total recharge of water, and the mass of applied, produced, transformed, residual, and leached parent and metabolite for each model was interpolated using the five modeled depths from 1 to 10 m. Soils with an unsaturated zone less than 1 m but greater than zero were assigned the same fluxes as the 1-m model; similarly, areas with unsaturated-zone thickness greater than 10 m were assigned the same fluxes as the 10-m model.

Ground-water models

Ground-water flow models were constructed at two scales as part of this study. The large-scale models, hereafter referred to as regional models, covered the aquifers that are important to the indicator basins and the surrounding areas such that the boundary conditions in the models would have minimal impact on the area of interest. The small-scale models, hereafter referred to as local models, were completed in the vicinity of the ground-water flowpath studies. MODFLOW-2000 (Harbaugh et al., 2000), a three-dimensional finite difference code, was used to simulate ground-water flow. MODPATH (Pollack, 1994), a particle tracking code, was used to simulate flow lines and travels times of ground water through the aquifers.

The regional models, which ranged in size from 146 to 2,600 km^2, were constructed first. The objectives of ground-water modeling in these studies were (1) to define ground-water flowpaths through the saturated subsurface to aid in the design of data collection networks, (2) to define the ground-water age distribution, (3) to increase the understanding of how surface water and ground water interact, (4) to provide a framework for constructing the local models and extrapolating the flowpath study results to the entire basin, and (5) to examine sensitivity of simulations to the uncertainty in model parameters.

The local models, which were developed using the regional models as a base to provide boundary conditions where necessary, ranged in size from 5 to 18 km^2. The purposes of these models were (1) to develop a refined understanding of ground-water flow in the area of the flowpath study, (2) to estimate ground-water travel times and pathlines of water to monitoring wells sampled as part of the flowpath studies, and (3) to provide a foundation for simulation of either transport or geochemical processes.

Conceptual models of ground-water flow were developed for the different areas and converted to numerical models. The conceptual models of geology for the regional models were generated from existing databases of well logs or other interpreted maps of aquifer thickness and extent. For the local models, the conceptual model was improved by using logs of wells installed as part of the ACT study. The density of wells in the flowpath study areas and the quality of logs were generally better than in the existing databases used for the regional model. In some cases, this added knowledge was used to improve the regional models as well.

Parameters representing aquifer properties and recharge in numerical models were adjusted to make simulated values better match field observations. Similar to the case of well logs, water levels for the regional models were generally based on existing data whereas, for the local models, these data were supplemented with data collected as part of the ACT study. In addition to head observations, observations of flow in streams were also used in refining the models. Both automated parameter estimation methods (Hill et al., 2000) and manual adjustment were used in the process of refining the models. Generally the models were steady-state models representing average conditions in the study areas. In the case of both the regional and local models, more data could lead to improved models; however, the existing models provide a way to begin testing of the conceptual models by producing numerical results that can be compared to observed data.

Use estimates for the selected pesticides

Data on the amounts and rates of pesticide use were obtained from a variety of sources for the three spatial scales of interest in each study area. Estimates for the small watersheds came from interviews with the growers or from state databases, whereas those for the two larger-scale studies in each watershed were computed from national databases. These estimates and their sources are listed in Table 15.

Physical and chemical properties of the pesticides and degradates of interest

A consistent set of values for the physical and chemical properties of the pesticides and degradates of interest was used to simulate the transport and fate of these compounds in the hydrologic system at all of the study sites. Figures 6 and 7 illustrate the relations of the parent pesticides and their degradates for the two most common pesticides discussed in this series of papers in the *Journal of Environmental Quality,* atrazine and metolachlor, respectively. When available, the values for the physical and chemical properties were obtained from an internal database that accompanies the RZWQM model. Values that were not available from the RZWQM database were either taken from the literature or (if a suitable published value did not appear to be available) calculated using a variety of property estimation techniques. Among the data available from different literature sources for a given parameter, top priority was given to the values recommended by Mackay et al. (1997), followed, in turn, by those selected by the Pesticide Properties Database (U.S. Department of Agriculture, 2006c) and then by values reported from individual laboratory studies. In cases where it was necessary to compute the value of a given parameter using one or more estimation techniques, measured values for structurally related compounds, if available, were adjusted — using the ratio of

the estimated values for the target and related compounds — to yield what were presumed to be more accurate values for the target compound. For each compound of interest, Table 14 lists the parameter values that were employed for these simulations, as well as either the literature source from which each value was obtained or, where necessary, the methods that were used for its estimation. Because of the considerable complexity of some of these methods, Figures 8 and 9 provide flowcharts that document the sequence of steps used for each computation.

Summary of Results of Quality Control Samples

A variety of quality control (QC) samples were obtained and analyzed to provide an indication of the data quality. The USGS National-Water Quality Laboratory (NWQL) maintains a robust QC program that includes laboratory blanks, spikes, and replicates (Pirkey and Glodt, 1998). The results from long-term method detection limits evaluations and laboratory performance evaluations are available from the USGS NWQL (U.S. Geological Survey, 2006c). In addition, the USGS Branch of Quality Systems, which is independent from the NWQL, conducts blind sample and standard reference sample programs to evaluate USGS laboratories. These data are available from the USGS Branch of Quality Systems (U.S. Geological Survey, 2006d).

In addition to the internal laboratory QC samples, blank, replicate, and spike (pesticides only) samples from the field were submitted to evaluate contamination and bias and variability. In general, one blank sample of deionized water that was known not to contain the analytes of interest above their method reporting limits was submitted for each 30 major ion and suspended sediment samples, each 20 nutrient samples, each 12 particulate and dissolved organic carbon samples, and each 15 pesticide samples. One replicate sample was submitted for each 20 major ion, suspended sediment, and nutrient samples, each 12 particulate and dissolved organic carbon samples, and each 15 pesticide samples. One field spike of the target pesticide analytes from the NWQL was submitted for each surface-water site and selected ground-water and GW/SW interaction sites. Field blanks (deionized water processed as a field sample) for nutrients and pesticides were submitted from each study area. The pooled results of these field QC samples, together with the method reporting limits, are presented in Tables 4, 5, 6, and 7.

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Disclaimer: Use of brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Table 1 – Published environmental setting documents for the study areas.

California
Large-Scale Study Area: Gronberg, J.M., Dubrovsky, N.M., Kratzer, C.R., Domagalski, J.L., Brown, L.R., and Burow, K.R., 1998, Environmental Setting of the San Joaquin-Tulare Basins, California. U.S. Geological Survey Water-Resources Investigations Report 97-4205, 45 p. Intermediate-Scale Study Area: Gronberg, J.M., and Kratzer, C.R., 2006, Environmental setting of the lower Merced River Basin, California. U.S. Geological Survey Scientific Investigations Report 2006-5152.
Indiana
Large-Scale Study Area: Schnoebelen, D.J., Fenelon, J.M., Baker, N.T., Martin, J.D., Bayless, E.R., Jacques, D.V., and Crawford, C.G., 1999, Environmental setting and natural factors and human influences affecting water quality in the White River Basin, Indiana. U.S. Geological Survey Water-Resources Investigations Report 97-4260, 66 p. Intermediate-Scale Study Area: Lathrop, T., 2005, Environmental Setting of the Sugar Creek and Leary Weber Ditch Basins, Indiana, 2002-04. U.S. Geological Survey Scientific Investigations Report 2006-5170.
Maryland
Large-Scale Study Area: Denver, J.M., Ator, S.W., Debrewer, L.D., Ferrari, M.J., Barbaro, J.R., Hancock, T.C., Brayton, M.J., and Nardi, M.R., 2004, Water quality in the Delmarva Peninsula, Delaware, Maryland, and Virginia, 1999-2001. U.S. Geological Survey Circular 1228, 31 p. Intermediate-Scale Study Area: Hancock, T.C., and M.J. Brayton. 2006. Environmental Setting of the Morgan Creek Basin, Maryland, 2002-04. U.S. Geological Survey Open File Report 2006-1151.
Nebraska
Large-Scale Study Area: Huntzinger, T.L., and Ellis, M.J., 1993, Central Nebraska river basins, Nebraska. *Water Resources Bulletin*, v. 29, no. 4, p. 533-574. Intermediate-Scale Study Area: Fredrick, B.S., Linard, J.I., and Carpenter, J.L., 2006, Environmental setting of Maple Creek Watershed, Nebraska. U.S. Geological Survey Scientific Investigations Report 2006-5037.
Washington
Large-Scale Study Area: Rinella, J.F., McKenzie, S.W., and Fuhrer, G.J., 1992, Surface-water-quality assessment of the Yakima River Basin, Washington – Analysis of available water-quality data through 1985 water year. U.S. Geological Survey Open-File Report 91-453, 244 p. Large-Scale Study Area: Rinella, J.F., McKenzie, S.W., Crawford, J.K., Foreman, W.T., Fuhrer, G.J., Morace, J.L., Aiken, G.R., 1999, Surface-water-quality assessment of the Yakima River basin, Washington; distribution of pesticides and other organic compounds in water, sediment, and aquatic biota, 1987-91; with a section on dissolved organic carbon in the Yakima River basin. U.S. Geological Survey Water-Supply Paper 2354-B, 180 p. Intermediate-Scale Study Area: Payne, K.L., H.M. Johnson, and R.W. Black. 2007. Environmental setting of the Granger Drain and DR2 Basins, Washington, 2003-2004. U.S. Geological Survey Scientific Investigations Report 2007-5102.

Table 2 – List of sites in ACT study with information on site characteristics and installed sensors.

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
CA	C10	11273500	MERCED RIVER AT RIVER ROAD BRIDGE NEAR NEWMAN, CA	SW	CFPT	---	---	37.35104847	-120.9618719	37 21 3.774492	120 57 42.738732	22.7	river	
CA	C18	372311120481001	MERCED R NR HIGHLINE CANAL SPILLWAY NR DELHI CA	GS	LT	---	---	37.38658333	-120.8029167	37 23 11.699988	120 48 10.500012	21.6	river	
CA	C11	11272500	Merced River near Stevinson, CA	SW	D	---	---	37.37077046	-120.9304826	37 22 14.773656	120 55 49.737216	23.0	river	
CA	C12	372316120480701	MERCED R NR RIVER MILE 16 NR DELHI CA	GS	LTCDP	---	---	37.38777778	-120.8019444	37 23 16.000008	120 48 6.999984	23.9	river	
CA	C13	373112120382901	MUSTANG CA MONTE VISTA AVE NR MONTPELIER CA	SW	CDFPT	---	---	37.52055556	-120.6411111	37 31 14.000016	120 38 27.999996	61.7	stream	
CA	C14	372829120420801	MUSTANG CA NEWPORT RD NR BALLICO CA	SW	---	---	---	37.47465824	-120.7032563	37 28 28.769664	120 42 11.72268	47.7	stream	
CA	C15	372839120413901	MUSTANG C A BIFURCATION STRUCTURE NR BALLICO CA	SW	---	---	---	37.4775	-120.6941667	37 28 39	120 41 39.000012	49.8	stream	
CA	C16	373012120393401	MUSTANG CRES A OAKDALE RD NR MONTPELIER CA	SW	---	---	---	37.5025	-120.6577778	37 30 9	120 39 28.000008	57.7	stream	
CA	C17	373020120385201	MUSTANG C 1.1MI S OF MONTE VISTA AVE NR MONTPELIER	SW	---	---	---	37.50555556	-120.6477778	37 30 20.000016	120 38 52.000008	58.6	stream	
CA	C20p	372316120481006	NAWQA WELL ACTFS1-1C NR DELHI, CA	GW	LT	8.5	61.0	37.38773889	-120.8028028	37 23 15.860004	120 48 10.090008	27.8	native vegetation	air hammer
CA	C20q	372316120481003	NAWQA WELL ACTFS1-1D NR DELHI, CA	GW	LT	14.9	61.0	37.387775	-120.8027306	37 23 15.99	120 48 9.830016	27.5	native vegetation	air hammer
CA	C20r	372316120481002	NAWQA WELL ACTFS1-1F NR DELHI, CA	GW	LT	24.7	61.0	37.387775	-120.8027306	37 23 15.99	120 48 9.830016	27.5	native vegetation	air hammer
CA	C20s	372316120481001	NAWQA WELL ACTFS1-1G NR DELHI, CA	GW	LT	28.7	61.0	37.387775	-120.8027306	37 23 15.99	120 48 9.830016	27.5	native vegetation	air hammer
CA	C20t	372316120481007	NAWQA WELL ACTFS1-1H NR DELHI, CA	GW	LT	51.8	305	37.38773333	-120.8027528	37 23 15.839988	120 48 9.910008	27.6	native vegetation	mud rotary
CA	C21p	372333120480103	NAWQA WELL ACTFS1-2B NR DELHI, CA	GW	LT	12.8	61.0	37.39231667	-120.8013056	37 23 32.340012	120 48 4.700016	30.1	native vegetation	mud rotary
CA	C21q	372333120480102	NAWQA WELL ACTFS1-2C NR DELHI, CA	GW	LT	18.6	61.0	37.39231667	-120.8013056	37 23 32.340012	120 48 4.700016	30.1	native vegetation	mud rotary
CA	C21r	372333120480101	NAWQA WELL ACTFS1-2D NR DELHI, CA	GW	LT	24.7	61.0	37.39231667	-120.8013056	37 23 32.340012	120 48 4.700016	30.1	native vegetation	mud rotary
CA	C22a	372351120480135	ACTVZ1-1A NR DELHI, CA, WATER CONTENT	UZ	M	0.3	---	37.39733333	-120.8004444	37 23 50.399988	120 48 1.599984	33.5	almond orchard	
CA	C22a	372351120480138	ACTVZ1-1A NR DELHI,CA,HEAT DISSIPATION	UZ	H	0.3	---	37.39733333	-120.8004444	37 23 50.399988	120 48 1.599984	33.5	almond orchard	
CA	C22b	372351120480136	ZCTVZ1-1B NR DELHI, CA, WATER CONTENT	UZ	M	0.6	---	37.39733333	-120.8004444	37 23 50.399988	120 48 1.599984	33.5	almond orchard	
CA	C22c	372351120480139	ACTVZ1-1B NR DELHI,CA,HEAT DISSIPATION	UZ	H	0.9	---	37.39733333	-120.8004444	37 23 50.399988	120 48 1.599984	33.5	almond orchard	
CA	C22c	372351120480131	VADOSE ZONE ACTVZ1-1B NR DELHI, CA, SUCTION LYS	UZ	S	0.9	---	37.39736667	-120.8004361	37 23 50.520012	120 48 1.569996	33.5	almond orchard	
CA	C22c	372351120480137	ACTVZ1-1C NR DELHI, CA, WATER CONTENT	UZ	M	0.9	---	37.39733333	-120.8004444	37 23 50.399988	120 48 1.599984	33.5	almond orchard	
CA	C22d	372351120480140	ACTVZ1-1C NR DELHI,CA,HEAT DISSIPATION	UZ	H	3.3	---	37.39733333	-120.8004444	37 23 50.399988	120 48 1.599984	33.5	almond orchard	
CA	C22e	372351120480141	ACTVZ1-1D NR DELHI,CA,HEAT DISSIPATION	UZ	H	4.6	---	37.39733333	-120.8004444	37 23 50.399988	120 48 1.599984	33.5	almond orchard	
CA	C22e	372351120480133	VADOSE ZONE ACTVZ1-1D NR DELHI, CA, SUCTION LYS	UZ	S	4.6	---	37.39736667	-120.8004361	37 23 50.520012	120 48 1.569996	33.5	almond orchard	
CA	C22f	372351120480142	ACTVZ1-1E NR DELHI,CA,HEAT DISSIPATION	UZ	H	6.1	---	37.39733333	-120.8004444	37 23 50.399988	120 48 1.599984	33.5	almond orchard	
CA	C22f	372351120480134	VADOSE ZONE ACTVZ1-1E NR DELHI, CA, SUCTION LYS	UZ	S	6.1	---	37.39736667	-120.8004361	37 23 50.520012	120 48 1.569996	33.5	almond orchard	
CA	C22p	372351120480104	NAWQA WELL ACTFS1-3A NR DELHI, CA	GW	LT	6.1	61.0	37.39736944	-120.8003528	37 23 50.529984	120 48 1.270008	33.5	almond orchard	mud rotary
CA	C22q	372351120480103	NAWQA WELL ACTFS1-3B NR DELHI, CA	GW	LT	13.7	61.0	37.39736944	-120.8003528	37 23 50.529984	120 48 1.270008	33.5	almond orchard	mud rotary
CA	C22r	372351120480102	NAWQA WELL ACTFS1-3C NR DELHI, CA	GW	LT	19.8	61.0	37.39736944	-120.8003528	37 23 50.529984	120 48 1.270008	33.5	almond orchard	mud rotary
CA	C22s	372351120480101	NAWQA WELL ACTFS1-3D NR DELHI, CA	GW	LT	26.5	61.0	37.39736944	-120.8003528	37 23 50.529984	120 48 1.270008	33.5	almond orchard	mud rotary
CA	C31p	373021120385101	NAWQA WELL ACTAS1-1A NR MONTPELIER, CA	GW	LT	47.9	152	37.50602778	-120.6475833	37 30 21.700008	120 38 51.299988	59.4	native vegetation	air hammer
CA	C32a	373021120385132	VADOSE ZONE ACTVZ1-2A NR MONTPELIER,CA	UZ	T	0.1	---	37.506	-120.6475278	37 30 21.6	120 38 51.100008	57.9	below creek bed	
CA	C32b	373021120385133	VADOSE ZONE ACTVZ1-2B NR MONTPELIER,CA	UZ	T	0.3	---	37.506	-120.6475278	37 30 21.6	120 38 51.100008	57.9	below creek bed	
CA	C32d	373021120385130	VADOSE ZONE ACTVZ1-2A NR MONTPELIER, CA, SUCTION	UZ	S	1.4	---	37.506	-120.6475278	37 30 21.6	120 38 51.100008	57.9	below creek bed	
CA	C32d	373021120385134	VADOSE ZONE ACTVZ1-2C NR MONTPELIER,CA	UZ	T	0.7	---	37.506	-120.6475278	37 30 21.6	120 38 51.100008	57.9	below creek bed	
CA	C32d	373021120385135	VADOSE ZONE ACTVZ1-2D NR MONTPELIER,CA	UZ	T	1.4	---	37.506	-120.6475278	37 30 21.6	120 38 51.100008	57.9	below creek bed	
CA	C33a	373021120385136	VADOSE ZONE ACTVZ1-3A NR MONTPELIER,CA	UZ	T	0.4	---	37.50566667	-120.6475556	37 30 20.400012	120 38 51.200016	57.9	below creek bed	
CA	C33b	373021120385137	VADOSE ZONE ACTVZ1-3B NR MONTPELIER,CA	UZ	T	0.8	---	37.50566667	-120.6475556	37 30 20.400012	120 38 51.200016	57.9	below creek bed	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
CA	C33c	373021120385138	VADOSE ZONE ACTVZ1-3C NR MONTPELIER,CA	UZ	T	1.2	---	37.50566667	-120.6475556	37 30 20.400012	120 38 51.200016	57.9	below creek bed	
CA	C33d	373021120385131	VADOSE ZONE ACTVZ1-2B NR MONTPELIER, CA, SUCTION	UZ	S	2.3	---	37.50566667	-120.6475556	37 30 20.400012	120 38 51.200016	57.9	below creek bed	
CA	C41	373115120382801	CULVERT DISCHARGE TO MUSTANG C A MONTE VISTA AVE	OV	---	---	---	37.52083333	-120.6411111	37 31 14.999988	120 38 27.999996	61.7	almond orchard	
CA	C46	372314120481101	PRECIP COLLECTOR A BLUMFIELD SITE NR DELHI CA	AT	R	---	---	37.38722222	-120.8030556	37 23 13.999992	120 48 11.000016	26.0	native vegetation	
CA	C47	372857120414001	TURLOCK AIRPORT RAINGAGE NR RUNWAY A TURLOCK CA	AT	R	---	---	37.4825	-120.6944444	37 28 57	120 41 39.999984	48.6	airport	
CA	C48	373022120385501	PRECIP GAGE S OF MONTE VISTA AVE NR MONTPELIER CA	AT	W	---	---	37.50597222	-120.6485833	37 30 21.499992	120 38 54.899988	61.4	native vegetation	
CA	C49	372354120480401	PRECIP GAGE A BALVERT SITE NR DELHI CA	AT	W	---	---	37.39833333	-120.8011111	37 23 53.999988	120 48 3.999996	32.7	almond orchard	
CA	C51a	372312120481111	GWSW ACTTR1-5-1A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38816944	-120.8015667	37 23 17.409984	120 48 5.640012	21.6	river	
CA	C51b	372312120481112	GWSW ACTTR1-5-1B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38816944	-120.8015667	37 23 17.409984	120 48 5.640012	21.6	river	
CA	C51c	372312120481113	GWSW ACTTR1-5-1C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38816944	-120.8015667	37 23 17.409984	120 48 5.640012	21.6	river	
CA	C52a	372312120481114	GWSW ACTTR1-5-2A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38820278	-120.8016194	37 23 17.530008	120 48 5.829984	21.6	river	
CA	C52b	372312120481115	GWSW ACTTR1-5-2B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38820278	-120.8016194	37 23 17.530008	120 48 5.829984	21.6	river	
CA	C52c	372312120481116	GWSW ACTTR1-5-2C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38820278	-120.8016194	37 23 17.530008	120 48 5.829984	21.6	river	
CA	C53a	372312120481117	GWSW ACTTR1-5-3A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38822778	-120.801675	37 23 17.620008	120 48 6.03	21.6	river	
CA	C53b	372312120481118	GWSW ACTTR1-5-3B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38822778	-120.801675	37 23 17.620008	120 48 6.03	21.6	river	
CA	C53c	372312120481119	GWSW ACTTR1-5-3C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38822778	-120.801675	37 23 17.620008	120 48 6.03	21.6	river	
CA	C54a	372312120481120	GWSW ACTTR1-5-4A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38825556	-120.8017278	37 23 17.720016	120 48 6.220008	21.6	river	
CA	C54b	372312120481121	GWSW ACTTR1-5-4B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38825556	-120.8017278	37 23 17.720016	120 48 6.220008	21.6	river	
CA	C54c	372312120481122	GWSW ACTTR1-5-4C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38825556	-120.8017278	37 23 17.720016	120 48 6.220008	21.6	river	
CA	C55a	372312120481123	GWSW ACTTR1-5-5A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38828333	-120.8017806	37 23 17.819988	120 48 6.410016	21.6	river	
CA	C55b	372312120481124	GWSW ACTTR1-5-5B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38828333	-120.8017806	37 23 17.819988	120 48 6.410016	21.6	river	
CA	C55c	372312120481125	GWSW ACTTR1-5-5C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38828333	-120.8017806	37 23 17.819988	120 48 6.410016	21.6	river	
CA	C61	372312120480007	GWSW ACTTR1-4-1 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38786111	-120.8019722	37 23 16.299996	120 48 7.099992	21.6	river	
CA	C61a	372312120481072	GWSW ACTTR1-4-1A PIEZOMETER NR DELHI, CA	GS	T	5.6	30.5	37.38774167	-120.8017333	37 23 15.870012	120 48 6.239988	23.8	river bank	
CA	C61b	372312120481071	GWSW ACTTR1-4-1B PIEZOMETER NR DELHI, CA	GS	T	4.3	30.5	37.38775556	-120.8017222	37 23 15.920016	120 48 6.199992	23.8	river bank	
CA	C62	372312120480008	GWSW ACTTR1-4-2 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38788889	-120.8019444	37 23 16.400004	120 48 6.999984	21.6	river	
CA	C62a	372312120481076	GWSW ACTTR1-4-2A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38774722	-120.8018056	37 23 15.889992	120 48 6.500016	21.6	river	
CA	C62b	372312120481077	GWSW ACTTR1-4-2B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38774722	-120.8018056	37 23 15.889992	120 48 6.500016	21.6	river	
CA	C62c	372312120481078	GWSW ACTTR1-4-2C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38774722	-120.8018056	37 23 15.889992	120 48 6.500016	21.6	river	
CA	C63	372312120480009	GWSW ACTTR1-4-3 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38788889	-120.8017778	37 23 16.400004	120 48 6.400008	21.6	river	
CA	C63a	372312120481079	GWSW ACTTR1-4-3A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38774167	-120.8018833	37 23 15.870012	120 48 6.779988	21.6	river	
CA	C63b	372312120481080	GWSW ACTTR1-4-3B PIEZOMETER NR DELHI, CA	GS	T	0.9	15.2	37.38773889	-120.8018861	37 23 15.860004	120 48 6.789996	21.6	river	
CA	C63c	372312120481081	GWSW ACTTR1-4-3C PIEZOMETER NR DELHI, CA	GS	T	2.8	15.2	37.38774722	-120.8018806	37 23 15.889992	120 48 6.770016	21.6	river	
CA	C64	372312120480010	GWSW ACTTR1-4-4 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38791667	-120.80175	37 23 16.500012	120 48 6.3	21.6	river	
CA	C64a	372312120481085	GWSW ACTTR1-4-4A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38775278	-120.8019278	37 23 15.910008	120 48 6.940008	21.6	river	
CA	C64b	372312120481086	GWSW ACTTR1-4-4B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38775278	-120.8019278	37 23 15.910008	120 48 6.940008	21.6	river	
CA	C64c	372312120481087	GWSW ACTTR1-4-4C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38775278	-120.8019278	37 23 15.910008	120 48 6.940008	21.6	river	
CA	C65	372312120480011	GWSW ACTTR1-4-5 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38783333	-120.8018056	37 23 16.199988	120 48 6.500016	21.6	river	
CA	C65a	372312120481088	GWSW ACTTR1-4-5A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38776389	-120.8019722	37 23 15.950004	120 48 7.099992	21.6	river	
CA	C65b	372312120481089	GWSW ACTTR1-4-5B PIEZOMETER NR DELHI, CA	GS	LT	0.9	15.2	37.38776111	-120.801975	37 23 15.939996	120 48 7.11	21.6	river	
CA	C65c	372312120481090	GWSW ACTTR1-4-5C PIEZOMETER NR DELHI, CA	GS	LT	2.8	15.2	37.38776667	-120.8019694	37 23 15.960012	120 48 7.089984	21.6	river	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
CA	C66	372312120480012	GWSW ACTTR1-4-6 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38786111	-120.8017778	37 23 16.299996	120 48 6.400008	21.6	river	
CA	C66a	372312120481094	GWSW ACTTR1-4-6A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38777778	-120.8020056	37 23 16.000008	120 48 7.220016	21.6	river	
CA	C66b	372312120481095	GWSW ACTTR1-4-6B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38777778	-120.8020056	37 23 16.000008	120 48 7.220016	21.6	river	
CA	C66c	372312120481096	GWSW ACTTR1-4-6C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38777778	-120.8020056	37 23 16.000008	120 48 7.220016	21.6	river	
CA	C67a	372312120481097	GWSW ACTTR1-4-7A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38779167	-120.8020389	37 23 16.050012	120 48 7.340004	21.6	river	
CA	C67b	372312120481098	GWSW ACTTR1-4-7B PIEZOMETER NR DELHI, CA	GS	LT	0.9	15.2	37.38778889	-120.8020444	37 23 16.040004	120 48 7.359984	21.6	river	
CA	C67c	372312120481099	GWSW ACTTR1-4-7C PIEZOMETER NR DELHI, CA	GS	LT	2.8	15.2	37.38779444	-120.8020361	37 23 16.059984	120 48 7.329996	21.6	river	
CA	C68a	372312120481103	GWSW ACTTR1-4-8A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.3878	-120.8020583	37 23 16.08	120 48 7.409988	21.6	river	
CA	C68b	372312120481104	GWSW ACTTR1-4-8B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.3878	-120.8020583	37 23 16.08	120 48 7.409988	21.6	river	
CA	C68c	372312120481105	GWSW ACTTR1-4-8C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.3878	-120.8020583	37 23 16.08	120 48 7.409988	21.6	river	
CA	C69a	372312120481106	GWSW ACTTR1-4-9A PIEZOMETER NR DELHI, CA	GS	T	3.6	30.5	37.38784444	-120.802175	37 23 16.239984	120 48 7.83	24.1	river bank	
CA	C69b	372312120481107	GWSW ACTTR1-4-9B PIEZOMETER NR DELHI, CA	GS	T	5.1	30.5	37.38783333	-120.8021806	37 23 16.199988	120 48 7.850016	24.1	river bank	
CA	C71a	372312120481056	GWSW ACTTR1-3-1A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38727222	-120.8021306	37 23 14.179992	120 48 7.670016	21.6	river	
CA	C71b	372312120481057	GWSW ACTTR1-3-1B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38727222	-120.8021306	37 23 14.179992	120 48 7.670016	21.6	river	
CA	C71c	372312120481058	GWSW ACTTR1-3-1C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38727222	-120.8021306	37 23 14.179992	120 48 7.670016	21.6	river	
CA	C72a	372312120481059	GWSW ACTTR1-3-2A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38730833	-120.8021778	37 23 14.309988	120 48 7.840008	21.6	river	
CA	C72b	372312120481060	GWSW ACTTR1-3-2B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38730833	-120.8021778	37 23 14.309988	120 48 7.840008	21.6	river	
CA	C72c	372312120481061	GWSW ACTTR1-3-2C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38730833	-120.8021778	37 23 14.309988	120 48 7.840008	21.6	river	
CA	C73a	372312120481062	GWSW ACTTR1-3-3A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38733333	-120.8022222	37 23 14.399988	120 48 7.999992	21.6	river	
CA	C73b	372312120481063	GWSW ACTTR1-3-3B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38733333	-120.8022222	37 23 14.399988	120 48 7.999992	21.6	river	
CA	C73c	372312120481064	GWSW ACTTR1-3-3C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38733333	-120.8022222	37 23 14.399988	120 48 7.999992	21.6	river	
CA	C74a	372312120481065	GWSW ACTTR1-3-4A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38736944	-120.8022778	37 23 14.529984	120 48 8.200008	21.6	river	
CA	C74b	372312120481066	GWSW ACTTR1-3-4B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38736944	-120.8022778	37 23 14.529984	120 48 8.200008	21.6	river	
CA	C74c	372312120481067	GWSW ACTTR1-3-4C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38736944	-120.8022778	37 23 14.529984	120 48 8.200008	21.6	river	
CA	C75a	372312120481068	GWSW ACTTR1-3-5A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38739722	-120.8023222	37 23 14.629992	120 48 8.359992	21.6	river	
CA	C75b	372312120481069	GWSW ACTTR1-3-5B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38739722	-120.8023222	37 23 14.629992	120 48 8.359992	21.6	river	
CA	C75c	372312120481070	GWSW ACTTR1-3-5C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38739722	-120.8023222	37 23 14.629992	120 48 8.359992	21.6	river	
CA	C81	372312120480001	GWSW ACTTR1-2-1 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38675	-120.803	37 23 12.3	120 48 10.8	21.6	river	
CA	C81a	372312120481016	GWSW ACTTR1-2-1A PIEZOMETER NR DELHI, CA	GS	T	2.5	30.5	37.38687778	-120.8028222	37 23 12.760008	120 48 10.159992	24.4	river bank	
CA	C81b	372312120481017	GWSW ACTTR1-2-1B PIEZOMETER NR DELHI, CA	GS	LT	4.4	30.5	37.38658611	-120.8028306	37 23 11.709996	120 48 10.190016	24.4	river bank	
CA	C82	372312120480002	GWSW ACTTR1-2-2 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38672222	-120.8030278	37 23 12.199992	120 48 10.900008	21.6	river	
CA	C82a	372312120481021	GWSW ACTTR1-2-2A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38661111	-120.8028667	37 23 11.799996	120 48 10.320012	21.6	river	
CA	C82b	372312120481022	GWSW ACTTR1-2-2B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38661111	-120.8028667	37 23 11.799996	120 48 10.320012	21.6	river	
CA	C82c	372312120481023	GWSW ACTTR1-2-2C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38661111	-120.8028667	37 23 11.799996	120 48 10.320012	21.6	river	
CA	C83	372312120480003	GWSW ACTTR1-2-3 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38663889	-120.8030278	37 23 11.900004	120 48 10.900008	21.6	river	
CA	C83a	372312120481024	GWSW ACTTR1-2-3A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38662778	-120.8029028	37 23 11.860008	120 48 10.450008	21.6	river	
CA	C83b	372312120481025	GWSW ACTTR1-2-3B PIEZOMETER NR DELHI, CA	GS	T	0.9	15.2	37.38663056	-120.8029	37 23 11.870016	120 48 10.44	21.6	river	
CA	C83c	372312120481026	GWSW ACTTR1-2-3C PIEZOMETER NR DELHI, CA	GS	T	2.8	15.2	37.386625	-120.8029056	37 23 11.85	120 48 10.460016	21.6	river	
CA	C84	372312120480004	GWSW ACTTR1-2-4 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38666667	-120.803	37 23 12.000012	120 48 10.8	21.6	river	
CA	C84a	372312120481030	GWSW ACTTR1-2-4A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38668889	-120.8029139	37 23 12.080004	120 48 10.490004	21.6	river	
CA	C84b	372312120481031	GWSW ACTTR1-2-4B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38668889	-120.8029139	37 23 12.080004	120 48 10.490004	21.6	river	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
CA	C84c	372312120481032	GWSW ACTTR1-2-4C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38668889	-120.8029139	37 23 12.080004	120 48 10.490004	21.6	river	
CA	C85	372312120480005	GWSW ACTTR1-2-5 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38669444	-120.8030833	37 23 12.099984	120 48 11.099988	21.6	river	
CA	C85a	372312120481033	GWSW ACTTR1-2-5A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38674722	-120.8029222	37 23 12.289992	120 48 10.519992	21.6	river	
CA	C85b	372312120481034	GWSW ACTTR1-2-5B PIEZOMETER NR DELHI, CA	GS	LTCDP	0.9	15.2	37.38675	-120.8029222	37 23 12.3	120 48 10.519992	21.6	river	
CA	C85c	372312120481035	GWSW ACTTR1-2-5C PIEZOMETER NR DELHI, CA	GS	LTCDP	2.8	15.2	37.38674722	-120.802925	37 23 12.289992	120 48 10.53	21.6	river	
CA	C86	372312120480006	GWSW ACTTR1-2-6 SEEPAGE METER NR DELHI, CA	GS	B	---	---	37.38666667	-120.8031111	37 23 12.000012	120 48 11.199996	21.6	river	
CA	C86a	372312120481039	GWSW ACTTR1-2-6A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38676944	-120.8029389	37 23 12.369984	120 48 10.580004	21.6	river	
CA	C86b	372312120481040	GWSW ACTTR1-2-6B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38676944	-120.8029389	37 23 12.369984	120 48 10.580004	21.6	river	
CA	C86c	372312120481041	GWSW ACTTR1-2-6C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38676944	-120.8029389	37 23 12.369984	120 48 10.580004	21.6	river	
CA	C87a	372312120481042	GWSW ACTTR1-2-7A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38679167	-120.8029528	37 23 12.450012	120 48 10.630008	21.6	river	
CA	C87b	372312120481043	GWSW ACTTR1-2-7B PIEZOMETER NR DELHI, CA	GS	TL	0.9	15.2	37.38679444	-120.80295	37 23 12.459984	120 48 10.62	21.6	river	
CA	C87c	372312120481044	GWSW ACTTR1-2-7C PIEZOMETER NR DELHI, CA	GS	TL	2.8	15.2	37.38678611	-120.8029528	37 23 12.429996	120 48 10.630008	21.6	river	
CA	C88a	372312120481048	GWSW ACTTR1-2-8A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38681111	-120.8029611	37 23 12.519996	120 48 10.659996	21.6	river	
CA	C88b	372312120481049	GWSW ACTTR1-2-8B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38681111	-120.8029611	37 23 12.519996	120 48 10.659996	21.6	river	
CA	C88c	372312120481050	GWSW ACTTR1-2-8C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38681111	-120.8029611	37 23 12.519996	120 48 10.659996	21.6	river	
CA	C89a	372312120481051	GWSW ACTTR1-2-9A PIEZOMETER NR DELHI, CA	GS	T	4.0	30.5	37.38694167	-120.803025	37 23 12.990012	120 48 10.89	23.5	river bank	
CA	C89b	372312120481052	GWSW ACTTR1-2-9B PIEZOMETER NR DELHI, CA	GS	T	5.2	30.5	37.38693333	-120.8030278	37 23 12.959988	120 48 10.900008	23.5	river bank	
CA	C92a	372312120481004	GWSW ACTTR1-1-2A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38658611	-120.803475	37 23 11.709996	120 48 12.51	21.6	river	
CA	C92b	372312120481005	GWSW ACTTR1-1-2B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38658611	-120.803475	37 23 11.709996	120 48 12.51	21.6	river	
CA	C92c	372312120481006	GWSW ACTTR1-1-2C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38658611	-120.803475	37 23 11.709996	120 48 12.51	21.6	river	
CA	C93a	372312120481007	GWSW ACTTR1-1-3A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38663056	-120.803475	37 23 11.870016	120 48 12.51	21.6	river	
CA	C93b	372312120481008	GWSW ACTTR1-1-3B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38663056	-120.803475	37 23 11.870016	120 48 12.51	21.6	river	
CA	C93c	372312120481009	GWSW ACTTR1-1-3C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38663056	-120.803475	37 23 11.870016	120 48 12.51	21.6	river	
CA	C94a	372312120481010	GWSW ACTTR1-1-4A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.386675	-120.803475	37 23 12.03	120 48 12.51	21.6	river	
CA	C94b	372312120481011	GWSW ACTTR1-1-4B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.386675	-120.803475	37 23 12.03	120 48 12.51	21.6	river	
CA	C94c	372312120481012	GWSW ACTTR1-1-4C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.386675	-120.803475	37 23 12.03	120 48 12.51	21.6	river	
CA	C95a	372312120481013	GWSW ACTTR1-1-5A TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.3	25	37.38671111	-120.803475	37 23 12.159996	120 48 12.51	21.6	river	
CA	C95b	372312120481014	GWSW ACTTR1-1-5B TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	0.5	25	37.38671111	-120.803475	37 23 12.159996	120 48 12.51	21.6	river	
CA	C95c	372312120481015	GWSW ACTTR1-1-5C TEMPORARY DRIVEPOINT NR DELHI, CA	GS	---	1.0	25	37.38671111	-120.803475	37 23 12.159996	120 48 12.51	21.6	river	
IN	I10	394340085524601	SUGAR CREEK AT CO RD 400 S AT NEW PALESTINE, IN	SW	CDPT	---	---	39.72777778	-85.87944444	39 43 40.000008	85 52 45.999984	240.8	stream	
IN	I11	03361650	SUGAR CREEK AT NEW PALESTINE, IN	SW	F	---	---	39.71416700	-85.88555500	39 42 51.0012	85 53 7.998	239.3	stream	
IN	I13	03361638	LEARY-WEBER DITCH AT MOHAWK, IN	SW	CDFPT	---	---	39.84250000	-85.82488889	39 50 33	85 49 29.6000004	257.9	stream	
IN	I30a	395045085510930	VADOSE ZONE ACTVZ1-1A AT MOHAWK, IN	UZ	S	0.9	---	39.84583333	-85.85250000	39 50 44.999988	85 51 9	265.8	agricultural field	
IN	I30b	395045085510931	VADOSE ZONE ACTVZ1-1B AT MOHAWK, IN	UZ	S	1.2	---	39.84583333	-85.85250000	39 50 44.999988	85 51 9	265.8	agricultural field	
IN	I30c	395045085510932	VADOSE ZONE ACTVZ1-1C AT MOHAWK, IN	UZ	S	1.5	---	39.84583333	-85.85250000	39 50 44.999988	85 51 9	265.8	agricultural field	
IN	I30d	395045085510933	VADOSE ZONE ACTVZ1-1D AT MOHAWK, IN	UZ	S	1.8	---	39.84583333	-85.85250000	39 50 44.999988	85 51 9	265.8	agricultural field	
IN	I31p	395046085510904	NAWQA WELL ACTAS1-1A AT MOHAWK, IN	GW	---	0.9	61	39.84600000	-85.85254444	39 50 45.6	85 51 9.159984	265.8	edge of field	hollow stem auger
IN	I31q	395046085510903	NAWQA WELL ACTAS1-1B AT MOHAWK, IN	GW	LT	1.6	61	39.84600000	-85.85254444	39 50 45.6	85 51 9.159984	265.8	edge of field	hollow stem auger
IN	I31r	395046085510901	NAWQA WELL ACTAS1-1C AT MOHAWK, IN	GW	LT	2.2	61	39.84600000	-85.85254444	39 50 45.6	85 51 9.159984	265.8	edge of field	hollow stem auger
IN	I31s	395046085510902	NAWQA WELL ACTAS1-1D AT MOHAWK, IN	GW	L	3.8	61	39.84600000	-85.85254444	39 50 45.6	85 51 9.159984	265.8	edge of field	hollow stem auger
IN	I32a	395151085504540	VADOSE ZONE ACTVZ1-2E AT MOHAWK, IN	UZ	Sp	0.6	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
IN	I32a	395151085504541	VADOSE ZONE ACTVZ1-2F AT MOHAWK, IN	UZ	Sp	0.6	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32a	395151085504560	VADOSE ZONE ACTVZ1-2K AT MOHAWK, IN	UZ	M	0.6	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32b	395151085504530	VADOSE ZONE ACTVZ1-2A AT MOHAWK, IN	UZ	S	0.9	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32b	395151085504550	VADOSE ZONE ACTVZ1-2G AT MOHAWK, IN	UZ	H	0.9	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32b	395151085504561	VADOSE ZONE ACTVZ1-2L AT MOHAWK, IN	UZ	M	0.9	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32c	395151085504531	VADOSE ZONE ACTVZ1-2B AT MOHAWK, IN	UZ	S	1.2	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32c	395151085504551	VADOSE ZONE ACTVZ1-2H AT MOHAWK, IN	UZ	H	1.2	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32c	395151085504562	VADOSE ZONE ACTVZ1-2M AT MOHAWK, IN	UZ	M	1.2	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
N	I32d	395151085504532	VADOSE ZONE ACTVZ1-2C AT MOHAWK, IN	UZ	S	1.5	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32d	395151085504552	VADOSE ZONE ACTVZ1-2I AT MOHAWK, IN	UZ	H	1.5	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32e	395151085504533	VADOSE ZONE ACTVZ1-2D AT MOHAWK, IN	UZ	S	1.8	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I32e	395151085504553	VADOSE ZONE ACTVZ1-2J AT MOHAWK, IN	UZ	H	1.8	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	agricultural field	
IN	I33p	395151085504504	NAWQA WELL ACTAS1-2A AT MOHAWK, IN	GW	LT	1.0	61	39.86405278	-85.84591111	39 51 50.590008	85 50 45.279996	266.7	edge of field	hollow stem auger
IN	I33q	395151085504503	NAWQA WELL ACTAS1-2B AT MOHAWK, IN	GW	LT	1.6	61	39.86405278	-85.84591111	39 51 50.590008	85 50 45.279996	266.7	edge of field	hollow stem auger
IN	I33r	395151085504502	NAWQA WELL ACTAS1-2C AT MOHAWK, IN	GW	LT	2.1	61	39.86405278	-85.84591111	39 51 50.590008	85 50 45.279996	266.7	edge of field	hollow stem auger
IN	I33s	395151085504501	NAWQA WELL ACTAS1-2D AT MOHAWK, IN	GW	LT	2.9	61	39.86405278	-85.84591111	39 51 50.590008	85 50 45.279996	266.7	edge of field	hollow stem auger
IN	I34p	395025085493501	NAWQA WELL ACTAS1-3A AT MOHAWK, IN	GW	---	5.2	61	39.84024167	-85.82614444	39 50 24.870012	85 49 34.119984	260.0	between field and	hollow stem auger
IN	I35p	395020085493001	NAWQA WELL ACTGWSW1-1 AT MOHAWK, IN	GS	---	3.1	15.2	39.83876111	-85.82500833	39 50 19.539996	85 49 30.029988	256.9	wooded riparian	hollow stem auger
IN	I36p	395021085493401	NAWQA WELL ACTGWSW1-2 AT MOHAWK, IN	GS	---	3.8	61	39.83916667	-85.82611111	39 50 21.000012	85 49 33.999996	257.0	wooded riparian	hollow stem auger
IN	I37p	395023085492601	NAWQA WELL ACTGWSW1-5 AT MOHAWK, IN	GS	---	2.2	15.2	39.83968056	-85.82474722	39 50 22.850016	85 49 29.089992	257.2	wooded riparian	auger
IN	I38p	395019085492701	NAWQA WELL ACTGWSW1-7 AT MOHAWK, IN	GS	---	2.7	25	39.83851111	-85.82411111	39 50 18.639996	85 49 26.799996	256.9	wooded riparian	driven
IN	I40	395124085510801	TILE DRAIN ACTTD1-1 AT MOHAWK, IN	TD	CTF	---	---	39.85666667	-85.85222222	39 51 24.000012	85 51 7.999992	266.7	agricultural field	
IN	I41	395120085502401	OVERLAND FLOW ACTOF1-1 AT MOHAWK, IN	OV	F	---	---	39.85555556	-85.84000000	39 51 20.000016	85 50 24	265.5	agricultural field	
IN	I47	395151085504595	RAIN SAMPLER ACTRS1-2 AT MOHAWK, IN	AT	R	---	---	39.86416667	-85.84583333	39 51 51.000012	85 50 44.999988	266.7	edge of field	
IN	I48	395045085510990	WEATHER STATION ACTWS1-1 AT MOHAWK, IN	AT	W	---	---	39.84583333	-85.85250000	39 50 44.999988	85 51 9	265.8	edge of field	
IN	I49	395151085504590	WEATHER STATION ACTWS1-2 AT MOHAWK, IN	AT	W	---	---	39.86405278	-85.84591111	39 51 50.590008	85 50 45.279996	266.7	edge of field	
IN	I51b	395023085492867	GWSW ACTTR1-5-1-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.84016944	-85.82460278	39 50 24.6099984	85 49 28.5700008	256.3	stream	
IN	I51c	395023085492868	GWSW ACTTR1-5-1-C DRIVEPOINT AT MOHAWK, IN	GS	---	0.9	0.91	39.84016944	-85.82460278	39 50 24.6099984	85 49 28.5700008	256.3	stream	
IN	I52	395023085492877	GWSW ACTSM1-5-2-A SEEPAGE METER AT MOHAWK, IN	GS	B	---	---	39.84010278	85.82473056	39 50 24.370008	85 49 29.030016	256.2	stream	
IN	I52b	395023085492870	GWSW ACTTR1-5-2-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.84016944	-85.82460278	39 50 24.6099984	85 49 28.5700008	256.2	stream	
IN	I52c	395023085492871	GWSW ACTTR1-5-2-C DRIVEPOINT AT MOHAWK, IN	GS	---	0.9	0.91	39.84016944	-85.82460278	39 50 24.6099984	85 49 28.5700008	256.2	stream	
IN	I53b	395023085492873	GWSW ACTTR1-5-3-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.84016944	-85.82460278	39 50 24.6099984	85 49 28.5700008	256.2	stream	
IN	I53c	395023085492874	GWSW ACTTR1-5-3-C DRIVEPOINT AT MOHAWK, IN	GS	---	0.9	0.91	39.84016944	-85.82460278	39 50 24.6099984	85 49 28.5700008	256.2	stream	
IN	I59p	395024085492801	NAWQA WELL ACTGWSW1-6 AT MOHAWK, IN	GS	---	2.0	25.3	39.84009444	-85.82449444	39 50 24.339984	85 49 28.179984	257.1	wooded riparian	driven
IN	I61a	395023085492857	GWSW ACTTR1-4-1-A TEMPORARY DPOINT AT MOHAWK, IN	GS	---	0.3	4.6	39.83982778	-85.82456111	39 50 23.3800008	85 49 28.4199996	256.1	stream	
IN	I61b	395023085492858	GWSW ACTTR1-4-1-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.83982778	-85.82456111	39 50 23.3800008	85 49 28.4199996	256.1	stream	
IN	I61c	395023085492859	GWSW ACTTR1-4-1-C DRIVEPOINT AT MOHAWK, IN	GS	---	1.0	0.91	39.83982778	-85.82456111	39 50 23.3800008	85 49 28.4199996	256.1	stream	
IN	I62a	395023085492860	GWSW ACTTR1-4-2-A TEMPORARY DPOINT AT MOHAWK, IN	GS	---	0.3	4.6	39.83982778	-85.82456111	39 50 23.3800008	85 49 28.4199996	256.3	stream	
IN	I62b	395023085492861	GWSW ACTTR1-4-2-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.83982778	-85.82456111	39 50 23.3800008	85 49 28.4199996	256.3	stream	
IN	I62c	395023085492862	GWSW ACTTR1-4-2-C DRIVEPOINT AT MOHAWK, IN	GS	---	1.0	0.91	39.83982778	-85.82456111	39 50 23.3800008	85 49 28.4199996	256.3	stream	
IN	I63a	395023085492863	GWSW ACTTR1-4-3-A TEMPORARY DPOINT AT MOHAWK, IN	GS	---	0.3	4.6	39.83982778	-85.82456111	39 50 23.3800008	85 49 28.4199996	256.3	stream	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
IN	I63b	395023085492864	GWSW ACTTR1-4-3-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.83982778	-85.82456111	39 50 23.3800008	85 49 28.4199996	256.3	stream	
IN	I63c	395023085492865	GWSW ACTTR1-4-3-C DRIVEPOINT AT MOHAWK, IN	GS	---	0.9	0.91	39.83982778	-85.82456111	39 50 23.3800008	85 49 28.4199996	256.3	stream	
IN	I71	395023085492878	GWSW ACTSM1-3-1-A SEEPAGE METER AT MOHAWK, IN	GS	B	---	---	39.83968333	-85.82465000	39 50 22.859988	85 49 28.74	255.9	stream	
IN	I71a	395023085492839	GWSW ACTTR1-3-1-A TEMPORARY DPOINT AT MOHAWK, IN	GS	---	0.3	4.6	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.9	stream	
IN	I71a	395023085492883	GWSW ACTTR1-3-1-A TEMP-LOGGER AT MOHAWK, IN	GS	T	0.2	---	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.9	stream	
IN	I71b	395023085492840	GWSW ACTTR1-3-1-B PIEZOM DPOINT AT MOHAWK, IN	GS	LT	0.4	15.2	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.9	stream	
IN	I71c	395023085492841	GWSW ACTTR1-3-1-C DRIVEPOINT AT MOHAWK, IN	GS	---	1.0	0.91	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.9	stream	
IN	I71c	395023085492884	GWSW ACTTR1-3-1-C TEMP-LOGGER AT MOHAWK, IN	GS	T	1.2	---	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.9	stream	
IN	I71d	395023085492842	GWSW ACTTR1-3-1-D PIEZOM DPOINT AT MOHAWK, IN	GS	LT	1.9	15.2	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.9	stream	
IN	I72b	395023085492844	GWSW ACTTR1-3-2-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I72c	395023085492845	GWSW ACTTR1-3-2-C DRIVEPOINT AT MOHAWK, IN	GS	---	0.8	0.91	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I72d	395023085492846	GWSW ACTTR1-3-2-D DRIVEPOINT AT MOHAWK, IN	GS	---	1.7	0.91	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I73	395023085492875	GWSW ACTSW1-3-3 SURFACE WATER SITE AT MOHAWK, IN	GS	LT	---	---	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I73	395023085492879	GWSW ACTSM1-3-3-A SEEPAGE METER AT MOHAWK, IN	GS	B	---	---	39.83967222	-85.82466389	39 50 22.819992	85 49 28.790004	255.8	stream	
IN	I73a	395023085492885	GWSW ACTTR1-3-3-A TEMP-LOGGER AT MOHAWK, IN	GS	T	0.1	---	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I73b	395023085492848	GWSW ACTTR1-3-3-B PIEZOM DPOINT AT MOHAWK, IN	GS	LT	0.4	15.2	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I73b	395023085492851	GWSW ACTTR1-3-3-B CONTINUOUS MONITOR AT MOHAWK, IN	GS	CDPT	0.5	---	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I73c	395023085492849	GWSW ACTTR1-3-3-C DRIVEPOINT AT MOHAWK, IN	GS	---	1.0	0.91	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I73c	395023085492886	GWSW ACTTR1-3-3-C TEMP-LOGGER AT MOHAWK, IN	GS	T	1.3	---	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I73d	395023085492850	GWSW ACTTR1-3-3-D PIEZOM DPOINT AT MOHAWK, IN	GS	LT	1.9	15.2	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I73d	395023085492852	GWSW ACTTR1-3-3-D CONTINUOUS MONITOR AT MOHAWK, IN	GS	CDPT	2.0	---	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	255.8	stream	
IN	I74a	395023085492853	GWSW ACTTR1-3-4-A PIEZOMETER AT MOHAWK, IN	GS	CT	1.7	15.2	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	257.1	stream bank	hollow stem auger
IN	I74b	395023085492854	GWSW ACTTR1-3-4-B PIEZOMETER AT MOHAWK, IN	GS	---	2.1	15.2	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	257.1	stream bank	hollow stem auger
IN	I74c	395023085492855	GWSW ACTTR1-3-4-C PIEZOMETER AT MOHAWK, IN	GS	---	2.5	15.2	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	257.1	stream bank	hollow stem auger
IN	I74c	395023085492887	GWSW ACTTR1-3-4-C TEMP-LOGGER AT MOHAWK, IN	GS	T	2.7	---	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	257.1	stream bank	
IN	I74d	395023085492856	GWSW ACTTR1-3-4-D PIEZOMETER AT MOHAWK, IN	GS	LT	3.9	15.2	39.83965278	-85.82459444	39 50 22.7500008	85 49 28.5399984	257.1	stream bank	hollow stem auger
IN	I79p	395023085492702	NAWQA WELL ACTGWSW1-4 TEMP-LOGGER AT MOHAWK, IN	GS	T	1.7	---	39.83969722	-85.82448333	39 50 22.909992	85 49 28.139988	257.2	wooded riparian	
IN	I79q	395023085492701	NAWQA WELL ACTGWSW1-4 AT MOHAWK, IN	GS	LT	2.4	15.2	39.83969722	-85.82448333	39 50 22.909992	85 49 28.139988	257.2	wooded riparian	auger
IN	I81b	395023085492831	GWSW ACTTR1-2-1-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.83945833	-85.82465278	39 50 22.0499988	85 49 28.7500008	256.0	stream	
IN	I81c	395023085492832	GWSW ACTTR1-2-1-C DRIVEPOINT AT MOHAWK, IN	GS	---	0.9	0.91	39.83945833	-85.82465278	39 50 22.0499988	85 49 28.7500008	256.0	stream	
IN	I82b	395023085492834	GWSW ACTTR1-2-2-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.4	0.91	39.83945833	-85.82465278	39 50 22.0499988	85 49 28.7500008	256.0	stream	
IN	I82c	395023085492835	GWSW ACTTR1-2-2-C DRIVEPOINT AT MOHAWK, IN	GS	---	1.0	0.91	39.83945833	-85.82465278	39 50 22.0499988	85 49 28.7500008	256.0	stream	
IN	I83	395023085492876	GWSW ACTSM1-2-3-A SEEPAGE METER AT MOHAWK, IN	GS	B	---	---	39.83946944	-85.82463333	39 50 22.089984	85 49 28.679988	256.1	stream	
IN	I83a	395023085492836	GWSW ACTTR1-2-3-A TEMPORARY DPOINT AT MOHAWK, IN	GS	---	0.3	4.6	39.83945833	-85.82465278	39 50 22.0499988	85 49 28.7500008	256.1	stream	
IN	I83b	395023085492837	GWSW ACTTR1-2-3-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.83945833	-85.82465278	39 50 22.0499988	85 49 28.7500008	256.1	stream	
IN	I83c	395023085492838	GWSW ACTTR1-2-3-C DRIVEPOINT AT MOHAWK, IN	GS	---	1.0	0.91	39.83945833	-85.82465278	39 50 22.0499988	85 49 28.7500008	256.1	stream	
IN	I91a	395023085492805	GWSW ACTTR1-1-1-A TEMP-LOGGER AT MOHAWK, IN	GS	T	0.1	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	
IN	I91b	395023085492802	GWSW ACTTR1-1-1-B PIEZOM DPOINT AT MOHAWK, IN	GS	LT	0.4	15.2	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	
IN	I91b	395023085492806	GWSW ACTTR1-1-1-B TEMP-LOGGER AT MOHAWK, IN	GS	T	0.7	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	
IN	I91c	395023085492803	GWSW ACTTR1-1-1-C DRIVEPOINT AT MOHAWK, IN	GS	---	1.0	0.91	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	
IN	I91c	395023085492807	GWSW ACTTR1-1-1-C TEMP-LOGGER AT MOHAWK, IN	GS	T	1.2	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
IN	I91d	395023085492804	GWSW ACTTR1-1-1-D PIEZOM DPOINT AT MOHAWK, IN	GS	LT	1.7	15.2	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	
IN	I91d	395023085492808	GWSW ACTTR1-1-1-D TEMP-LOGGER AT MOHAWK, IN	GS	T	1.8	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	
IN	I92	395023085492880	GWSW ACTSM1-1-2-A SEEPAGE METER AT MOHAWK, IN	GS	B	---	---	39.83932500	-85.82455833	39 50 21.57	85 49 28.409988	256.0	stream	
IN	I92b	395023085492810	GWSW ACTTR1-1-2-B DRIVEPOINT AT MOHAWK, IN	GS	---	0.5	0.91	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	
IN	I92c	395023085492811	GWSW ACTTR1-1-2-C DRIVEPOINT AT MOHAWK, IN	GS	---	1.0	0.91	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	
IN	I92d	395023085492812	GWSW ACTTR1-1-2-D DRIVEPOINT AT MOHAWK, IN	GS	---	2.0	0.91	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	256.0	stream	
IN	I93	395023085492881	GWSW ACTSM1-1-3-A SEEPAGE METER AT MOHAWK, IN	GS	B	---	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93	395023085492882	GWSW ACTSW1-1-3 SURFACE WATER SITE AT MOHAWK, IN	GS	L	---	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93a	395023085492813	GWSW ACTTR1-1-3-A TEMPORARY DPOINT AT MOHAWK, IN	GS	---	0.3	4.6	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93a	395023085492817	GWSW ACTTR1-1-3-A TEMP-LOGGER AT MOHAWK, IN	GS	T	0.0	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93b	395023085492814	GWSW ACTTR1-1-3-B PIEZOM DPOINT AT MOHAWK, IN	GS	LT	0.4	15.2	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93b	395023085492818	GWSW ACTTR1-1-3-B TEMP-LOGGER AT MOHAWK, IN	GS	T	0.1	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93c	395023085492815	GWSW ACTTR1-1-3-C DRIVEPOINT AT MOHAWK, IN	GS	---	1.0	0.91	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93c	395023085492819	GWSW ACTTR1-1-3-C TEMP-LOGGER AT MOHAWK, IN	GS	T	0.5	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93d	395023085492816	GWSW ACTTR1-1-3-D PIEZOM DPOINT AT MOHAWK, IN	GS	LT	1.3	15.2	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93d	395023085492820	GWSW ACTTR1-1-3-D TEMP-LOGGER AT MOHAWK, IN	GS	T	0.9	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I93e	395023085492821	GWSW ACTTR1-1-3-E TEMP-LOGGER AT MOHAWK, IN	GS	T	1.4	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	255.9	stream	
IN	I94a	395023085492822	GWSW ACTTR1-1-4-A PIEZOMETER AT MOHAWK, IN	GS	---	1.6	15.2	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	257.0	stream bank	hollow stem auger
IN	I94a	395023085492826	GWSW ACTTR1-1-4-A TEMP-LOGGER AT MOHAWK, IN	GS	T	1.7	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	257.0	stream bank	
IN	I94b	395023085492823	GWSW ACTTR1-1-4-B PIEZOMETER AT MOHAWK, IN	GS	---	2.4	15.2	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	257.0	stream bank	hollow stem auger
IN	I94b	395023085492827	GWSW ACTTR1-1-4-B TEMP-LOGGER AT MOHAWK, IN	GS	T	2.5	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	257.0	stream bank	
IN	I94c	395023085492824	GWSW ACTTR1-1-4-C PIEZOMETER AT MOHAWK, IN	GS	LT	3.3	15.2	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	257.0	stream bank	hollow stem auger
IN	I94c	395023085492828	GWSW ACTTR1-1-4-C TEMP-LOGGER AT MOHAWK, IN	GS	T	3.3	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	257.0	stream bank	
IN	I94d	395023085492825	GWSW ACTTR1-1-4-D PIEZOMETER AT MOHAWK, IN	GS	---	4.3	15.2	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	257.0	stream bank	hollow stem auger
IN	I94d	395023085492829	GWSW ACTTR1-1-4-D TEMP-LOGGER AT MOHAWK, IN	GS	T	4.3	---	39.83927222	-85.82456111	39 50 21.3799992	85 49 28.4199996	257.0	stream bank	
IN	I99p	395022085492802	NAWQA WELL ACTGWSW1-3 TEMP-LOGGER AT MOHAWK, IN	GS	T	1.5	---	39.83938056	-85.82440556	39 50 21.770016	85 49 27.860016	257.0	wooded riparian	
IN	I99q	395022085492801	NAWQA WELL ACTGWSW1-3 AT MOHAWK, IN	GS	LT	2.2	15.2	39.83938056	-85.82440556	39 50 21.770016	85 49 27.860016	257.0	wooded riparian	auger
MD	M13	01493500	MORGAN CREEK near Kennedyville, MD	SW	CDFPT	---	---	39.280028	76.014556	39 16 48.1	76 00 52.4	0.4	stream	
MD	M14	01493499	Morgan Creek near Worton	SW	---	---	---	39.285556	76.007778	39 17 08	76 00 28	1.5	stream	
MD	M15	0149349949	Morgan Creek Trib nr Worton	SW	---	---	---	39.283956	76.009525	39 17 02	76 00 36	2.4	riparian zone	
MD	M16	0149349980	Buckel Pond nr Kennedyville, MD	SW	L	---	---	39.280003	76.007950	39 16 49	76 00 29	10.8	pond	
MD	M20a	391701076003201	VADOSE ZONE ACTVZ1-3A nr Kennedyville, MD	UZ	S	0.6	---	39.283692	76.009022	39 17 01.28590	76 00 32.48296	8.3	agricultural field	
MD	M20b	391701076003202	VADOSE ZONE ACTVZ1-3B nr Kennedyville, MD	UZ	S	1.2	---	39.283692	76.009022	39 17 01.28590	76 00 32.48296	8.3	agricultural field	
MD	M20c	391701076003203	VADOSE ZONE ACTVZ1-3C nr Kennedyville, MD	UZ	S	4.3	---	39.283692	76.009022	39 17 01.28590	76 00 32.48296	8.3	agricultural field	
MD	M20p	391702076003301	NAWQA WELL ACTFS1-3A	GW	L	4.9	91	39.283761	76.009153	39 17 01.54139	76 00 32.94577	7.8	wooded riparian	hollow stem auger
MD	M20q	391702076003302	NAWQA WELL ACTFS1-3B	GW	---	10.1	91	39.283761	76.009153	39 17 01.54139	76 00 32.94577	7.8	wooded riparian	hollow stem auger
MD	M20r	391702076003303	NAWQA WELL ACTFS1-3C	GW	L	14.3	91	39.283761	76.009153	39 17 01.54139	76 00 32.94577	7.8	wooded riparian	hollow stem auger
MD	M21a	391700076002501	VADOSE ZONE ACTVZ1-2A nr Kennedyville, MD	UZ	S	0.6	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21a	391700076002506	VADOSE ZONE ACTVZ1-2F nr Kennedyville, MD	UZ	Sp	0.5	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21a	391700076002508	VADOSE ZONE ACTVZ1-2H NEAR KENNEDYVILLE, MD	UZ	H	0.4	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21a	391700076002512	VADOSE ZONE ACTVZ1-2L NEAR KENNEDYVILLE, MD	UZ	M	0.5	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
MD	M21b	391700076002513	VADOSE ZONE ACTVZ1-2M NEAR KENNEDYVILLE, MD	UZ	M	0.8	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21c	391700076002509	VADOSE ZONE ACTVZ1-2I NEAR KENNEDYVILLE, MD	UZ	H	1.1	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21c	391700076002514	VADOSE ZONE ACTVZ1-2N NEAR KENNEDYVILLE, MD	UZ	M	1.1	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21d	391700076002502	VADOSE ZONE ACTVZ1-2B nr Kennedyville, MD	UZ	S	1.3	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21d	391700076002507	VADOSE ZONE ACTVZ1-2G nr Kennedyville, MD	UZ	Sp	1.2	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21e	391700076002515	VADOSE ZONE ACTVZ1-2O NEAR KENNEDYVILLE, MD	UZ	M	1.4	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21f	391700076002503	VADOSE ZONE ACTVZ1-2C nr Kennedyville, MD	UZ	S	2.4	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21f	391700076002510	VADOSE ZONE ACTVZ1-2J NEAR KENNEDYVILLE, MD	UZ	H	2.3	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21g	391700076002504	VADOSE ZONE ACTVZ1-2D nr Kennedyville, MD	UZ	S	4.3	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21g	391700076002511	VADOSE ZONE ACTVZ1-2K NEAR KENNEDYVILLE, MD	UZ	H	4.1	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21h	391700076002505	VADOSE ZONE ACTVZ1-2E nr Kennedyville, MD	UZ	S	5.5	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21h	391700076002516	VADOSE ZONE ACTVZ1-2P NEAR KENNEDYVILLE, MD	UZ	H	5.5	---	39.283386	76.006689	39 17 00.19088	76 00 24.07748	12.5	agricultural field	
MD	M21p	391700076002401	NAWQA WELL ACTFS1-2A	GW	L	7.3	91	39.283422	76.006689	39 17 00.32062	76 00 24.07934	12.5	agricultural field	hollow stem auger
MD	M21q	391700076002402	NAWQA WELL ACTFS1-2B	GW	---	9.8	91	39.283422	76.006689	39 17 00.32062	76 00 24.07934	12.7	agricultural field	hollow stem auger
MD	M21r	391700076002403	NAWQA WELL ACTFS1-2C	GW	L	13.1	91	39.283422	76.006689	39 17 00.32062	76 00 24.07934	12.7	agricultural field	hollow stem auger
MD	M22a	391659076001801	VADOSE ZONE ACTVZ1-1A nr Kennedyville, MD	UZ	S	0.6	---	39.283106	76.004900	39 16 59.17607	76 00 17.63500	18.1	agricultural field	
MD	M22b	391659076001802	VADOSE ZONE ACTVZ1-1B nr Kennedyville, MD	UZ	S	1.2	---	39.283106	76.004900	39 16 59.17607	76 00 17.63500	18.1	agricultural field	
MD	M22c	391659076001803	VADOSE ZONE ACTVZ1-1C nr Kennedyville, MD	UZ	S	4.4	---	39.283106	76.004900	39 16 59.17607	76 00 17.63500	18.1	agricultural field	
MD	M22d	391659076001804	VADOSE ZONE ACTVZ1-1D nr Kennedyville, MD	UZ	S	9.1	---	39.283106	76.004900	39 16 59.17607	76 00 17.63500	18.1	agricultural field	
MD	M22p	391659076001701	NAWQA WELL ACTFS1-1A	GW	L	10.4	152	39.283178	76.004853	39 16 59.43699	76 00 17.47177	18.2	agricultural field	hollow stem auger
MD	M22q	391659076001702	NAWQA WELL ACTFS1-1B	GW	---	14.3	91	39.283178	76.004853	39 16 59.43699	76 00 17.47177	18.2	agricultural field	hollow stem auger
MD	M22r	391659076001703	NAWQA WELL ACTFS1-1C	GW	L	17.8	91	39.283178	76.004853	39 16 59.43699	76 00 17.47177	18.2	agricultural field	hollow stem auger
MD	M30p	391710075584001	NAWQA WELL ACTAS1-1A	GW	---	3.5	91	39.286208	75.977822	39 17 10.35387	75 58 40.16059	13.6	side of road	hollow stem auger
MD	M31p	391710075584002	NAWQA WELL ACTAS1-1B	GW	---	9.1	91	39.286208	75.977822	39 17 10.35387	75 58 40.16059	13.6	side of road	hollow stem auger
MD	M32p	391820075580201	KE Be 189	GW	---	16.3	76	39.305572	75.967225	39 18 20.06	75 58 02.01	11.8	side of road	unknown, existing l
MD	M33p	391717075571001	KE Be 194	GW	---	9.4	55	39.288056	75.952872	39 17 17.00	75 57 10.34	24.7	side of road	unknown, existing l
MD	M34p	391717075571002	KE Be 195	GW	---	18.3	85	39.288056	75.952872	39 17 17.00	75 57 10.34	24.7	side of road	unknown, existing l
MD	M35p	391710075584001	KE Be 207	GW	---	13.3	30.5	39.313625	75.937792	39 18 49.05	75 56 16.05	21.3	side of road	unknown, existing l
MD	M47	391659075595901	Depositional Collector at Horizon Dairy, near Kennedyville, MD	AT	R	---	---	39.283597	75.997983	39 17 00.95	75 59 52.74	18.3	adjacent to field	
MD	M48	391700076002302	WEATHER STATION ACTWS1-2 NEAR KENNEDYVILLE, MD	AT	W	---	---	39.283403	76.006736	39 17 00.25431	76 00 24.24535	12.5	agricultural field	
MD	M51a	391704076003401	GWSW SITE ACTTR1-4-1A	GS	---	0.4	18.3	39.284050	76.009283	39 17 02.58	76 00 33.42	2.7	wooded riparian	
MD	M51b	391704076003402	GWSW SITE ACTTR1-4-1B	GS	---	1.7	15.2	39.284050	76.009283	39 17 02.58	76 00 33.42	2.7	wooded riparian	
MD	M61a	391703076003701	GWSW SITE ACTTR1-3-1A	GS	---	2.8	15.2	39.284194	76.010119	39 17 03.10	76 00 36.43	3.0	wooded riparian	
MD	M62a	391703076003601	GWSW SITE ACTTR1-3-2A	GS	---	2.5	15.2	39.284114	76.009933	39 17 02.81	76 00 35.76	2.3	wooded riparian	
MD	M63a	391703076003501	GWSW SITE ACTTR1-3-3A	GS	---	2.8	15.2	39.284081	76.009839	39 17 02.69	76 00 35.42	2.4	wooded riparian	
MD	M64a	391703076003401	GWSW SITE ACTTR1-3-4A	GS	---	2.3	15.2	39.284000	76.009653	39 17 02.40	76 00 34.75	2.4	wooded riparian	
MD	M65a	391702076003401	GWSW SITE ACTTR1-3-5A	GS	L	0.4	18.3	39.283911	76.009467	39 17 02.08	76 00 34.08	2.6	wooded riparian	
MD	M65b	391702076003402	GWSW SITE ACTTR1-3-5B	GS	---	1.6	15.2	39.283911	76.009467	39 17 02.08	76 00 34.08	2.6	wooded riparian	
MD	M65c	391702076003403	GWSW SITE ACTTR1-3-5C	GS	---	2.3	15.2	39.283911	76.009467	39 17 02.08	76 00 34.08	2.5	wooded riparian	
MD	M65d	391702076003404	GWSW SITE ACTTR1-3-5D	GS	L	3.1	15.2	39.283911	76.009467	39 17 02.08	76 00 34.08	2.6	wooded riparian	
MD	M67	0149349945	Morgan Creek Trib nr Morgnec Rd nr Worton	SW	---	---	---	39.283797	76.010114	39 17 01.67	76 00 36.41	2.6	riparian zone	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
MD	M68	0149349970	Morgan Creek nr Wallis Rd nr Kennedyville	SW	---	---	---	39.281467	76.012042	39 16 53.28	76 00 43.35	0.9	stream	
MD	M69	391702076003501	Diffuse Seep near Kennedyville, MD	GW	---	---	---	39.283747	76.009686	39 17 01.49	76 00 34.87	2.5	riparian zone	
MD	M71a	391702076003901	GWSW SITE ACTTR1-2-1A	GS	---	2.6	15.2	39.283858	76.010475	39 17 01.89	76 00 37.71	2.2	wooded riparian	
MD	M72a	391702076003801	GWSW SITE ACTTR1-2-2A	GS	---	2.6	15.2	39.283806	76.010300	39 17 01.70	76 00 37.08	2.6	wooded riparian	
MD	M73a	391702076003701	GWSW SITE ACTTR1-2-3A	GS	---	2.4	15.2	39.283781	76.010208	39 17 01.61	76 00 36.75	2.5	wooded riparian	
MD	M74a	391701076003701	GWSW SITE ACTTR1-2-4A	GS	---	1.1	15.2	39.283736	76.010067	39 17 01.45	76 00 36.24	2.6	wooded riparian	
MD	M75a	391701076003601	GWSW SITE ACTTR1-2-5A	GS	---	0.4	18.3	39.283700	76.009928	39 17 01.32	76 00 35.74	2.6	wooded riparian	
MD	M75b	391701076003602	GWSW SITE ACTTR1-2-5B	GS	---	1.2	15.2	39.283700	76.009928	39 17 01.32	76 00 35.74	2.6	wooded riparian	
MD	M81a	391657076004001	GWSW SITE ACTTR1-1-1A	GS	---	2.4	15.2	39.282611	76.010886	39 16 57.40	76 00 39.19	2.1	wooded riparian	
MD	M82a	391657076003901	GWSW SITE ACTTR1-1-2A	GS	---	2.7	15.2	39.282550	76.010711	39 16 57.18	76 00 38.56	2.2	wooded riparian	
MD	M83a	391657076003801	GWSW SITE ACTTR1-1-3A	GS	---	2.5	15.2	39.282542	76.010594	39 16 57.15	76 00 38.14	2.5	wooded riparian	
MD	M84a	391657076003701	GWSW SITE ACTTR1-1-4A	GS	---	2.4	15.2	39.282461	76.010386	39 16 56.86	76 00 37.39	2.4	wooded riparian	
MD	M85a	391657076003601	GWSW SITE ACTTR1-1-5A	GS	---	0.4	18.3	39.282411	76.010153	39 16 56.68	76 00 36.55	2.4	wooded riparian	
MD	M85b	391657076003602	GWSW SITE ACTTR1-1-5B	GS	L	2.5	15.2	39.282411	76.010153	39 16 56.68	76 00 36.55	2.4	wooded riparian	
NE	N10	06800000	MAPLE CREEK NEAR NICKRSON, NE	SW	CDFPT	---	---	41.56027778	-96.54083333	41 33 37	96 32 27	369.3	stream	
NE	N13	6799750	TRIBUTARY TO SOUTH FORK DRY CREEK NR SCHUYLER, NE	SW	CDFPT	---	---	41.53941667	-97.13733333	41 32 21.9	97 08 14.4	452.3	stream	
NE	N20a	413350096324730	VADOSE ZONE ACTVZ1-4A NEAR NICKERSON, NE	UZ	S	1.5	---	41.56388889	-96.54638889	41 33 50.000004	96 32 47.000004	349.2	wooded riparian	
NE	N20b	413350096324731	VADOSE ZONE ACTVZ1-4B NEAR NICKERSON, NE	UZ	S	2.7	---	41.56388889	-96.54638889	41 33 50.000004	96 32 47.000004	349.2	wooded riparian	
NE	N20c	413350096324732	VADOSE ZONE ACTVZ1-4C NEAR NICKERSON, NE	UZ	S	4.0	---	41.56388889	-96.54638889	41 33 50.000004	96 32 47.000004	349.2	wooded riparian	
NE	N20p	413350096324701	CNBR ACT FP1-4A	GW	LT	3.7	152	41.56390	-96.54631	41 33 50.0364	96 32 46.7088	349.2	wooded riparian	hollow stem auger
NE	N20q	413350096324702	CNBR ACT FP1-4B	GW	LT	6.5	152	41.56390	-96.54629	41 33 50.04	96 32 46.6548	349.2	wooded riparian	hollow stem auger
NE	N20r	413350096324703	CNBR ACT FP1-4C	GW	LT	10.1	61	41.56390	-96.54628	41 33 50.0328	96 32 46.6152	349.2	wooded riparian	hollow stem auger
NE	N21p	413348096324801	CNBR ACT FP1-3A	GW	LT	15.5	152	41.56325	-96.54675	41 33 47.6928	96 32 48.2928	360.9	pasture	hollow stem auger
NE	N21q	413348096324802	CNBR ACT FP1-3B	GW	LT	19.4	61	41.56322	-96.54677	41 33 47.6028	96 32 48.354	361.2	pasture	hollow stem auger
NE	N21r	413348096324803	CNBR ACT FP1-3C	GW	LT	22.8	61	41.56324	-96.54676	41 33 47.6496	96 32 48.318	361.0	pasture	hollow stem auger
NE	N22a	413341096325530	VADOSE ZONE ACTVZ1-3A NEAR NICKERSON, NE	UZ	S	1.5	---	41.56138889	-96.54861111	41 33 41.000004	96 32 54.999996	366.8	edge of field	
NE	N22b	413341096325531	VADOSE ZONE ACTVZ1-3B NEAR NICKERSON, NE	UZ	S	7.0	---	41.56138889	-96.54861111	41 33 41.000004	96 32 54.999996	366.8	edge of field	
NE	N22c	413341096325532	VADOSE ZONE ACTVZ1-3C NEAR NICKERSON, NE	UZ	S	19.8	---	41.56138889	-96.54861111	41 33 41.000004	96 32 54.999996	366.8	edge of field	
NE	N22p	413341096325501	CNBR ACT FP1-2A	GW	LT	21.4	152	41.56139	-96.54853	41 33 41.0004	96 32 54.6972	366.7	edge of field	hollow stem auger
NE	N22q	413341096325502	CNBR ACT FP1-2B	GW	LT	25.9	61	41.56138	-96.54853	41 33 40.9536	96 32 54.69	366.8	edge of field	hollow stem auger
NE	N22r	413341096325503	CNBR ACT FP1-2C	GW	LT	28.8	61	41.56137	-96.54852	41 33 40.914	96 32 54.654	366.9	edge of field	hollow stem auger
NE	N23a	413334096325330	VADOSE ZONE ACTVZ1-2A NEAR NICKERSON, NE	UZ	S	1.5	---	41.55944444	-96.54805556	41 33 33.999984	96 32 53.000016	366.9	agricultural field	
NE	N23b	413334096325331	VADOSE ZONE ACTVZ1-2B NEAR NICKERSON, NE	UZ	S	7.0	---	41.55944444	-96.54805556	41 33 33.999984	96 32 53.000016	366.9	agricultural field	
NE	N23c	413334096325332	VADOSE ZONE ACTVZ1-2C NEAR NICKERSON, NE	UZ	S	19.8	---	41.55944444	-96.54805556	41 33 33.999984	96 32 53.000016	366.9	agricultural field	
NE	N23p	413334096325301	CNBR ACT FP1-1A	GW	LT	20.8	152	41.55959	-96.54809	41 33 34.5132	96 32 53.1168	366.9	agricultural field	hollow stem auger
NE	N23q	413334096325302	CNBR ACT FP1-1B	GW	LT	25.0	61	41.55960	-96.54809	41 33 34.56	96 32 53.124	366.9	agricultural field	hollow stem auger
NE	N23r	413334096325303	CNBR ACT FP1-1C	GW	LT	28.6	61	41.55962	-96.54809	41 33 34.614	96 32 53.1276	366.9	agricultural field	hollow stem auger
NE	N30a	413302097090540	VADOSE ZONE ACT PAN LYSIMETER NEAR SCHULYER, NE	UZ	Sp	1.2	---	41.55055556	-97.15138889	41 33 2.000016	97 9 5.000004	483.7	agricultural field	
NE	N30b	413302097090530	VADOSE ZONE ACTVZ1-1A NEAR SCHULYER, NE	UZ	S	1.5	---	41.55055556	-97.15138889	41 33 2.000016	97 9 5.000004	483.7	agricultural field	
NE	N30c	413302097090531	VADOSE ZONE ACTVZ1-1B NEAR SCHULYER, NE	UZ	S	2.4	---	41.55055556	-97.15138889	41 33 2.000016	97 9 5.000004	483.7	agricultural field	
NE	N30d	413302097090532	VADOSE ZONE ACTVZ1-1C NEAR SCHULYER, NE	UZ	S	4.0	---	41.55055556	-97.15138889	41 33 2.000016	97 9 5.000004	483.7	agricultural field	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
NE	N30e	413302097090533	VADOSE ZONE ACTVZ1-1D NEAR SCHULYER, NE	UZ	S	7.6	---	41.55055556	-97.15138889	41 33 2.000016	97 9 5.000004	483.7	agricultural field	
NE	N30p	413340096402701	18N 7E 6BCCC1 (DO-24)	GW	---	7.6	152	41.561083	-96.67425	41 33 39.8988	96 40 27.3	392.9	agricultural field	hollow stem auger
NE	N31p	414343096595801	20N 4E 5CCDC1 (CO-13)	GW	---	7.6	305	41.728656	-96.999683	41 43 43.1616	96 59 58.8588	444.4	agricultural field	hollow stem auger
NE	N32p	414527097094101	21N 2E 35ABAA1 (S-11)	GW	---	20.0	305	41.757581	-97.161464	41 45 27.2916	97 9 41.2704	484.9	agricultural field	hollow stem auger
NE	N34	413236097090501	18W 02E 12CCAA	GW	---	~90	~900	41.543475	-97.151525	41 32 36.51	97 9 5.49	476.1	irrigation well	mud rotary
NE	N35	413247097084801	18W 02E 12CADA	GW	---			41.546358	-97.146783	41 32 46.8888	97 8 48.4188	490.7	spring	mud rotary
NE	N47	413302097090595	RAIN SAMPLER ACTS1-1 NEAR SCHUYLER, NE	AT	RW	---	---	41.550556	-97.1513889	41 33 2	97 9 5	483.7	agricultural field	
NE	N65a	413351096324924	GWSW SITE ACTTR1-4-1A NEAR NICKERSON, NE	GS	T	0.3	---	41.564056	-96.54725	41 33 50.6016	96 32 50.1	371.0	hyporheic zone	
NE	N65b	413351096324901	GWSW SITE ACTTR1-4-1B NEAR NICKERSON, NE	GS	T	0.5	15.2	41.564056	-96.54725	41 33 50.6016	96 32 50.1	371.0	hyporheic zone	
NE	N65c	413351096324925	GWSW SITE ACTTR1-4-1C NEAR NICKERSON, NE	GS	LT	1.0	---	41.564056	-96.54725	41 33 50.6016	96 32 50.1	371.0	hyporheic zone	
NE	N65d	413351096324902	GWSW SITE ACTTR1-4-1D NEAR NICKERSON, NE	GS	LT	2.0	15.2	41.564056	-96.54725	41 33 50.6016	96 32 50.1	371.0	hyporheic zone	
NE	N64a	413351096324926	GWSW SITE ACTTR1-4-2A NEAR NICKERSON, NE	GS	---	0.3	---	41.564083	-96.547222	41 33 50.6988	96 32 49.9992	371.3	hyporheic zone	
NE	N64b	413351096324927	GWSW SITE ACTTR1-4-2B NEAR NICKERSON, NE	GS	---	0.5	---	41.564083	-96.547222	41 33 50.6988	96 32 49.9992	371.3	hyporheic zone	
NE	N64c	413351096324928	GWSW SITE ACTTR1-4-2C NEAR NICKERSON, NE	GS	---	1.0	---	41.564083	-96.547222	41 33 50.6988	96 32 49.9992	371.3	hyporheic zone	
NE	N64d	413351096324929	GWSW SITE ACTTR1-4-2D NEAR NICKERSON, NE	GS	---	1.5	---	41.564083	-96.547222	41 33 50.6988	96 32 49.9992	371.3	hyporheic zone	
NE	N63a	413351096324930	GWSW SITE ACTTR1-4-3A NEAR NICKERSON, NE	GS	T	0.3	---	41.564222	-96.547194	41 33 51.1992	96 32 49.8984	371.0	hyporheic zone	
NE	N63b	413351096324931	GWSW SITE ACTTR1-4-3B NEAR NICKERSON, NE	GS	T	0.5	---	41.564222	-96.547194	41 33 51.1992	96 32 49.8984	371.0	hyporheic zone	
NE	N63c	413351096324932	GWSW SITE ACTTR1-4-3C NEAR NICKERSON, NE	GS	LCDPT	1.0	15.2	41.564222	-96.547194	41 33 51.1992	96 32 49.8984	371.0	hyporheic zone	
NE	N63d	413351096324933	GWSW SITE ACTTR1-4-3D NEAR NICKERSON, NE	GS	LCDPT	2.0	15.2	41.564222	-96.547194	41 33 51.1992	96 32 49.8984	371.0	hyporheic zone	
NE	N62a	413351096324934	GWSW SITE ACTTR1-4-4A NEAR NICKERSON, NE	GS	---	0.3	---	41.564278	-96.547139	41 33 51.4008	96 32 49.7004	371.2	hyporheic zone	
NE	N62b	413351096324935	GWSW SITE ACTTR1-4-4B NEAR NICKERSON, NE	GS	---	0.5	---	41.564278	-96.547139	41 33 51.4008	96 32 49.7004	371.2	hyporheic zone	
NE	N62c	413351096324936	GWSW SITE ACTTR1-4-4C NEAR NICKERSON, NE	GS	---	1.0	---	41.564278	-96.547139	41 33 51.4008	96 32 49.7004	371.2	hyporheic zone	
NE	N61a	413351096324937	GWSW SITE ACTTR1-4-5A NEAR NICKERSON, NE	GS	---	0.3	---	41.564389	-96.547139	41 33 51.8004	96 32 49.7004	372.0	hyporheic zone	
NE	N61b	413351096324938	GWSW SITE ACTTR1-4-5B NEAR NICKERSON, NE	GS	---	0.5	---	41.564389	-96.547139	41 33 51.8004	96 32 49.7004	372.0	hyporheic zone	
NE	N61c	413351096324939	GWSW SITE ACTTR1-4-5C NEAR NICKERSON, NE	GS	---	1.0	---	41.564389	-96.547139	41 33 51.8004	96 32 49.7004	372.0	hyporheic zone	
NE	N61d	413351096324940	GWSW SITE ACTTR1-4-5D NEAR NICKERSON, NE	GS	---	2.0	---	41.564389	-96.547139	41 33 51.8004	96 32 49.7004	372.0	hyporheic zone	
NE	N81	413351096324903	GWSW SITE ACTTR1-2-1 STILLING NEAR NICKERSON, NE	SW	CDPT	---	15.2	41.564167	-96.549444	41 33 51.0012	96 32 57.9984	370.4	stream	
NE	N84a	413351096324905	GWSW SITE ACTTR1-2-1A NEAR NICKERSON, NE	GS	---	0.3	---	41.564167	-96.549444	41 33 51.0012	96 32 57.9984	370.4	hyporheic zone	
NE	N84b	413351096324906	GWSW SITE ACTTR1-2-1B NEAR NICKERSON, NE	GS	---	0.5	---	41.564167	-96.549444	41 33 51.0012	96 32 57.9984	370.4	hyporheic zone	
NE	N84c	413351096324907	GWSW SITE ACTTR1-2-1C NEAR NICKERSON, NE	GS	---	1.0	---	41.564167	-96.549444	41 33 51.0012	96 32 57.9984	370.4	hyporheic zone	
NE	N83a	413351096324908	GWSW SITE ACTTR1-2-2A NEAR NICKERSON, NE	GS	---	0.3	---	41.564167	-96.546611	41 33 51.0012	96 32 47.7996	370.9	hyporheic zone	
NE	N83b	413351096324909	GWSW SITE ACTTR1-2-2B NEAR NICKERSON, NE	GS	---	0.5	15.2	41.564167	-96.546611	41 33 51.0012	96 32 47.7996	370.9	hyporheic zone	
NE	N83c	413351096324910	GWSW SITE ACTTR1-2-2C NEAR NICKERSON, NE	GS	---	1.0	---	41.564167	-96.546611	41 33 51.0012	96 32 47.7996	370.9	hyporheic zone	
NE	N83d	413351096324911	GWSW SITE ACTTR1-2-2D NEAR NICKERSON, NE	GS	---	2.0	15.2	41.564167	-96.546611	41 33 51.0012	96 32 47.7996	370.9	hyporheic zone	
NE	N82a	413351096324916	GWSW SITE ACTTR1-2-4A NEAR NICKERSON, NE	GS	T	0.3	---	41.564278	-96.546528	41 33 51.4008	96 32 47.5008	371.0	hyporheic zone	
NE	N82b	413351096324917	GWSW SITE ACTTR1-2-4B NEAR NICKERSON, NE	GS	T	0.5	15.2	41.564278	-96.546528	41 33 51.4008	96 32 47.5008	371.0	hyporheic zone	
NE	N82c	413351096324918	GWSW SITE ACTTR1-2-4C NEAR NICKERSON, NE	GS	LT	1.0	---	41.564278	-96.546528	41 33 51.4008	96 32 47.5008	371.0	hyporheic zone	
NE	N82d	413351096324919	GWSW SITE ACTTR1-2-4D NEAR NICKERSON, NE	GS	LT	2.0	15.2	41.564278	-96.546528	41 33 51.4008	96 32 47.5008	371.0	hyporheic zone	
NE	N81a	413351096324920	GWSW SITE ACTTR1-2-5A NEAR NICKERSON, NE	GS	---	0.3	---	41.564333	-96.546167	41 33 51.5988	96 32 46.2012	372.0	hyporheic zone	
NE	N81b	413351096324921	GWSW SITE ACTTR1-2-5B NEAR NICKERSON, NE	GS	---	0.5	---	41.564333	-96.546167	41 33 51.5988	96 32 46.2012	372.0	hyporheic zone	
NE	N81c	413351096324922	GWSW SITE ACTTR1-2-5C NEAR NICKERSON, NE	GS	---	1.0	---	41.564333	-96.546167	41 33 51.5988	96 32 46.2012	372.0	hyporheic zone	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
NE	N81d	413351096324923	GWSW SITE ACTTR1-2-5D NEAR NICKERSON, NE	GS	---	2.0	---	41.564333	-96.546167	41 33 51.5988	96 32 46.2012	372.0	hyporheic zone	
WA	W10	12505450	GRANGER DRAIN AT GRANGER, WA	SW	CDFPT	---	---	46.34346299	-120.1869950	46 20 36.466764	120 11 13.182	219.5	stream	
WA	W13	462023120075200	DR 2 AT YAKIMA VALLEY HIGHWAY NEAR GRANGER, WA	SW	CDFPT	---	---	46.33947179	-120.1321426	46 20 22.098444	120 7 55.713324	227.0	stream	
WA	W14	462023120075240	GWSW ACTSW1-1 AT DR2 NR GRANGER, WA	OV	---	---	---	46.33947179	-120.1321426	46 20 22.098444	120 7 55.713324	228.1	stream	
WA	W15	12504508	SUNNYSIDE CANAL	SW	---	---	---	46.36596375	-120.0958803	46 21 57.4695	120 5 45.168936	259.1	canal	
WA	W20p	462027120075301	10N/21E-24G01 ACT WELL FS1-01A NR GRANGER, WA	GW	L	2.4	152	46.34086111	-120.1315000	46 20 27.099996	120 7 53.4	228.8	adjacent to field	hollow stem auger
WA	W20q	462027120075302	10N/21E-24G02 ACT WELL FS1-01B NR GRANGER, WA	GW	L	9.1	152	46.34086111	-120.1315000	46 20 27.099996	120 7 53.4	228.8	adjacent to field	hollow stem auger
WA	W21p	462033120074301	10N/21E-24A01 ACT WELL FS1-02A NR GRANGER, WA	GW	L	1.5	152	46.34252778	-120.1287500	46 20 33.100008	120 7 43.5	231.0	adjacent to field	hollow stem auger
WA	W21q	462033120074302	10N/21E-24A02 ACT WELL FS1-02B NR GRANGER, WA	GW	L	9.1	152	46.34252778	-120.1287500	46 20 33.100008	120 7 43.5	230.9	adjacent to field	hollow stem auger
WA	W21r	462033120074303	10N/21E-24A03 ACT WELL FS1-02C NR GRANGER, WA	GW	L	16.8	152	46.34252778	-120.1287222	46 20 33.100008	120 7 43.399992	230.8	adjacent to field	hollow stem auger
WA	W21s	462033120074304	10N/21E-24A04 ACT WELL FS1-02D NR GRANGER, WA	GW	L	27.1	152	46.34252778	-120.1287500	46 20 33.100008	120 7 43.5	231.0	adjacent to field	mud rotary
WA	W22a	462044120073740	VADOSE ZONE ACTVZ1-1F NR GRANGER, WA	UZ	Sp	0.6	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22a	462044120073741	VADOSE ZONE ACTVZ1-1G NR GRANGER, WA	UZ	Sp	0.6	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22a	462044120073760	VADOSE ZONE ACTVZ1-1M NR GRANGER, WA	UZ	M	0.6	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	l field	
WA	W22b	462044120073761	VADOSE ZONE ACTVZ1-1N NR GRANGER, WA	UZ	M	0.9	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22d	462044120073750	VADOSE ZONE ACTVZ1-1H NR GRANGER, WA	UZ	H	1.1	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22e	462044120073730	VADOSE ZONE ACTVZ1-1B NR GRANGER, WA	UZ	S	1.2	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22e	462044120073762	VADOSE ZONE ACTVZ1-1P NR GRANGER, WA	UZ	M	1.2	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22f	462044120073763	VADOSE ZONE ACTVZ1-1Q NR GRANGER, WA	UZ	M	1.5	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22g	462044120073751	VADOSE ZONE ACTVZ1-1J NR GRANGER, WA	UZ	H	1.7	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22h	462044120073731	VADOSE ZONE ACTVZ1-1C NR GRANGER, WA	UZ	S	1.9	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22i	462044120073752	VADOSE ZONE ACTVZ1-1K NR GRANGER, WA	UZ	H	2.6	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22j	462044120073732	VADOSE ZONE ACTVZ1-1D NR GRANGER, WA	UZ	S	2.8	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22k	462044120073753	VADOSE ZONE ACTVZ1-1L NR GRANGER, WA	UZ	H	3.5	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22l	462044120073733	VADOSE ZONE ACTVZ1-1E NR GRANGER, WA	UZ	S	3.7	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W22p	462044120073701	10N/21E-24A05 VADOSE ZONE ACTVZ1-1A NR GRANGER	GW	L	5.2	152	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	hollow stem auger
WA	W23p	462105120071301	10N/22E-18M01 ACT WELL FS1-03A NR GRANGER, WA	GW	L	3.0	152	46.35144444	-120.1202500	46 21 5.199984	120 7 12.9	238.3	field	hollow stem auger
WA	W23q	462105120071302	10N/22E-18M02 ACT WELL FS1-03B NR GRANGER, WA	GW	L	11.4	152	46.35144444	-120.1202500	46 21 5.199984	120 7 12.9	238.3	field	hollow stem auger
WA	W24p	462125120070201	10N/22E-18F01 ACT WELL FS1-04A NR GRANGER, WA	GW	L	6.1	152	46.35694444	-120.1172778	46 21 24.999984	120 7 2.200008	246.3	field	hollow stem auger
WA	W24q	462125120070202	10N/22E-18F02 ACT WELL FS1-04B NR GRANGER, WA	GW	L	12.2	305	46.35694444	-120.1172778	46 21 24.999984	120 7 2.200008	246.1	field	hollow stem auger
WA	W25p	462138120065801	10N/22E-07P01 ACT WELL FS1-05A NR GRANGER, WA	GW	L	7.9	152	46.36069444	-120.1160000	46 21 38.499984	120 6 57.6	252.0	field	hollow stem auger
WA	W25q	462138120065802	10N/22E-07P02 ACT WELL FS1-05B NR GRANGER, WA	GW	---	19.7	152	46.36069444	-120.1160000	46 21 38.499984	120 6 57.6	252.0	field	mud rotary
WA	W30p	462217120060901	10N/22E-08E01 ACT WELL AS1-01A NR GRANGER, WA	GW	L	16.8	152	46.37141667	-120.1024167	46 22 17.100012	120 6 8.700012	265.8	field	mud rotary
WA	W31p	462114120064701	10N/22E-18G01 ACT WELL AS1-02A NR GRANGER, WA	GW	---	3.0	152	46.35377778	-120.1131667	46 21 13.600008	120 6 47.400012	239.7	field	mud rotary
WA	W31q	462114120064702	10N/22E-18G02 ACT WELL AS1-02B NR GRANGER, WA	GW	---	14.2	152	46.35377778	-120.1131667	46 21 13.600008	120 6 47.400012	239.9	field	mud rotary
WA	W32p	462044120081101	10N/21E-24C01 ACT WELL AS1-03A NR GRANGER, WA	GW	L	2.4	152	46.34563889	-120.1362778	46 20 44.300004	120 8 10.600008	232.8	adjacent to field	hollow stem auger
WA	W32q	462044120081102	10N/21E-24C02 ACT WELL AS1-03B NR GRANGER, WA	GW	---	11.3	152	46.34563889	-120.1362778	46 20 44.300004	120 8 10.600008	232.7	adjacent to field	hollow stem auger
WA	W41	462033120073700	OVERLAND FLOW ACTOF1-1 NR GRANGER, WA	OV	---	---	---	46.34252778	-120.1269722	46 20 33.100008	120 7 37.099992	228.6	stream	
WA	W42	462023120075242	OVERLAND FLOW ACTOF1-3 NR GRANGER, WA	OV	---	---	---	46.33947179	-120.1321426	46 20 22.098444	120 7 55.713324	224.0	stream	
WA	W46	462125120095390	Air Samplers	AT	A	---	---	46.35705000	-120.1647778	46 21 25.38	120 9 53.2	231	wetland	
WA	W48	462125120095390	WEATHER STATION ACTWS1-1 NR GRANGER, WA	AT	W	---	---	46.35705000	-120.1647778	46 21 25.38	120 9 53.2	231	wetland	

State	Site ID for Figures[1]	USGS Site Identification Number	USGS Site Name	Compart-ment[2]	Sensors[3]	Depth BLS[4] (m)	Screen Length (cm)	Latitude DD (NAD83)	Longitude DD (NAD83)	Latitude DMS (NAD83)	Longitude DMS (NAD83)	Elevation (NAVD88) (m)	Land Cover	Well Installation Method
WA	W49	462044120073790	VADOSE ZONE ACTWS1-2 NR GRANGER, WA	AT	W	---	---	46.34550000	-120.1268333	46 20 43.8	120 7 36.599988	237.9	field	
WA	W51a	462023120075210	GWSW ACTTR1-1-1A AT DR2 NR GRANGER, WA	GS	---	0.4	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream bank	
WA	W51c	462023120075212	GWSW ACTTR1-1-1C AT DR2 NR GRANGER, WA	GS	---	1.9	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream bank	
WA	W51d	462023120075201	GWSW ACTTR1-1-1D AT DR2 NR GRANGER ,WA	GS	T	0.4	15.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream bank	
WA	W51e	462023120075202	GWSW ACTTR1-1-1E AT DR2 NR GRANGER, WA	GS	T	1.5	15.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream bank	
WA	W52a	462023120075213	GWSW ACTTR1-1-2A AT DR2 NR GRANGER, WA	GS	---	0.5	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W52b	462023120075214	GWSW ACTTR1-1-2B AT DR2 NR GRANGER, WA	GS	---	0.9	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W53	462023120075209	GWSW ACTSW1-2 AT DR2 NR GRANGER, WA	GS	LT	---	---	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W53a	462023120075216	GWSW ACTTR1-1-3A AT DR2 NR GRANGER, WA	GS	---	0.3	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W53b	462023120075217	GWSW ACTTR1-1-3B AT DR2 NR GRANGER, WA	GS	---	1.1	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W53d	462023120075203	GWSW ACTTR1-1-3D AT DR2 NR GRANGER, WA	GS	CDLPT	0.4	15.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W53e	462023120075204	GWSW ACTTR1-1-3E AT DR2 NR GRANGER, WA	GS	CDLPT	1.2	15.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W54a	462023120075219	GWSW ACTTR1-1-4A AT DR2 NR GRANGER, WA	GS	---	0.5	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W55b	462023120075223	GWSW ACTTR1-1-5B AT DR2 NR GRANGER, WA	GS	---	1.2	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream bank	
WA	W55c	462023120075224	GWSW ACTTR1-1-5C AT DR2 NR GRANGER, WA	GS	---	1.9	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream bank	
WA	W61b	462023120075226	GWSW ACTTR1-2-1B AT DR2 NR GRANGER, WA	GS	---	1.1	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream bank	
WA	W61c	462023120075227	GWSW ACTTR1-2-1C AT DR2 NR GRANGER, WA	GS	---	2.2	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream bank	
WA	W62b	462023120075229	GWSW ACTTR1-2-2B AT DR2 NR GRANGER, WA	GS	---	0.9	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W62c	462023120075230	GWSW ACTTR1-2-2C AT DR2 NR GRANGER, WA	GS	---	1.9	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W62d	462023120075205	GWSW ACTTR1-2-2D AT DR2 NR GRANGER, WA	GS	T	0.6	15.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W62e	462023120075206	GWSW ACTTR1-2-2E AT DR2 NR GRANGER, WA	GS	T	1.8	15.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W63a	462023120075231	GWSW ACTTR1-2-3A AT DR2 NR GRANGER, WA	GS	---	0.4	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W63c	462023120075233	GWSW ACTTR1-2-3C AT DR2 NR GRANGER, WA	GS	---	1.9	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W63d	462023120075207	GWSW ACTTR1-2-3D AT DR2 NR GRANGER, WA	GS	LT	0.4	15.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W63e	462023120075208	GWSW ACTTR1-2-3E AT DR2 NR GRANGER, WA	GS	LT	1.8	15.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W64a	462023120075234	GWSW ACTTR1-2-4A AT DR2 NR GRANGER, WA	GS	---	0.5	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	
WA	W64c	462023120075236	GWSW ACTTR1-2-4C AT DR2 NR GRANGER, WA	GS	---	1.9	1.2	46.33947222	-120.1321389	46 20 22.099992	120 7 55.700004	224	stream	

1: Naming Convention for Figures 1-5 There are three parts to the site naming convention: state identifier, site identifier, depth identifier (if needed). Site IDs for figures have the form "C20a" and "W12"

The state identifiers are: C – California, I – Indiana, M – Maryland, N – Nebraska, W – Washington

The site identifiers will be based on the flowing scheme:

- 10 – intermediate (NAWQA indicator) stream WQ collection site
- 11 – intermediate (NAWQA indicator) stream discharge collection site
- 12 – other indicator stream sites
- 13 – small stream gage and WQ site
- 14 to19 – any other SW sites
- 20 to 29 – wells and vadose zone sites along the flow system. The site closest to the stream will be number as 20, the next closest site will be 21, etc. The co-located vadose zone sampling sites and well nests will all have the same site identifier.
- 30 to 39 – wells and vadose zone sites that are not located in the flow system
- 40 – tile drain site
- 41 to 45 – overland flow sites
- 46 – air or rain collectors for WQ
- 47 – rain collectors for WQ
- 48 and 49 – weather stations

50 to 59 – upstream most transect at GW-SW study site (TR1) The numbering scheme will start with the installation on the left bank with 60 and work across the stream in consecutive order. The same goes for the 60, 70, 80 and 90s series of locations. The stilling well, GW seep and seepage meter locations will be assigned a number corresponding to the nearest transect.

The depth identifiers will be based on the flowing scheme:

For vadose zone and ground-water installation, letters will be used to signify the depth order.

a to g – vadose zone installation with "a" being closest to land surface

p to z – ground-water installations, with "p" being closest to land surface

If there is a sampling depth that straddles the fluctuations in the water table (sometimes in the UZ, sometimes in the VZ), it will be assigned depth "p"

For GW/SW depths, "a" will be the depth closest to the sediment water interface and then the locations below will assigned a letter in order, "b" is the second deepest location, etc.

2: Abbreviations for the Environmental Compartment AT: atmosphere, GS: ground water-surface water interaction area, GW: ground water, IR: irrigation, OV: overland flow, SW: surface water, UZ: unsaturated zone

3: Abbreviations for the sensors installed at each site

A: Air sampler for chemical analyses
B: Water flux across stream bed (seepage meter)
C: Specific conductance
D: Dissolved oxygen
F: Stream flow, discharge
H: Heat dissipation
L: Water level, continuous
M: Soil moisture
P: pH
R: Rain sampler for chemical analyses
S: Soil lysimeter - suction
Sp: Soil lysimeter - pan
T: Temperature
W: Weather parameters

4: Screen Depth

For GW and VZ sites, this depth below land surface to the top of the screen

For GW-SW sites (GS), this depth is the top of the screened depth below the sediment-water interface

Table 3 – Chemical analyses by environmental compartment and laboratory. (F: filtered water, U: unfiltered water; S: solids)

Environmental Compartment	Field Parameters[1]	Nutrients	Major Ions	Dissolved organic carbon	Pesticides and pesticide degradates	Suspended sediment	Chemicals for age dating	Isotopes of nitrogen and oxygen	Solids characterization	Mineralogy of solids
For details, see Table …	6	7	6	6	4 and 5	6			10	
Rain	U	F ,U	F, U	F	F	U				
Surface water	U	F, U	F, U	F	F	U				
Irrigation water	U	F, U	F, U	F	F	U				
Overland flow water	U	F, U	F, U	F	F	U				
Unsaturated zone water	U	F	F, U		F			U		
Unsaturated zone solids					S			S	S	S
Tile drain water	U	F	F, U		F					
Ground water	U	F	F, U	F	F		U	U		
Aquifer solids					S			S	S	S
Ground-water/ surface-water interface	U	F	F, U	F	F		U	U		
Laboratory[2]	Field	NWQL	NWQL	DOC	NWQL, OGRL	District	CFC	RSIL	UZ, PSA	MIN

1: These generally included pH, specific conductance, dissolved oxygen and temperature. Oftentimes alkalinity was also determined in the field, but sometimes samples were sent to the USGS National Water-Quality Laboratory (http://nwql.usgs.gov).

2: Field: measurements preformed by field personnel; NWQL: USGS National Water-Quality Laboratory; OGRL: Kansas Organic Geochemistry Research Laboratory (http://ks.water.usgs.gov/Kansas/researchlab.html); DOC: Dissolved Organic Carbon Laboratory (http://water.usgs.gov/nrp/proj.bib/aiken.html); CFC: Reston Chlorofluorocarbon Laboratory (http://water.usgs.gov/lab); RSIL: Reston Stable Isotope Laboratory (http://www.isotopes.usgs.gov); UZ Unsaturated Zone Laboratory (http://water.usgs.gov/nrp/proj.bib/weeks.html); PSA: Particle Size Analysis Laboratory (http://wwwrcamnl.wr.usgs.gov/uzf/); MIN: Mineralogy Laboratory (http://water.usgs.gov/nrp/proj.bib/jones.html); District: USGS District Sediment Laboratories (http://water.usgs.gov/osw/techniques/sedimentlabs.html)

Table 4 – Pesticides that were targeted in this study.

Analyte	Chemical Registry Number	PCODE (water)	PCODE (solids)	Analytical Schedule[1]	Method Reporting Limit (μg/L)[2]	Number of Field Blanks[3]	Percent of Blanks < MRL[3]	Number of Field Duplicates[3]	Average Standard Deviation of Field Duplicates (μg/L)[3]
Amide Herbicides									
Acetochlor	34256-82-1	49260	63257	G, L	0.006	66	95	51	3.1(5.4)
Alachlor	15972-60-8	46342	63258	G, L	0.005	66	98	50	0.9(2.6)
Dimethenamid	87674-68-8	61588	---	L	0.02	49	100	47	3.5(22.7)
Flufenacet	142459-58-3	62481	---	L	0.02	48	100	46	0(0)
Metolachlor	51218-45-2	39415	63332	G, L	0.013	66	98	51	8.2(23.5)
Pronamide	23950-58-5	82676	63369	G	0.004	66	98	49	0(0)
Propachlor	1918-16-7	04024	---	L	0.025	5	100	6	0(0)
Organophosphate Insecticides									
Azinphos-methyl	86-50-0	82686	63263	G	0.05	66	98	49	1.2(4.1)
Chlorpyrifos	2921-88-2	38933	63273	G	0.005	66	97	51	2.9(7.2)
Diazinon	333-41-5	39572	63284	G	0.005	66	100	51	0.7(2.7)
Dichlorvos	62-73-7	38775	63286	G	0.0118	63	100	47	0(0)
Dicrotophos	141-66-2	38454	63288	G	0.0843	62	100	43	0(0)
Dimethoate	60-51-5	82662	63291	G	0.0061	63	98	46	0(0)
Ethion	563-12-2	82346	63302	G	0.004	63	95	47	0(0)
Fenamiphos	22224-92-6	61591	63305	G	0.029	63	100	47	0(0)
Fonofos	944-22-9	04095	63319	G	0.003	66	100	51	0(0)
Isofenphos	25311-71-1	61594	63323	G	0.0034	63	98	47	0(0)
Malathion	121-75-5	39532	63327	G	0.027	66	100	51	0(0)
Methidathion	950-37-8	61598	63329	G	0.0058	63	98	47	0.1(0.7)
Methyl parathion	298-00-0	82667	63351	G	0.015	66	100	51	0(0)
Phorate	298-02-2	82664	63354	G	0.011	66	100	51	0(0)
Phosmet	732-11-6	61601	63356	G	0.0079	56	100	43	0(0)
Terbufos	13071-79-9	82675	63380	G	0.017	66	100	51	0(0)
Triazine Herbicides									
Atrazine	1912-24-9	39632	63262	G	0.007	66	97	49	8.1(19.5)
Metribuzin	21087-64-9	82630	63333	G	0.006	65	98	51	0.3(1.3)
Prometon	1610-18-0	04037	63359	G	0.005	56	98	38	1.1(2.3)
Prometryn	7287-19-6	04036	63360	G	0.0054	63	98	47	0(0)
Simazine	122-34-9	04035	63370	G	0.005	66	97	51	5(10.4)
Terbuthylazine	5915-41-3	04022	63384	G	0.0102	62	100	44	0.3(1.7)
Miscellaneous Pesticides (use)									
Benfluralin (herbicide)	1861-40-1	82673	63265	G	0.01	66	98	51	0(0)
Carbaryl (insecticide)	63-25-2	82680	63269	G	0.041	66	100	50	0.6(2.1)
Cyfluthrin (insecticide)	68359-37-5	61585	63279	G	0.008	57	100	44	0(0)
Cypermethrin (insecticide)	52315-07-8	61586	63281	G	0.0086	63	100	47	0(0)
Dacthal (herbicide)	1861-32-1	82682	63282	G	0.003	66	94	51	3.9(14.9)
Fipronil (insecticide)	120068-37-3	62166	63313	G	0.016	66	98	51	0.1(0.5)
Gylphosate (herbicide)	1071-83-6	39941	---	LG	---	----		---	---
Iprodione (fungicide)	36734-19-7	61593	63322	G	1.4223	63	100	47	0.4(1.5)
Metalaxyl (fungicide)	57837-19-1	61596	63328	G	0.0051	58	100	46	0(0)
Myclobutanil (fungicide)	88671-89-0	61599	63335	G	0.008	63	98	47	1.0(3.4)
Pendimethalin (herbicide)	40487-42-1	82683	63353	G	0.022	66	98	51	0.2(1.1)
Permethrin, cis (insecticide)	54774-45-7	82687	63365	G	0.006	66	100	51	1.6(8.4)
Tebuthiuron (herbicide)	34014-18-1	82670	63376	G	0.016	66	98	50	0(0)
Trifluralin (herbicide)	1582-09-8	82661	63390	G	0.009	66	98	51	4.4(17.9)

1: The target pesticides were analyzed in two different methods. Those compounds marked "G" were analyzed by gas chromatography/mass spectrometry (Zaugg et al. 1995; Lindley et al. 1996; Sandstrom et al. 2001; Madsen et al. 2002). Those compounds marked "L" were analyzed by high-performance liquid chromatography/mass spectrometry (Lee and Strahan, 2003). A few compounds were in both analytical methods. In these case, the results from the gas chromatographic method were the values that were used in the data interpretation. Those compounds marked "LG" were analyzed by a high-performance liquid chromatography/mass spectrometry specifically for glyphosate and it transformation product (Lee et al. 2002).
2: Method Reporting Limit (MRL) is the most commonly reported limit in the water year 2004 data set. The U.S. Geological Survey defines a laboratory reporting limit as approximately twice the long-term method detection limit (Foreman et al. 1999).
3: Data is only for water samples from water year 2004.

Table 5 – Pesticide transformation products that were targeted in this study.

Analyte	Chemical Registry Number	PCODE (water)	PCOD (solids	Parent Compound	Analytical Schedule[1]	Method Reporting Limit (µg/L)[2]	Number of Field Blanks[3]	Percent of Blanks < MRL[3]	Number of Field Duplicates[3]	Average Standard Deviation of Field Duplicates (µg/L)[3]
Amide Herbicides										
Acetochlor ESA	---	61029	---	Acetochlor	L	0.02	48	98	46	4.2(9.9)
Acetochlor OXA	---	61030	---	Acetochlor	L	0.02	48	98	46	4.8(15.4)
Acetochlor SAA	---	62847	---	Acetochlor	L	0.02	48	100	44	8.3(30.9)
Acetochlor ESA - secondary amide	---	62850	---	Acetochlor	L	0.02	48	100	43	4.7(13.3)
Alachlor ESA	---	50009	---	Alachlor	L	0.02	48	100	46	9.4(23.4)
Alachlor ESA - secondary amide	---	62849	---	Alachlor	L	0.02	48	100	46	0(0)
Alachlor OXA	---	61031	---	Alachlor	L	0.02	48	100	46	2.5(9.1)
Alachlor SAA	140939-16-8	62848	---	Alachlor	L	0.02	48	100	46	1.6(9.8)
2-Chloro-2,6-diethylacetanilide	6967-29-9	61618	63246	Alachlor	G	0.005	63	97	47	0(0)
2,6-Diethylaniline	579-66-8	82660	63243	Alachlor	G	0.006	66	100	51	0(0)
Dimethenamid ESA	---	61951	---	Dimethenamid	L	0.02	48	100	46	0.3(2.0)
Dimethenamid OXA	---	62482	---	Dimethenamid	L	0.02	48	100	46	0(0)
Flufenacet ESA	---	61952	---	Flufenacet	L	0.02	48	100	46	0(0)
Flufenacet OXA	---	62483	---	Flufenacet	L	0.02	48	100	46	0(0)
Metolachlor ESA	---	61043	---	Metolachlor	L	0.02	48	100	46	9.1(17.6)
Metolachlor OXA	---	61044	---	Metolachlor	L	0.02	48	100	46	4.0(10.1)
2-[(2-Ethyl-6-methylphenyl) amino]-1-propanol	61520-53-4	61615	63244	Metolachlor	G	0.1256	20	100	2	0(0)
2-Ethyl-6-methylaniline	24549-06-2	61620	63247	Metolachlor	G	0.0045	63	98	47	0.3(1.7)
Propachlor ESA	---	62766	---	Propachlor	L	0.05	48	100	46	0(0)
Propachlor OXA	---	62767	---	Propachlor	L	0.02	48	100	46	0(0)
Organophosphate Insecticides										
Azinphos-methyl-oxon	961-22-8	61635	63264	Azinphos-methyl	G	0.07	62	100	41	0(0)
Chlorpyrifos, oxygen analog	5598-15-2	61636	63274	Chlorpyrifos	G	0.0562	63	100	47	0(0)
Diazoxon	962-58-3	61638	63285	Diazinon	G	0.01	63	98	47	1.0(6.1)
Ethion monoxon	17356-42-2	61644	63303	Ethion	G	0.0336	63	100	47	0(0)
Fenamiphos sulfone	31972-44-8	61645	63306	Fenamiphos	G	0.007	40	98	26	0(0)
Fenamiphos sulfoxide	31972-43-7	61646	63307	Fenamiphos	G	0.031	59	100	37	0(0)
Total Fenamiphos	---	---	63308	Fenamiphos	G	.			---	---
Fonofos, oxygen analog	944-21-8	61649	63320	Fonofos	G	0.0021	59	98	44	0(0)
Malaoxon	1634-78-2	61652	63326	Malathion	G	0.008	42	98	28	0(0)
Methyl paraoxon	950-35-6	61664	63349	Methyl parathion	G	0.0299	62	100	46	0(0)
Phorate oxon	2600-69-3	61666	63355	Phorate	G	0.0973	63	100	47	0(0)
Phosmet oxon	3735-33-9	61668	63357	Phorate	G	0.0553	41	100	36	3.7(22.1)
Terbufos sulfone, oxygen analogue	56070-15-6	61674	63383	Terbufos	G	0.0676	63	100	47	0(0)
Triazine Herbicides										
CIAT (Deethylatrazine)	6190-65-4	04040	63283	Atrazine	G	0.006	66	97	51	9.2(14.4)
Miscellaneous Pesticides (use)										
1-Naphthol	90-15-3	49295	63240	Carbaryl	G	0.0882	62	100	44	0(0)
3,4-Dichloroaniline	95-76-1	61625	63248	Linuron	G	0.0045	63	98	47	1.3(4.7)
4-Chloro-2-methylphenol	1570-64-5	61633	63255	MCPA/MCPB	G	0.0056	62	100	44	0.8(4.9)
AMPA	1066-51-9	50464	---	Glyhosate	LG	---			---	---
Desulfinylfipronil	---	62170	63316	Fipronil	G	0.012	66	98	51	0(0)
Desulfinylfipronil amide	---	62169	63317	Fipronil	G	0.029	66	100	51	0(0)
Fipronil sulfide	120067-83-6	62167	63314	Fipronil	G	0.013	66	97	51	0.1(0.5)
Fipronil sulfone	120068-36-2	62168	63315	Fipronil	G	0.024	66	100	51	0.1(0.4)

1: The target pesticides were analyzed in three different methods. Those compounds marked "G" were analyzed by gas chromatography/mass spectrometry (Zaugg et al. 1995; Lindley et al. 1996; Sandstrom et al., 2001; Madsen et al. 2002)). Those compounds marked "L" were analyzed by high-performance liquid chromatography/ mass spectrometry (Lee and Strahan, 2003). Those compounds marked "LG" were analyzed by a high-performance liquid chromatography/mass spectrometry specifically for glyphosate and it transformation product (Lee et al. 2002).

2: Method Reporting Limit (MRL) is the most commonly reported limit in the water year 2004 data set. The U.S. Geological Survey defines a laboratory reporting limit as approximately twice the long-term method detection limit (Foreman et al. 1999).

3: Data is only for water samples from water year 2004.

Table 6 – Inorganic, natural organic, and physical parameters that are targeted in this study[1].

Analyte	Chemical Registry Number	Matrix	PCODE (water)	Environmental Compartment[2]	Method Reporting Limit (MRL) (mg/L)[3]	Number of Field Blanks[4]	Percent of Blanks < MRL[4]	Number of Field Duplicates[4]	Ave (SD) of Field Duplicates (mg/L)[4]
Inorganic Parameters									
Alkalinity, field	---	water, filtered	00418	ALL	---	0	---	5	2.6(3.4)
Alkalinity, laboratory	---	water, filtered	29801	ALL		0	---	19	2.3(5.2)
Bromide	24959-67-9	water, filtered	71870	GW, UZ	0.016	25	0	37	22.4(39.2)
Calcium	7440-70-2	water, filtered	00915	ALL	0.01	43	86	57	7.2(28.9)
Chloride	16887-00-6	water, filtered	00940	ALL	0.2	46	2.2	63	10.3(39.4)
Dissolved oxygen, field	---	water, whole	00300	ALL	---			13	0.4(0.6)
Fluoride	16984-48-8	water, filtered	00950	ALL	0.17	43	2.3	57	4.0(8.4)
Iron	7439-89-6	water, filtered	01046	ALL	6.4	43	4.7	57	14.6(20.2)
Magnesium	7439-95-4	water, filtered	00925	ALL	0.008	43	18.6	57	7.8(31.1)
Manganese	7439-96-5	water, filtered	01056	ALL	0.8	43	16.3	57	17.5(30.9)
pH, field	---	water, whole	00400	ALL	---	0	---	12	1.0(1.7)
pH, laboratory	---	water, unfiltered	00403	ALL	---	0	---	54	1.3(1.5)
Potassium	7440-09-7	water, filtered	00935	ALL	0.16	43	2.3	57	7.5(26.2)
Residue on evaporation, 180°C	---	water, filtered	70300	ALL	10	41	4.9	54	7.4(25.6)
Silica	7631-86-9	water, filtered	00955	ALL	0.04	43	53.5	57	6.3(27.8)
Sodium	7440-23-5	water, filtered	00930	ALL	0.1	35	20	56	3.7(10.7)
Specific conductance, field	---	water, whole	00095	ALL	---	0	---	18	5.5(19.9)
Specific conductance, laboratory	---	water, unfiltered	90095	ALL	2.6	44	61.4	57	5.3(25.6)
Sulfate	14808-79-8	water, filtered	00945	ALL	0.18	46	4.3	63	10.2(37.8)
Organic Parameters									
Dissolved organic carbon	---	water, filtered	00681	ALL	0.33	56	58.9	---	---
Specific UV absorbance (SUVA)	---	water, filtered	63162	ALL	---	49	--	56	13.5(15.4)
Total inorganic carbon	---	filter	00608	SW	0.12	25	0	25	12.3(34.3)
Total carbon	---	filter	00694	SW	0.12	25	16	25	16.0(13.6
Total organic carbon	---	filter	00689	SW	0.12	25	16	25	17.0(14.8)
Total particulate nitrogen	17778-88-0	filter	49570	SW	0.022	25	12	25	18.6(20.5)
Physical Parameters									
Suspended sediment	---	water, unfiltered	80154	SW,T,O	--	0	--	12	7.6(7.9)
Temperature, field	---	water, whole	00010	ALL	--	0	--	13	0(0)

1: These water samples were analyzed by the methods described in Fishman (1993), Fishman and Friedman (1989), and the American Public Health Association (1998).
2: Samples obtained from SW: surface water, T: tile drains, O: overland flow, GW: ground water and at the GW-SW interface. UZ unsaturated zone.
3: Method Reporting Limit (MRL) is the most commonly reported limit in the water year 2004 data set. The U.S. Geological Survey defines a laboratory reporting limit as approximately twice the long-term method detection limit (Foreman et al. 1999).
4: Data is only for water samples from water year 2004.

Table 7 – Nutrients that are targeted in the this study.

Analyte	Chemical Registry Number	Matrix	PCODE (water)	Environmental Compartment[2]	Method Reporting Limit (MRL) (mg/L)[3]	Number of Field Blanks[4]	Percent of Blanks < MRL[4]	Number of Field Duplicates[4]	Ave (SD) of Field Duplicates (mg/L)[4]
Nitrogen, ammonia	7664-4-7	water, filtered	00608	ALL	0.04	65	0	73	8.3(19.6)
Nitrogen, nitrite	14797-65-0	water, filtered	00613	ALL	0.008	65	4.6	72	10.4(25.9)
Nitrogen, nitrite + nitrate	---	water, filtered	00631	ALL	0.06	66	3.0	74	9.6(33.8)
Phosphorus, phosphate, ortho	14265-44-2	water, filtered	00671	ALL	0.006	62	8.1	71	10.7(29.4)
Phosphorus	7723-14-0	water, whole	00665	SW	0.004	35	11.4	31	18.5(46.9)
Nitrogen, ammonia + org N	17778-88-0	water, whole	00625	SW	0.03	33	24.2	0	0(0)
Nitrogen, ammonia + org N	---	water, filtered	00623	GW,UZ	0.03	23	13	1	-- (--)

1: SW includes water samples obtained from surface water, rain, tile drains and overland flow. GW included water samples obtained from ground water and at the GW-SW interface. UZ are samples from the unsaturated zone.
2: Method Reporting Limit (MRL) is the most commonly reported limit in the water year 2004 data set. The U.S. Geological Survey defines a laboratory reporting limit (LRL) as approximately twice the long-term method detection limit (Foreman et al. 1999).
3: Data is only for water samples from water year 2004.

Table 8 – Measured and calculated weather parameters.

Parameter Name	Units	PCODE
Measured Parameters		
Air temperature[1]	degrees Celsius	00020
Net radiation (net solar + net long wave radiation)[5]	Watts per square meter	72124
Precipitation[4]	millimeters per hour	72131
Relative humidity[1]	percent	00052
Solar radiation[3]	Watts per square meter	62608
Standard deviation of wind direction[2]	degrees (direction)	72126
Wind direction[2]	degrees clockwise from true north	00036
Wind speed[2]	meters per second	62625
Calculated Parameters		
Atmospheric saturated water vapor pressure	kilopascals	72127
Atmospheric water vapor pressure	kilopascals	72125
Potential evapotranspiration, Penman method	millimeters per hour	72130
Potential evapotranspiration, Priestley-Taylor method	millimeters per hour	72129
Potential latent heat flux, Penman method	Watts per square meter	72128

1: Vaisala HMP45C
2: RM Young Wind Sentry Wind Set 03001
3: Li-Cor18 Silicon Pyranometer w/ fixed multiplier Li200x
4: Texas Electronics 8" Tipping Bucket Rain Gage TE525WS
5: REBS Net Radiometer Q7-1

Table 9 – Information on the streams and their watersheds.

Study Area	Stream Name	USGS Site ID	Area (km^2)	Beginning of Discharge Record
Large streams				
CA	San Joaquin River (Vernalis, CA)	11303500	35,060	1923
IN	White River (Petersburg, IN)	03374000	29,280	1928
MD	----	----	----	----
NE	Elkhorn River (Waterloo, NE)	06800500	17,870	1928
WA	Yakima River (Kiona, WA)	12510500	14,540	1905
Intermediate streams				
CA	Merced River (Stevinson, CA)	11272500	3297.1	1940
IN	Sugar Creek (New Palestine, IN)	03361650	243.2	1967
MD	----	----	----	----
NE	Maple Creek (Fremont, NE)	06800000	953.1	1951
WA	Granger Drain (Granger, WA)	12505450	160.6	1991
Small streams				
CA	Mustang Creek	373112120382901	54.4	November 2003
IN	Lery-Weber Ditch	03361638	7.2	July 2002
MD	Morgan Creek	01493500	31	1951
NE	Unnamed Tributary	06799750	1.5	June 2003
WA	DR2 Drain	462023120075200	5.5	March 2003

Table 10 – Physical and chemical parameters of solids that were targeted in the ACT study.

Analyte	Chemical Registry Number	PCODE	Units
Solids diameter, < 0.0005 mm	---	62923	percent
Solids diameter, < 0.001 mm	---	62924	percent
Solids diameter, < 0.002 mm	---	62925	percent
Solids diameter, < 0.004 mm	---	62926	percent
Solids diameter, < 0.008 mm	---	62927	percent
Solids diameter, < 0.016 mm	---	62928	percent
Solids diameter, < 0.031 mm	---	62929	percent
Solids diameter, < 0.05 mm	---	62930	percent
Solids diameter, < 0.0625 mm	---	62931	percent
Solids diameter, < 0.1 mm	---	62932	percent
Solids diameter, < 0.125 mm	---	62933	percent
Solids diameter, < 0.25 mm	---	62934	percent
Solids diameter, < 0.5 mm	---	62935	percent
Solids diameter, < 1 mm	---	62936	percent
Solids diameter, < 2 mm	---	62937	percent
Solids diameter, < 4 mm	---	62938	percent
Solids diameter, < 8 mm	---	62939	percent
Solids diameter, < 16 mm	---	62940	percent
Solids diameter, < 32 mm	---	62941	percent
Solids diameter, < 64 mm	---	62942	percent
Solids diameter, < 128 mm	---	62943	percent
Moisture content, solids, Gravimetric	---	62948	grams of water per cubic centimeter
Moisture content, solids, Volumetric	---	62949	percent
Organic matter (loss on ignition)	---	63740	percent
Organic carbon	---	49271	grams per kilogram, dry weight
Chloride, solids	16887-00-6	62951	micrograms per gram, dry weight
Sulfate, solids	14808-79-8	62952	micrograms per gram, dry weight
Nitrate, solids	14797-55-8	62953	micrograms per gram, dry weight
Nitrite, solids	14797-65-0	62954	micrograms per gram, dry weight
Bulk density	---	62947	grams per cubic centimeter

Table 11 – Subsamples were obtained from the water collected from unsaturated zone lysimeters in the order listed.

Priority	Analyte	Minimum Analyte Volume (mL)	Cumulative Volume (mL)	Bottle Type
1	pH and specific conductance	0	0	Sample container
2	Bromide	5	5	glass vial
3	Nutrients	25	30	125 mL dark plastic bottle
4	Pesticide by immunoassay[1]	5	35	glass vial
5	Pesticides[2]	50	80	1-L amber glass bottle
6	Pesticides[3]	10	90	125 mL amber glass vial
7	Major ions[4]	20, 30	140	125 mL clear plastic bottles
8	Alkalinity	25 (50)	165 (190)	125 mL clear plastic bottle
9	Dissolved organic carbon	20	185 (210)	40 mL amber glass vial
10	Stable H and O isotopes	10	195 (235)	glass vial with Polyseal cap

1. Depending on which pesticides were applied at that site, the choice of the immunoassay varied.
2. If a sample was sent to the laboratory for gas-chromatography analysis (Table 4), then the immunoassay sample was not collected, thus freeing up 5 mL of water.
3. This is for a sample was sent to the laboratory for liquid-chromatography analysis (Table 4).
4. Residue on evaporation was not an analyte (Table 6).

Table 12 – Chemical species to calculate the age date of the water, dissolved gases and nitrogen and oxygen isotopes.

Analyte	Chemical Registry Number	Matrix	PCODE	Laboratory[1]
Age Dating Parameters				
CFC-11 (Trichlorofluoromethane)	75-69-4	water, unfiltered	50281	CFC
CFC-12 (Dichlorodifluoromethane)	75-71-8	water, unfiltered	50282	CFC
CFC-113 (1,1,1-trichloro-2,2,2-trifluoroethane)	76-13-1	water, unfiltered	50283	CFC
SF_6 (Sulfur hexafluoride)	2551-62-4	water, unfiltered	63149	CFC
Tritium (in water)	---	water, unfiltered	07018	NWQL
Dissolved Gases				
Carbon dioxide (CO_2)	124-38-9	water, whole	85544	RSIL
Nitrogen (N_2)	7727-37-9	water, whole	00597	RSIL
Argon (Ar)	7440-37-1	water, whole	82043	RSIL
Oxygen (O_2)	7782-44-7	water, whole	62971	RSIL
Isotopes of nitrogen and oxygen				
N-15/N-14 in nitrate	---	water, filtered	82690	RSIL
O-18/O-16 in nitrate	---	water, filtered	63041	RSIL
N-15/N-14 in ammonium	---	water, filtered	82691	RSIL

1: CFC: Reston Chlorofluorocarbon Laboratory; RSIL: Reston Stable Isotope Laboratory; NWQL: USGS National Water-Quality Laboratory

Table 13 – Sources of the model input data. (C = calibrated to minimize initial perturbance or match observations, D = derived from other model output; E= estimated values, L = literature values, S = site specific data measured by this study)

Model Element	SWAT[1]	WEBMOD[2]	LEACHM[3]	RZWQM[4]	MODFLOW[5]
Site Characteristics					
Land-surface slope	S	S	E	E	
Land-surface aspect	S	S		E	
Site elevation	S	S		S	S
Site latitude	S	S		S	
Soil Properties					
Particle size	S		S	SL	
Bulk density	S		L, C	S, L, C	
Organic matter	S		S	S	
Soil moisture	C				SW
Soil tension					
Pedotransfer function			C	C	R
Saturated hydraulic conductivity	L	L	C	C	C
Initial tension				E	
Initial temperature				E	
Macropore geometry				C	
Soil-crust hydraulic conductivity				L	
Effective Porosity	L	L	C		
Weather Properties					
Precipitation	S, L	S, L	D		
Solar radiation	D	D		S	
Wind run				S	
Relative humidity				S	
Temperature	S, L	S, L	S, L	S, L	
Potential Evapotranspiration			D		C
Snowpack properties		C			
Snowpack			D		
Recharge					D
Agricultural Practices					
Planting	S	S	S	L	S
Tillage	S	S	S	L	S
Irrigation	S	S	S	L	S
Harvest	S	S	S	L	S
Nutrients					
Initial concentration	RSW				
Nutrient type	RSW				
Nutrient application rate / method	RSW				
Microbiology				C	
Pesticides					
Initial concentration			C	C	
Molecular weight				L	
Water solubility			L	L	
Henry's Law constant			L	L	
Vapor pressure			L	L	
Application rate			S	S	
Compartment specific half-lives			C	L	

1. SWAT: Soil-Water Assessment Tool
2. WEBMOD: Water, Energy, and Biogeochemical MODel
3. LEACHM: Leaching Estimation and Chemistry Model
4. RZWQM: Root Zone Water Quality Model
5. MODFLOW: MODular finite-difference ground-water FLOW model

Table 14 – Physical/chemical properties of the selected pesticides. Values in bold font are calculated based on chemical structure. Numbers in brackets refer to the data source. The number of significant figures presented vary based on source of the value. "---" means not applicable.

Compound	Molecular Weight (Daltons)	Water Solubility (mg/L)	Sub-cooled Water Solubility (moles/m^3)	Melting Point (^{0}K)	Vapor Pressure (mm Hg)	Sub-cooled Vapor Pressure (mm)	Henry's Law Constant (Pa m^3/mol)	pK$_a$ (---)	K$_{oc}$ (mL/g OC)	log K$_{ow}$ (---)	Soil Half-life at 25 C (days)	Foliar Half-life (days)
Acetochlor	269.8 [1]	223 [1]	8.27x10^{-01} [7]	liquid [1]	3.4x10^{-08}	6.04x10^{-04} [7]	7.31x10^{-04} [13]	--- [3]	315 [16]	3.03 [20]	16 [10]	
Acetochlor ESA	315.4 [2]	263,000 [4]			4.77x10^{-04} [6]				41 [16]	-1.34 [21]		
Acetochlor SAA	341.5 [2]	91,000 [4]			9.06x10^{-08} [6]				106 [17]	-0.84 [21]		
Alachlor	269.8 [3]	240 [3]	1.2x10^{+00} [7]	313.7 [3]	1.40x10^{-05} [3]	2.68x10^{-03} [7]	2.10x10^{-03} [13]	--- [3]	170 [3]	2.80 [3]	15 [3]	3 [15]
Alachlor ESA	315.4 [2]											
Alachlor OXA	265.3 [2]											
Atrazine	215.7 [3]	33 [3]	4.95x10^{+00} [7]	449.2 [3]	2.89x10^{-07} [3]	1.25x10^{-03} [7]	2.52x10^{-04} [13]	1.68 [3]	100 [3]	2.40 [3]	60 [3]	5 [15]
Atrazine, Deethyl	187.6 [2]	2700 [5]			8.9x10^{-05} [12]		1.92x10^{-05} [14]		110 [18]		241 [22]	
Atrazine, Deisopropyl	173.6 [2]	980 [5]			3.1x10^{-04} [12]		1.73x10^{-04} [14]		130 [18]		48 [23]	
Atrazine, Hydroxy	197.2 [2]	16 [5]			1.1x10^{-05} [12]		4.12x10^{-04} [14]		493 [18]		121 [24]	
Azinphos-methyl	317.3 [3]	29 [3]	2.80x10^{-01} [7]	346.7 [3]	2.00x10^{-07} [3]	8.17x10^{-05} [7]	2.92x10^{-04} [13]	--- [3]	1,000 [3]	2.70 [3]	10 [3]	2 [15]
Benfluralin	335.3 [3]	0.1 [3]	7.64x10^{-04} [7]	338.9 [3]	6.60x10^{-05} [3]	2.25x10^{-02} [7]	2.95x10^{+01} [13]	--- [3]	9,000 [3]	2.02 [3]	40 [3]	
Carbaryl	301.2 [3]	120 [3]	5.90x10^{+00} [7]	415.2 [3]	1.20x10^{-06} [3]	2.37x10^{-03} [7]	4.02x10^{-04} [13]	--- [3]	300 [3]	2.30 [3]	10 [3]	7 [15]
Chlorpyrifos	350.6 [3]	0.4 [3]	1.67x10^{-03} [7]	314.7 [3]	1.70x10^{-05} [3]	3.32x10^{-03} [7]	1.99x10^{+00} [13]	--- [3]	6,070 [3]	5.00 [3]	30 [3]	3.3 [15]
Cyfluthrin	434.3 [3]	0.002 [3]	1.05x10^{-05} [7]	334 [9]	1.60x10^{-08} [3]	4.88x10^{-06} [7]	4.63x10^{-01} [13]	--- [3]	100,000 [3]		30 [3]	5 [15]
Cypermethrin	416.3 [3]	0.004 [3]	3.46x10^{-05} [7]	353.7 [3]	1.40x10^{-09} [3]	6.71x10^{-07} [7]	1.94x10^{-02} [13]	--- [3]	100,000 [3]		30 [3]	5 [15]
Dacthal (DCPA)	166.2 [3]	136,000 [3]	1.67x10^{+04} [7]	429.2 [3]	3.36x10^{-09} [3]	9.15x10^{-06} [7]	5.47x10^{-10} [13]	--- [3]	200 [3]	4.87 [3]	150 [3]	10 [15]
Diazinon	332 [3]	0.5 [3]	1.51x10^{-03} [7]	liquid [3]	2.50x10^{-06} [3]	4.44x10^{-02} [7]	2.95x10^{+01} [13]	--- [3]	5,000 [3]	3.30 [3]	100 [3]	4 [15]
Dichlorvos	221 [3]	10000 [3]	4.52x10^{+01} [7]	liquid [9]	1.20x10^{-02} [3]	2.13x10^{+02} [7]	4.71x10^{+00} [13]	--- [3]	30 [3]		0.5 [3]	
Dicrotophos	237.2 [3]	1,000,000 [3]	4.22x10^{+03} [7]	liquid [9]	1.60x10^{-04} [3]	2.84x10^{+00} [7]	6.75x10^{-04} [13]	--- [3]	75 [3]		20 [3]	20 [15]
Dieldrin	380.9 [3]	0.2 [3]	1.72x10^{-02} [7]	449.7 [3]	3.00x10^{-06} [3]	1.31x10^{-02} [7]	7.62x10^{-01} [13]	--- [3]	12,000 [3]	3.70 [3]	1000 [3]	5 [15]
Dimethoate	229.3 [3]	39,800 [3]	3.20x10^{+02} [7]	324.7 [3]	2.50x10^{-05} [3]	6.15x10^{-03} [7]	1.92x10^{-05} [13]	--- [3]	20 [3]	0.80 [3]	7 [3]	3 [15]
Ethion	384.5 [3]	1.1 [3]	1.23x10^{-03} [7]	261.2 [3]	2.40x10^{-06} [3]	1.37x10^{-04} [7]	1.12x10^{-01} [13]	--- [3]	10,000 [3]	5.10 [3]	150 [3]	7 [15]
Fenamiphos	303.4 [3]	400 [3]	2.30x10^{+00} [7]	322.2 [3]	1.00x10^{-06} [3]	2.32x10^{-04} [7]	1.01x10^{-04} [13]	--- [3]	100 [3]	3.25 [3]	50 [3]	--- [15]
Fonofos	246.3 [3]	16.9 [3]	6.86x10^{-02} [7]	liquid [3]	3.40x10^{-04} [3]	6.04x10^{+00} [7]	8.81x10^{+01} [13]	--- [3]	870 [3]		40 [3]	0.65 [15]
Glyphosate	169.1 [2]	10,100 [8]		184.5 [8]			< 7 x 10^{-11} [8]	< 2, 2.6, 5.6, 10.6 [8]		-2.8 [8]	2 [8]	
Hexazinone	252.3 [3]	33,000 [3]	1.06x10^{+03} [7]	389.2 [3]	2.00x10^{-07} [3]	2.17x10^{-04} [7]	2.04x10^{-07} [13]	--- [3]	54 [3]		90 [3]	30 [15]
Iprodione	330.2 [3]	13.9 [3]	5.53x10^{-01} [7]	410 [9]	1.20x10^{-07} [3]	2.10x10^{-04} [7]	3.80x10^{-04} [13]	--- [3]	700 [3]		14 [3]	5 [15]
Isofenphos	345.4 [3]	24 [3]	6.95x10^{-02} [7]	liquid [9]	3.00x10^{-06} [3]	5.33x10^{-02} [7]	7.67x10^{-01} [13]	--- [3]	600 [3]		150 [3]	30 [15]
Malathion	330.3 [3]	130 [3]	2.37x10^{-01} [7]	276.0 [3]	8.00x10^{-06} [3]	6.43x10^{-04} [7]	2.71x10^{-03} [13]	--- [3]	1,800 [3]		1 [3]	3 [15]
Metalaxyl	279.3 [3]	8400 [3]	9.09x10^{+01} [7]	346.1 [9]	5.63x10^{-06} [3]	2.27x10^{-03} [7]	2.50x10^{-05} [13]	--- [3]	50 [3]		70 [3]	30 [15]
Methidathion	302.3 [3]	220 [3]	1.02x10^{+00} [7]	312.7 [3]	3.37x10^{-06} [3]	6.29x10^{-04} [7]	6.17x10^{-04} [13]	--- [3]	400 [3]		7 [3]	3 [15]

Compound	Molecular Weight (Daltons)	Water Solubility (mg/L)	Sub-cooled Water Solubility (moles/m^3)	Melting Point (^{0}K)	Vapor Pressure (mm Hg)	Sub-cooled Vapor Pressure (mm)	Henry's Law Constant (Pa m^3/mol)	pK_a (---)	K_{oc} (mL/g OC)	log K_{ow} (---)	Soil Half-life at 25 C (days)	Foliar Half-life (days)
Methyl parathion	263.2 [3]	60 [3]	3.05×10^{-01} [7]	310.7 [3]	1.50×10^{-05} [3]	2.68×10^{-03} [7]	8.77×10^{-03} [13]	--- [3]	5,100 [3]	3.00 [3]	5 [3]	3 [15]
Metolachlor	283.8 [3]	530 [3]	$1.87\times10^{+00}$ [7]	liquid [3]	3.14×10^{-05} [3]	5.58×10^{-01} [7]	2.99×10^{-01} [13]	--- [3]	200 [3]	3.13 [25]	90 [3]	5 [15]
Metolachlor ESA	329.4 [2]	212,000 [4]					2.80×10^{-05} [14]		2 [19]	-1.24 [21]		
Metolachlor OXA	279.3 [2]	967 [4]					2.63×10^{-03} [14]		39 [19]	1.30 [21]		
Metribuzin	214.3 [3]	1220 [3]	$5.80\times10^{+01}$ [7]	398.9 [3]	1.00×10^{-05} [3]	1.36×10^{-02} [7]	2.34×10^{-04} [13]	1 [3]	60 [3]		40 [3]	5 [15]
Myclobutanil	288.8 [3]	142 [3]	$1.28\times10^{+00}$ [7]	339.5 [9]	1.60×10^{-06} [3]	5.54×10^{-04} [7]	4.34×10^{-04} [13]	--- [3]	500 [3]		66 [3]	--- [15]
Permethrin	391.3 [3]	0.006 [3]	3.77×10^{-05} [7]	337.2 [3]	1.30×10^{-08} [3]	4.27×10^{-06} [7]	1.13×10^{-01} [13]	--- [3]	100,000 [3]		30 [3]	8 [15]
Pendimethalin	281.3 [3]	0.275 [3]	2.00×10^{-03} [7]	329.2 [3]	9.40×10^{-06} [3]	2.57×10^{-03} [7]	$1.28\times10^{+00}$ [13]	--- [3]	5,000 [3]		90 [3]	30 [15]
Phorate	260.4 [3]	22 [3]	1.77×10^{-02} [7]	230.2 [3]	6.40×10^{-04} [3]	1.79×10^{-02} [7]	$1.01\times10^{+00}$ [13]	--- [3]	1,000 [3]	3.80 [3]	60 [3]	2 [15]
Phosmet	317.3 [3]	20 [3]	1.86×10^{-01} [7]	345.1 [3]	4.90×10^{-07} [3]	1.93×10^{-04} [7]	1.04×10^{-03} [13]	--- [3]	820 [3]	2.80 [3]	19 [3]	3 [15]
Prometon	225.3 [3]	720 [3]	$1.46\times10^{+01}$ [7]	364 [3]	7.73×10^{-06} [3]	4.70×10^{-03} [7]	3.22×10^{-04} [13]	4.27 [3]	150 [3]		500 [3]	30 [15]
Prometryn	241.4 [3]	33 [3]	$1.19\times10^{+00}$ [7]	392.2 [3]	1.24×10^{-06} [3]	1.44×10^{-03} [7]	1.21×10^{-03} [13]	4.05 [3]	400 [3]	3.34 [3]	60 [3]	10 [15]
Pronamide	256.1 [3]	15 [3]	$1.18\times10^{+00}$ [7]	428.7 [3]	8.50×10^{-05} [3]	2.29×10^{-01} [7]	1.93×10^{-01} [13]	--- [3]	800 [3]		60 [3]	20 [15]
Propachlor	211.7 [3]	613 [3]	$9.61\times10^{+00}$ [7]	350.2 [3]	2.30×10^{-04} [3]	1.02×10^{-01} [7]	1.06×10^{-02} [13]	--- [3]	80 [3]	1.60 [3]	6.3 [3]	3 [15]
Simazine	201.7 [3]	6.2 [3]	$3.14\times10^{+00}$ [7]	499.2 [3]	2.21×10^{-08} [3]	3.01×10^{-04} [7]	9.59×10^{-05} [13]	1.65 [3]	130 [3]	1.90 [3]	60 [3]	5 [15]
Tebuthiuron	228.3 [3]	2500 [3]	$2.61\times10^{+02}$ [7]	435.9 [3]	2.00×10^{-06} [3]	6.36×10^{-03} [7]	2.44×10^{-05} [13]	--- [3]	80 [3]		360 [3]	30 [15]
Terbufos	288.4 [3]	5 [3]	5.00×10^{-03} [7]	244.0 [3]	3.20×10^{-04} [3]	1.23×10^{-02} [7]	$2.46\times10^{+00}$ [13]	--- [3]	500 [3]		5 [3]	2.5 [15]
Trifluralin	335.3 [3]	0.3 [3]	1.47×10^{-03} [7]	319.7 [3]	1.10×10^{-04} [3]	2.41×10^{-02} [7]	$1.64\times10^{+01}$ [13]	--- [3]	8,000 [3]	3.00 [3]	60 [3]	3 [15]

Data sources:
[1] CAC Group (2007); [2] Calculated based on molecular formula; [3] RZWQM internal database; Ahuja, et al. (2000); [4] Estimated from K_{ow} using equation 2-3 from Lyman (1990a); [5] Bayless (2001); [6] Unit conversion; [7] Majewski and Capel (1995) Table 6.1 calculated using S (entropy of fusion) values of 56 J/mol-K; [8] International Programme On Chemical Safety (2007); [9] U.S Department of Agriculture, 2006c; [10] Ma, et al. (2004); [11] Computed using boiling point value estimated relative to metolachlor, using method "e" in Figure 9; [12] Estimated relative to parent compound using path e in Figure 9; [13] Calculated as equal to sub-cooled vapor pressure divided by the sub-cooled water solubility; [14] Scaled from literature value for parent compound, using paths e, g and n in Figure 9; [15] Knisel (1993) ; [16] Computed from median of six KD (distribution coefficient) values from U.S.EPA (1994), using the equation Koc = KD / foc, where foc = (%OM/100%) / 1.724 (Hamaker and Thompson, 1972); [17] Scaled from value for acetochlor ESA, using path h in Figure 8; [18] Data from Seybold and Mersie (1996) for a silt loam; [19] Computed relative to parent compound using path h in Figure 8 and 'agricultural chemicals' equation from Sabljic et al. (1995); [20] Monsanto (2007); [21] Estimated relative to value for parent compound using path b in Figure 8; [22] Half-life for deethyl atrazine disappearance in a sandy clay loam reported at 24°C by Kruger et al. (1997) was adjusted to 25°C using the activation energy of 48.4 kJ/mol reported by Baer and Calvet (1999) for disappearance of its parent compound (atrazine) from a silt loam; [23] Reported by Kruger, et al. (1993) for a sandy clay loam; [24] Reported by Winkelmann and Klaine (1991) for a silt loam; [25] Mackay, et al. (1997)

Table 15 – Use estimates and application rates of selected pesticides. There was no use of the targeted pesticides (Table 4) in either Mustang Creek (CA) in 2003 or 2004 or in Leary-Weber Ditch (IN) in 2004. A missing value means that the pesticide was not used in the watershed.

	State	CA	CA	IN	IN	IN	MD	MD	MD	NE	NE	NE	NE	WA	WA	WA	WA
	Basin Name	Merced River	San Joaquin River	Lery Weber	Sugar Creek	White River	Morgan Creek	Morgan Creek	un-named creek	un-named creek	un-named creek	Maple Creek	Elkhorn River	DR-2	DR-2	Granger Drain	Yakima River
	Year of Record			2003			2003	2004	2002	2003	2004			2003	2004		
Herbicides																	
Total	Acetochlor			3	6373	435627			28	31	38	15998	203563	100	121	59	1048
% crop	Acetochlor			100	100	100			100	100	100	100	100	100	100	100	100
Total	Alachlor	51	1643		1549	98988						7816	103254	65	78	220	6050
% crop	Alachlor	100	100		100	100						100	100	100	100	100	100
Total	Atrazine	120	2010	245	12242	836930	2735	3463	11	12	15	36426	461817	39	47	144	3896
% crop	Atrazine	36	58	100	100	100	100	100	100	100	100	100	100	100	100	100	100
% pasture	Atrazine	64	41														
Total	DCPA	55	4599			52								1			125
% crop	DCPA	100	100			1								100			100
%orchards	DCPA	0	0			2								0			0
% pasture	DCPA	0	0			97								0			0
Total	Dimethenamid				764	50462						1394	17740	26	31	60	1418
% crop	Dimethenamid				100	100						100	100	100	100	100	100
Total	Hexazinone	364	3246		1	180								3	5	33	490
% pasture	Hexazinone	100	100		100	100								100	100	100	100
Total	Metolachlor	526	16368		10302	700443	1759	1997				37110	472918	94	115	222	5886
% crop	Metolachlor	100	100		100	100	100	100				100	100	100	100	100	100
Total	Metribuzin	23	821		204	13464						563	7520	29	18	298	7264
% crop	Metribuzin	100	100		96	93						100	100	100	100	66	79
% pasture	Metribuzin	0	0		4	7						0	0	0	0	34	21
Total	Pendimethalin	882	29848		3605	222985						6937	93170	0	1	95	2827
% crop	Pendimethalin	100	100		100	100						100	100	100	100	100	100
Total	Prometryn	174	5688														
% crop	Prometryn	100	100														
Total	Pronamide	11	469													33	778
% crop	Pronamide	100	100													22	31
%orchards	Pronamide	0	0													37	44
% pasture	Pronamide	0	0													40	25
Total	Propachlor											115	727			7	131
% crop	Propachlor											100	100			100	100
Total	Simazine	3430	17117		389	26626	1858	2162				0	0	32	26	1258	41715
% crop	Simazine	0	0		100	100	100	100				0	0	100	100	1	1
%orchards	Simazine	100	100		0	0	0	0				0	0	0	0	99	99

	State	CA	CA	IN	IN	IN	MD	MD	MD	NE	NE	NE	NE	WA	WA	WA	WA
	Basin Name	Merced River	San Joaquin River	Lery Weber	Sugar Creek	White River	Morgan Creek	Morgan Creek	un-named creek	un-named creek	un-named creek	Maple Creek	Elkhorn River	DR-2	DR-2	Granger Drain	Yakima River
	Year of Record			2003			2003	2004	2002	2003	2004			2003	2004		
Total	Trifluralin	4557	63248		593	36827			55	16		5752	77453	32	21	204	4026
% crop	Trifluralin	23	54		100	100			100	100		99	99	100	100	65	66
%orchards	Trifluralin	12	4		0	0						0	0	0	0	9	14
% pasture	Trifluralin	66	42		0	0						1	1	0	0	26	19
Insecticides																	
Total	Azinphos-methyl	6286	27090			69										3734	120835
% crop	Azinphos-methyl	0	0			0										0	0
%orchards	Azinphos-methyl	100	100			100										100	100
Total	Carbaryl	2430	17479		10	4998						172	5752	36	24	1204	39319
% crop	Carbaryl	9	41		29	37						6	1	100	100	6	3
%orchards	Carbaryl	91	59		0	1						0	0	0	0	94	97
% pasture	Carbaryl	0	0		71	62						94	99	0	0	0	0
Total	Chlorpyrifos	14536	107486	103	638	43655			12	14	2	1909	24197	46	52	3511	113621
% crop	Chlorpyrifos	9	37	100	100	100			100	100	100	94	94	100	100	4	3
%orchards	Chlorpyrifos	81	51		0	0						0	0	0	0	96	97
% pasture	Chlorpyrifos	10	12		0	0						6	6	0	0	0	0
Total	Cyfluthrin	29	463		5	351						31	399	0	0		
% crop	Cyfluthrin	21	48		98	97						100	100	100	100		
%orchards	Cyfluthrin	12	14		0	0											
% pasture	Cyfluthrin	67	37		2	3											
Total	Cypermethrin	6	276														20
% crop	Cypermethrin	100	100														100
Total	Diazinon	6273	32782			45										111	3406
% crop	Diazinon	3	17			47										8	7
%orchards	Diazinon	97	83			53										92	93
Total	Dicrotophos															0	0
Total	Dimethoate	1041	18374		3	815	17	33				40	500	1	1	152	5261
% crop	Dimethoate	34	69		1	51	100	100				4	3	100	100	19	20
%orchards	Dimethoate	11	4		0	1						0	0	0	0	77	78
% pasture	Dimethoate	55	28		99	48						96	97	0	0	5	2
Total	Ethion																
Total	Fenamiphos	636	3496														2
% crop	Fenamiphos	0	1														0
%orchards	Fenamiphos	100	99														100
Total	Fonofos	42	1543														
% crop	Fonofos	100	100														

	State	CA	CA	IN	IN	IN	MD	MD	MD	NE	NE	NE	NE	WA	WA	WA	WA
	Basin Name	Merced River	San Joaquin River	Lery Weber	Sugar Creek	White River	Morgan Creek	Morgan Creek	un-named creek	un-named creek	un-named creek	Maple Creek	Elkhorn River	DR-2	DR-2	Granger Drain	Yakima River
	Year of Record			2003			2003	2004	2002	2003	2004			2003	2004		
Total	Malathion	1550	15353		2	280								34	21	612	20207
% crop	Malathion	6	20		0	7								100	100	4	2
%orchards	Malathion	12	6		0	3								0	0	92	96
% pasture	Malathion	82	74		100	90								0	0	4	2
Total	Methidathion	3668	16273													62	1965
% crop	Methidathion	0	0													0	0
%orchards	Methidathion	100	100													100	100
Total	Methyl parathion	1071	5287		11	1583						3002	38196	1	1	1590	51645
% crop	Methyl parathion	0	4		11	24						100	100	100	100	1	0
%orchards	Methyl parathion	100	96		0	0						0	0	0	0	99	100
% pasture	Methyl parathion	0	0		89	76						0	0	0	0	0	0
Total	Permethrin	1205	6751		28	2318						591	7660	27	32	24	780
% crop	Permethrin	4	22		98	97						99	99	100	100	94	97
%orchards	Permethrin	88	65		0	0						0	0	0	0	0	0
% pasture	Permethrin	8	13		2	3						1	1	0	0	6	3
Total	Phorate	186	5681		112	7772						688	8807	2	2	160	5422
% crop	Phorate	100	100		100	100						100	100	100	100	12	22
%orchards	Phorate	0	0		0	0						0	0	0	0	88	78
Total	Phosmet	9081	44229		4	717										260	8025
%orchards	Phosmet	98	96		0	22										100	100
% pasture	Phosmet	2	4		100	78										0	0
Total	Terbufos				1012	69170						4509	57377	15	18		
% crop	Terbufos				100	100						100	100	100	100		
Fungicides																	
Total	Iprodione	5027	22427													42	1955
% crop	Iprodione	0	2													33	53
%orchards	Iprodione	100	98													67	47
Total	Metalaxyl	35	1157			593							1			90	2927
% crop	Metalaxyl	63	82			100							100			5	10
%orchards	Metalaxyl	37	18			0							0			95	90
Total	Myclobutanil	677	3565			13								2	2	108	3712
% crop	Myclobutanil	2	13			0								100	100	0	0
%orchards	Myclobutanil	98	87			100								0	0	100	100

Figure 1 – Maps of the study sites in California

a. Location of the study area

b. Map of the Merced River watershed with Mustang Creek outlined

c. Contour map of the Mustang Creek watershed and sampling locations

d. Map of the ground water-surface water interaction study area

e. Cross section of the ground water flow system and unsaturated zone study area

f. Planar view of the ground water-surface water interaction study area

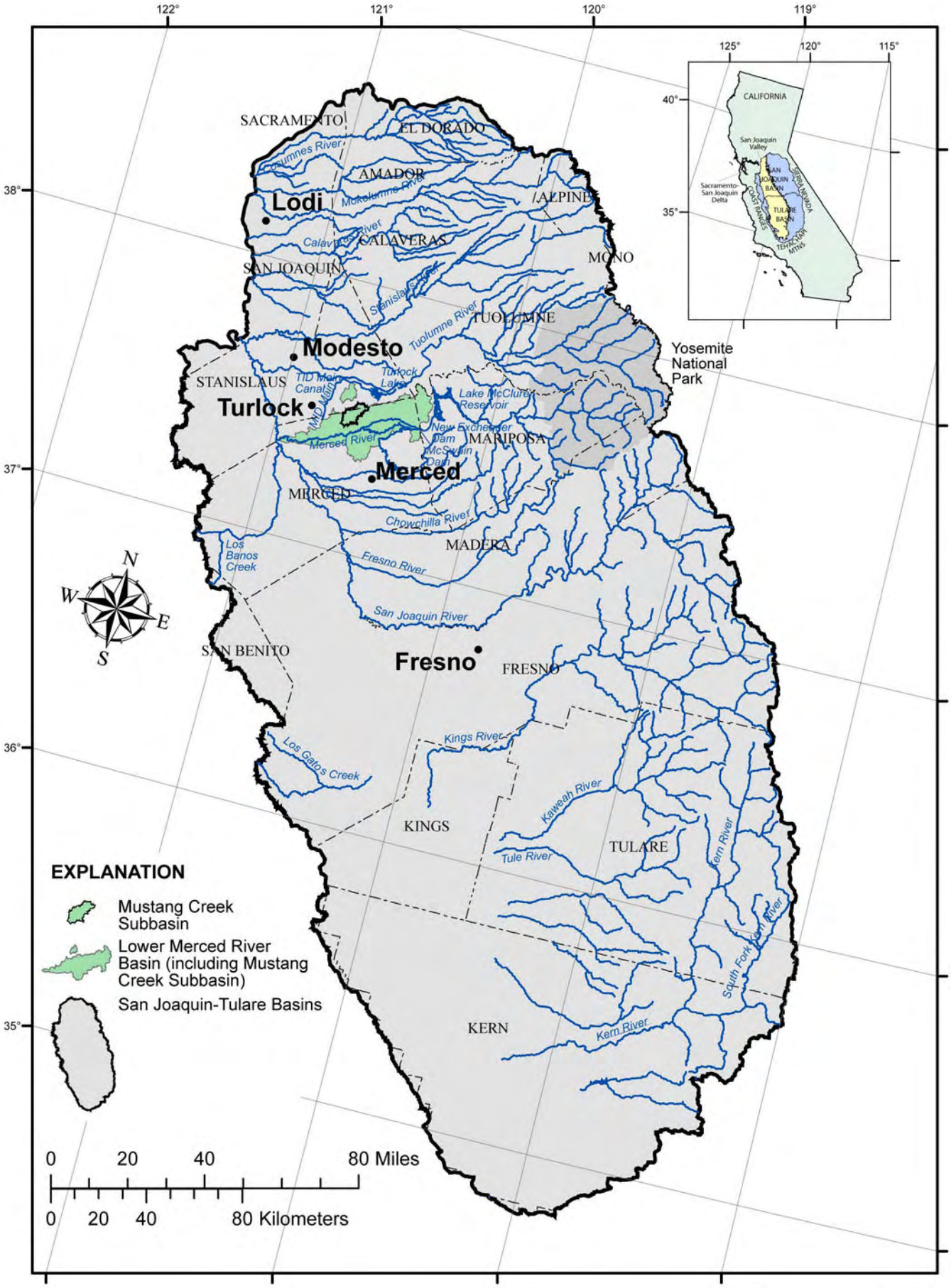


Figure 1.a. Location of the lower Merced River Basin, within the San Joaquin-Tulare Basins study unit, California.

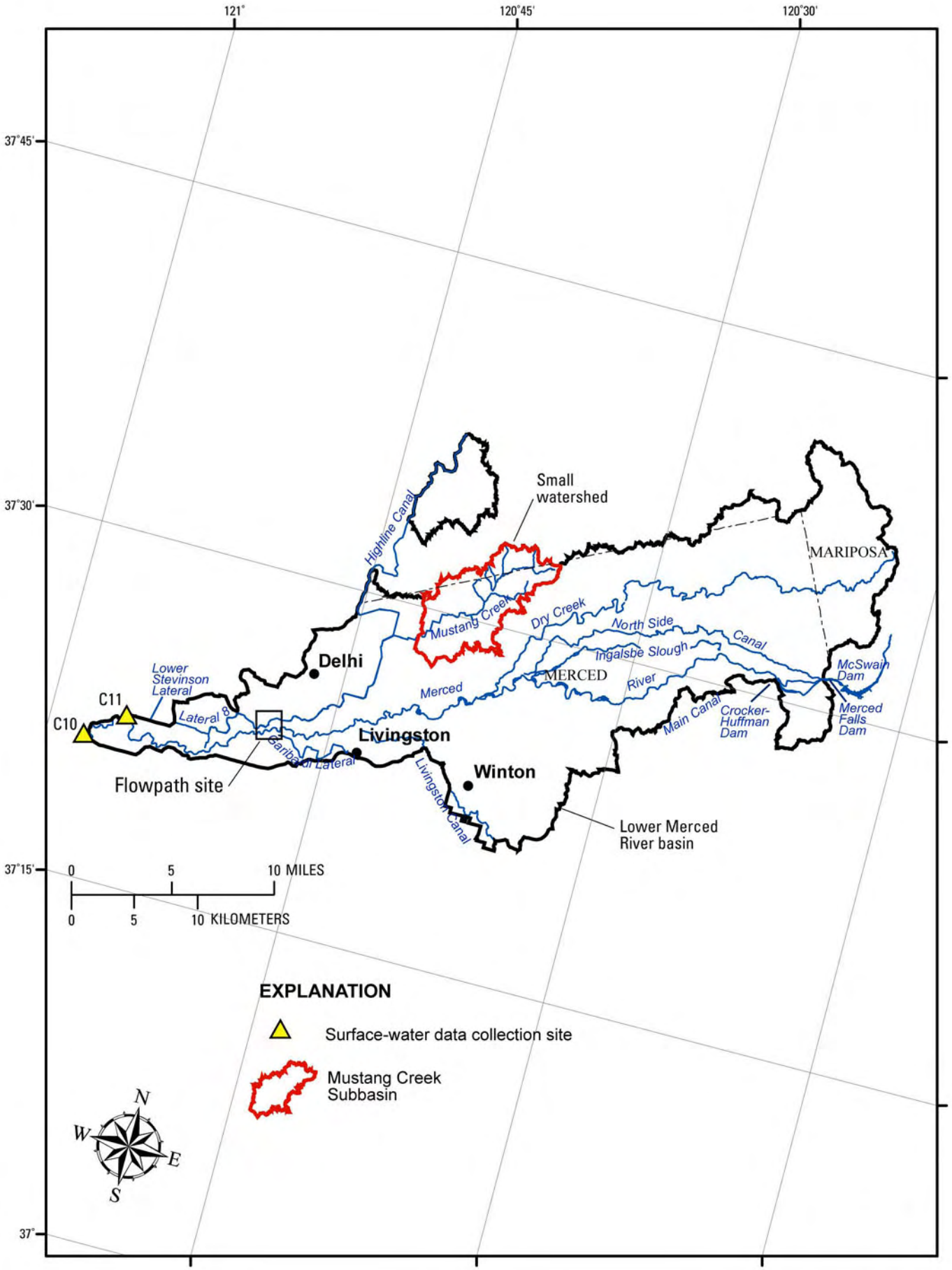
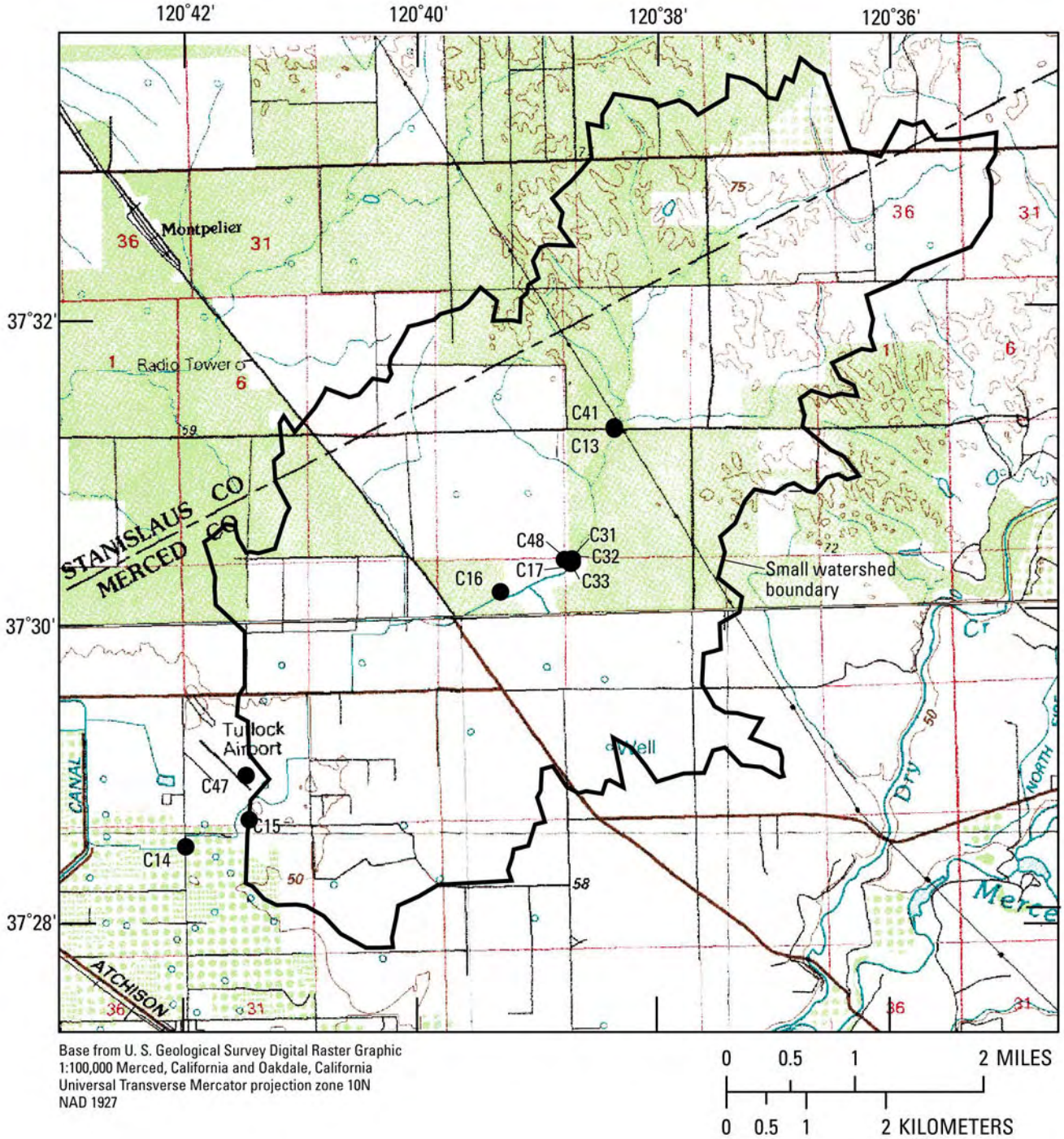


Figure 1.b. Locations, streamflow gages, subbasins, and the flowpath study site in the lower Merced River Basin, California.

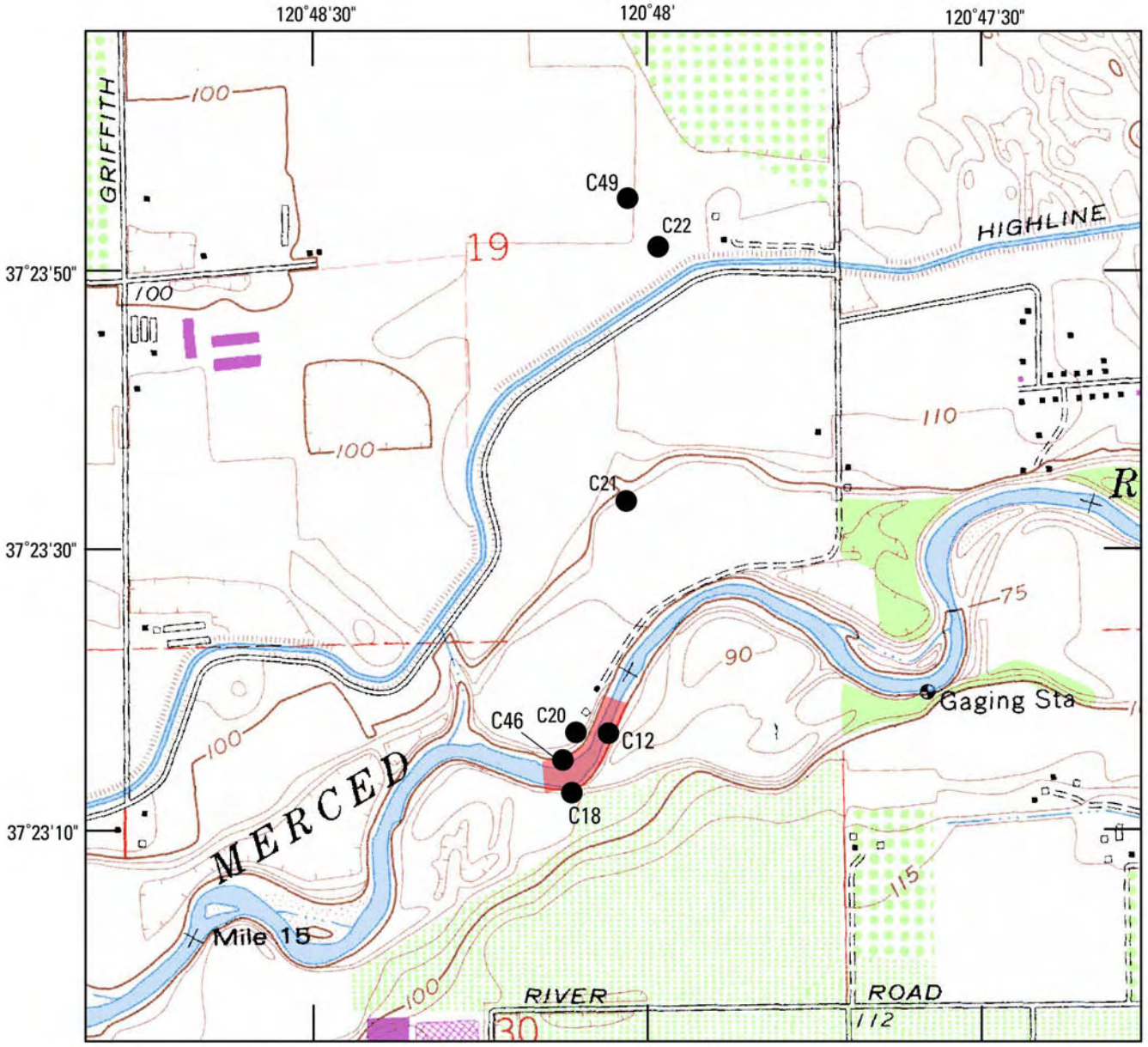


Base from U. S. Geological Survey Digital Raster Graphic
1:100,000 Merced, California and Oakdale, California
Universal Transverse Mercator projection zone 10N
NAD 1927

EXPLANATION

C47 Data collection site and site identifier

Figure 1.c. Contour maps showing data collection sites in the San Joaquin Study unit within the Mustang Creek small study watershed.



Base from U. S. Geological Survey Digital Raster Graphic
1:24,000 Turlock, California, 1978
Universal Transverse Mercator projection zone 10N
NAD 1927

0 625 1,250 2,500 FEET

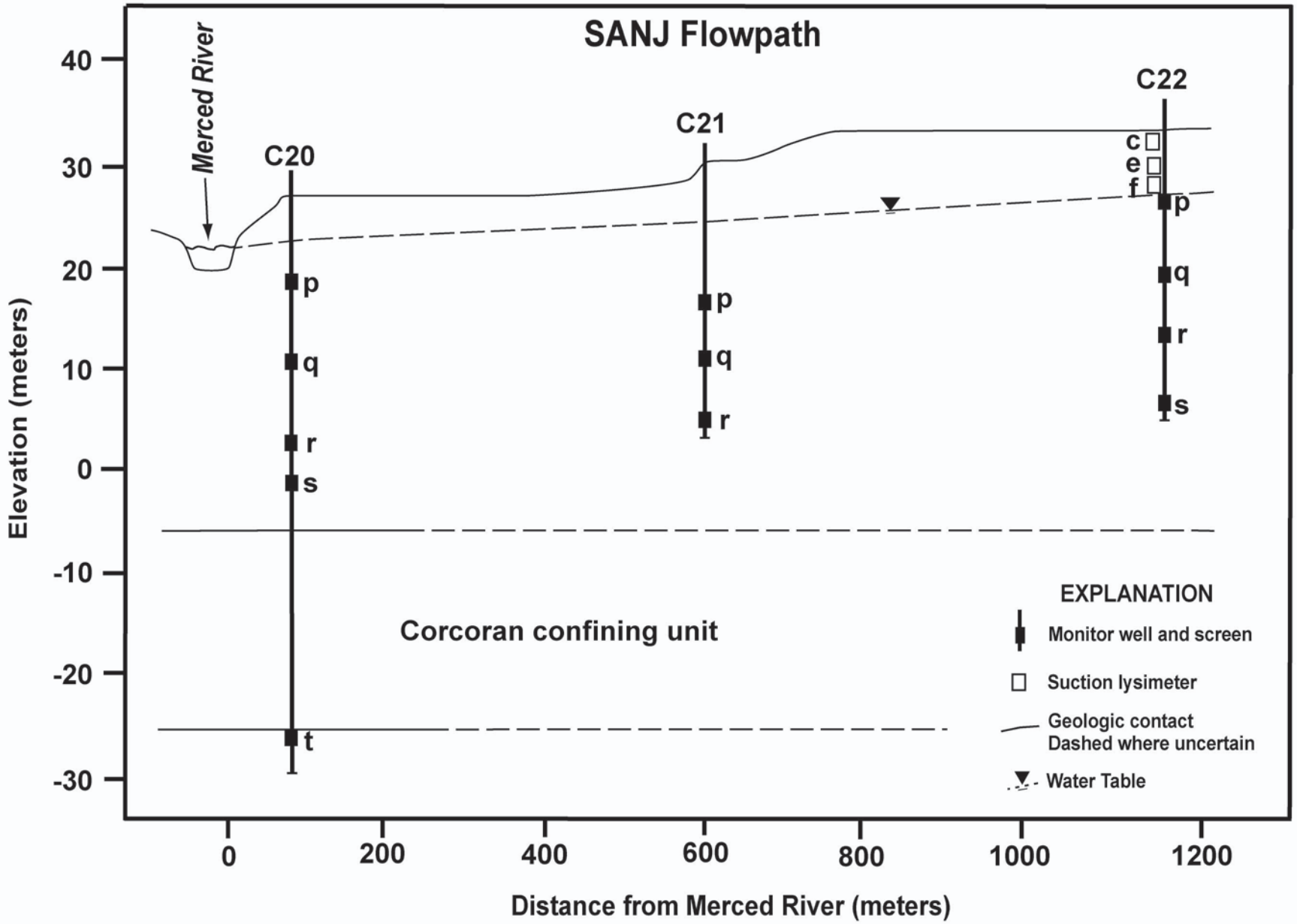
0 125 250 500 METERS

EXPLANATION

C21 Data collection site and site identifier

Ground-water Surface water interaction study site

Figure 1.d


SANJ Flowpath
Merced River
C20
C21
C22
c
e
f
p
q
r
s
t
Corcoran confining unit
EXPLANATION
Monitor well and screen
Suction lysimeter
Geologic contact
Dashed where uncertain
Water Table
Elevation (meters)
40
30
20
10
0
-10
-20
-30
0
200
400
600
800
1000
1200
Distance from Merced River (meters)

Figue 1.e

SANJ Ground-water/Surface-water interaction study site diagram, Merced River

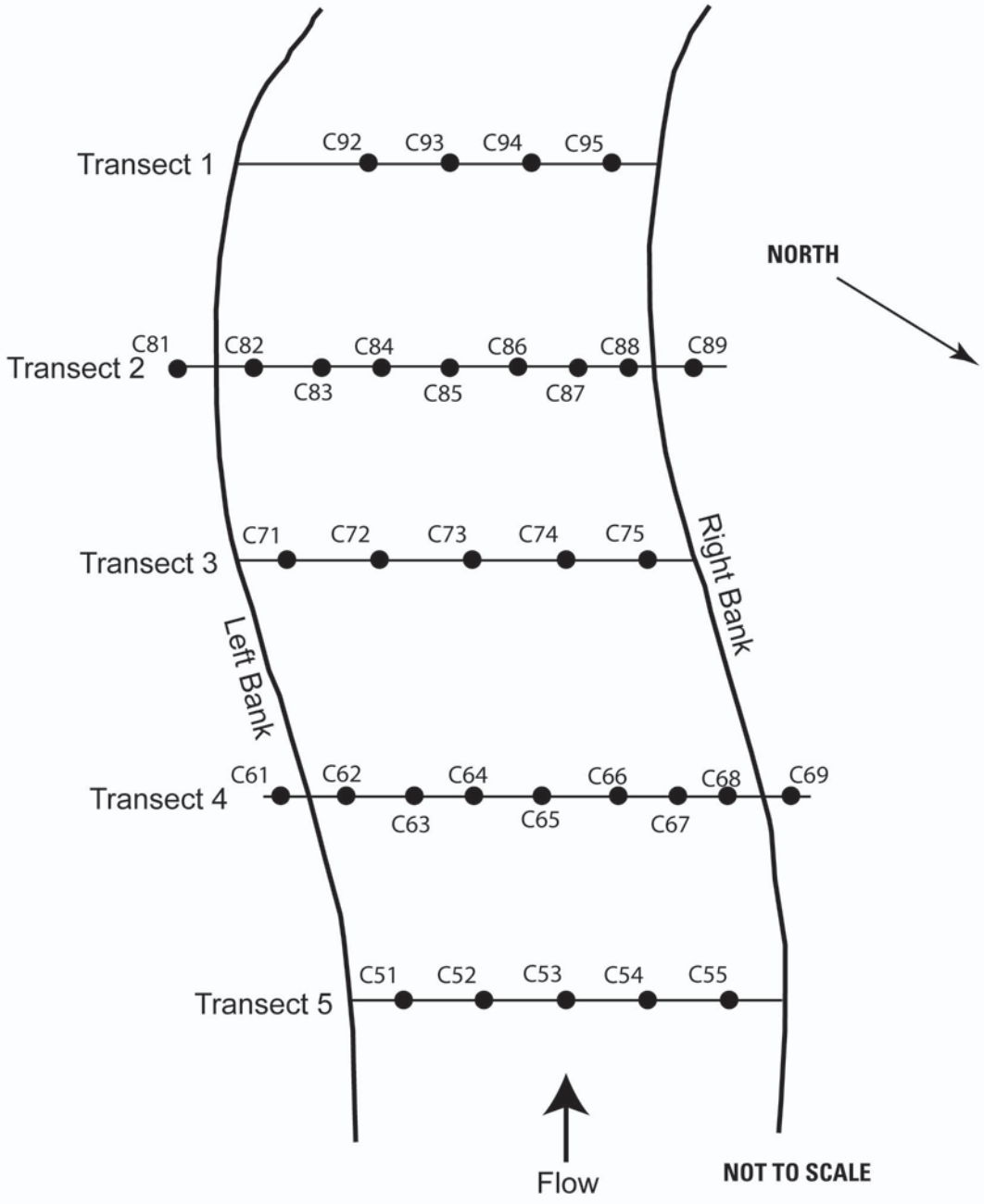


Figure 1.f

Figure 2 – Maps of the study sites in Indiana

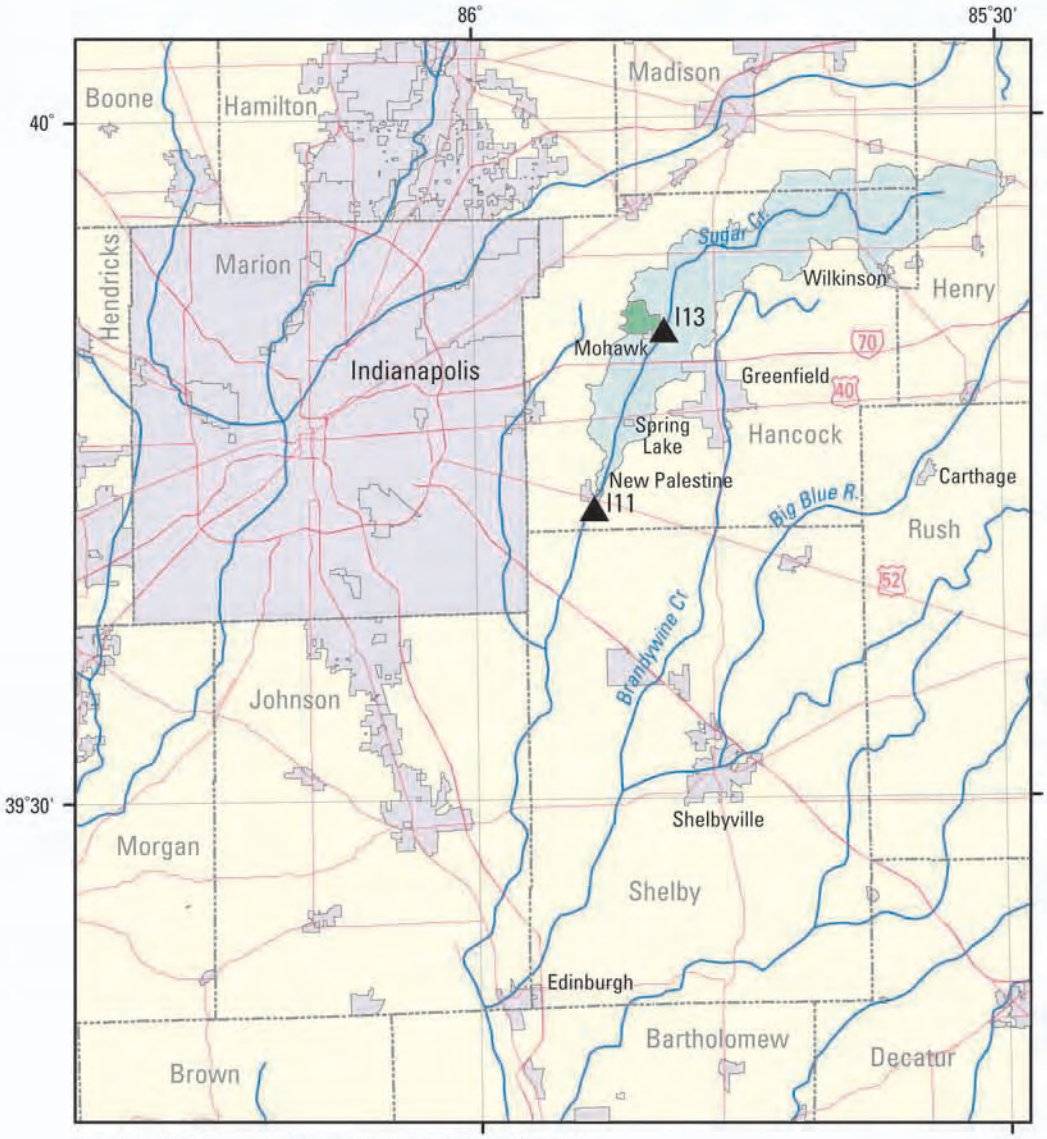
a. Location of the study area

b. Map of the Sugar Creek watershed with Lery Weber Ditch outlined

c. Contour map of the Lery Weber Ditch watershed and sampling locations

d. Map of the ground water-surface water interaction study area

e. Planar view of the ground water-surface water interaction study area



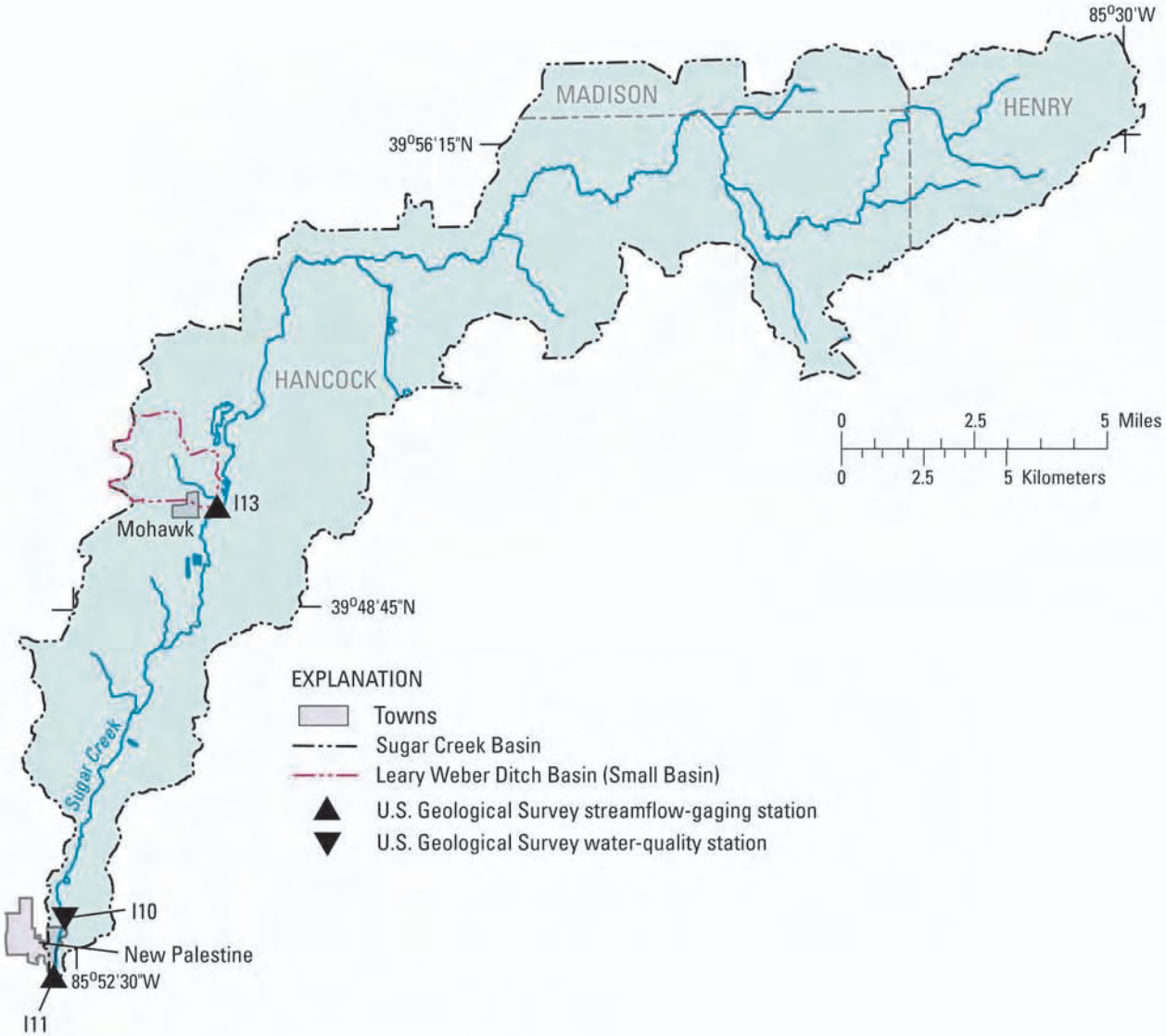
Base from U.S. Geological Survey digital data 1:100,000, 1983
Universal Transverse Mercator projection,
Zone 16, North American Datum, 1983

EXPLANATION

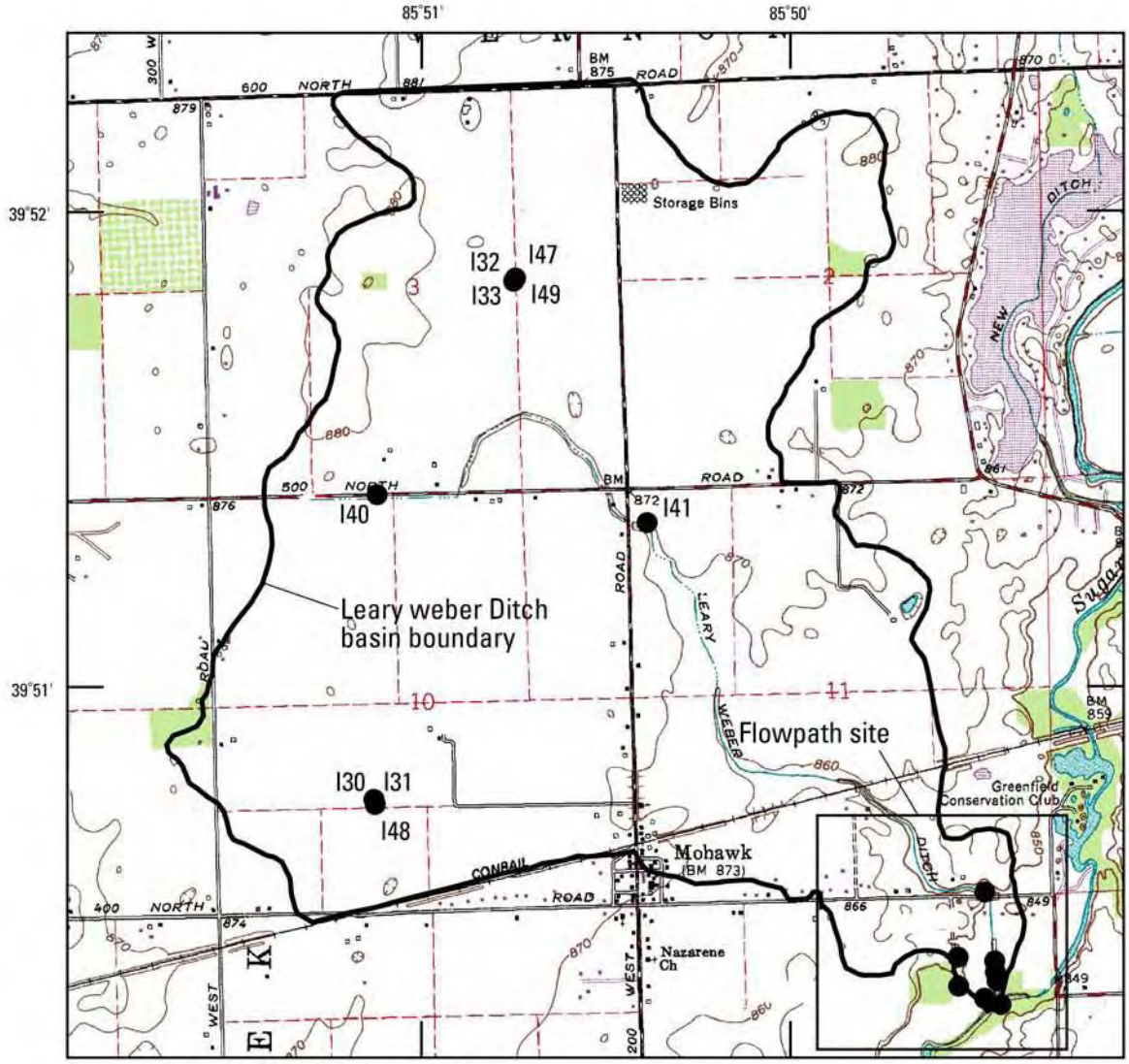
- Cities and towns
- Sugar Creek Basin
- Leary Weber Ditch Basin
- ▲ U.S. Geological Survey streamflow-gaging station

0 5 10 Miles

0 5 10 Kilometers



Base from U.S. Geological Survey digital data, 1:100,000, 1983
Universal Transverse Mercator projection,
Zone 16, North American Datum, 1983



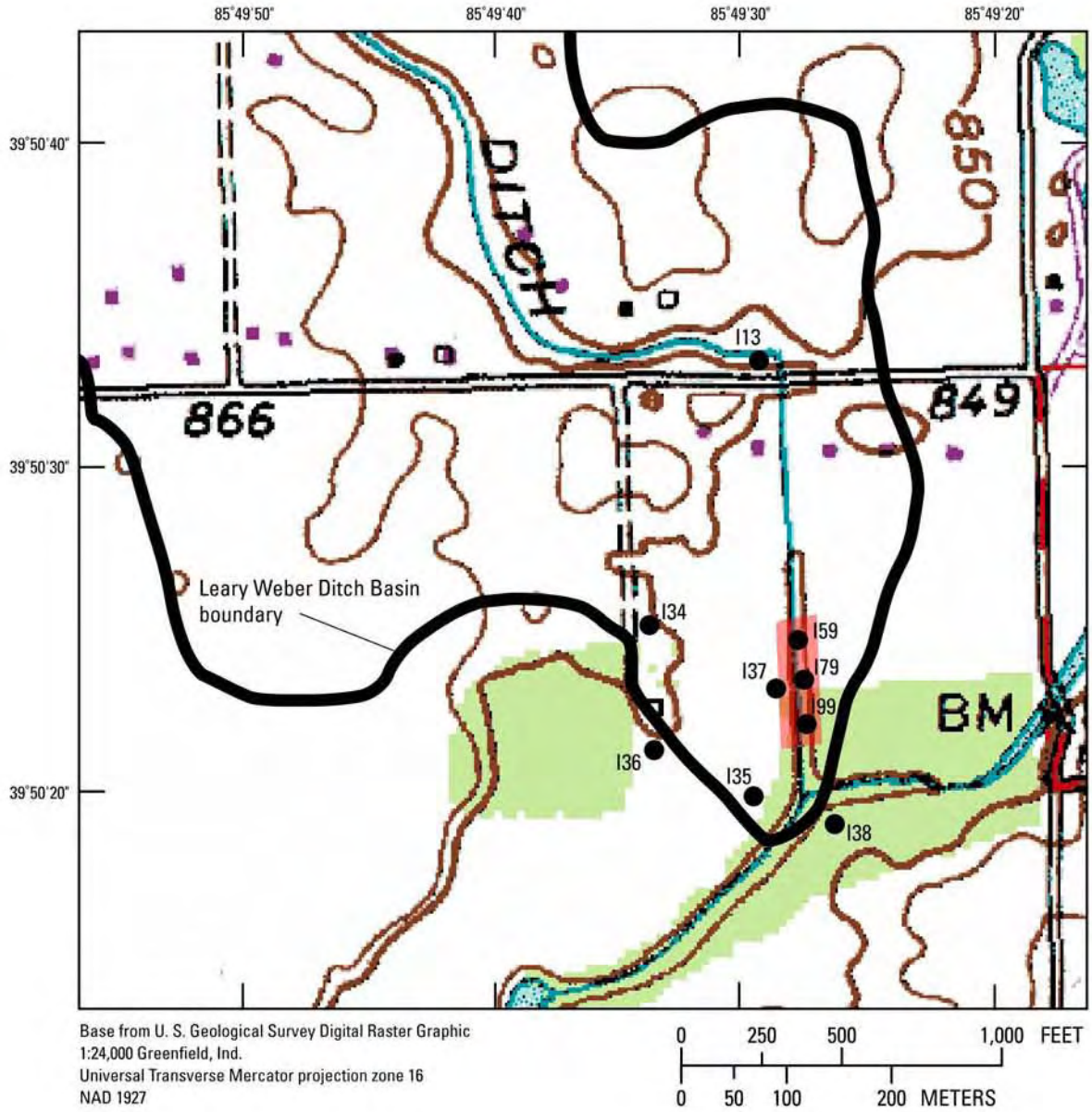
Base from U. S. Geological Survey Digital Raster Graphic
1:24,000 Greenfield, Ind.
Universal Transverse Mercator projection zone 16
NAD 1927

0 0.25 0.5 1 MILE

0 0.25 0.5 1 KILOMETER

EXPLANATION

I37 Data collection site and site identifier



EXPLANATION

I37 Data collection site and site identifier

Ground-water Surface water interaction study site

WHMI Ground-water/Surface-water interaction study site

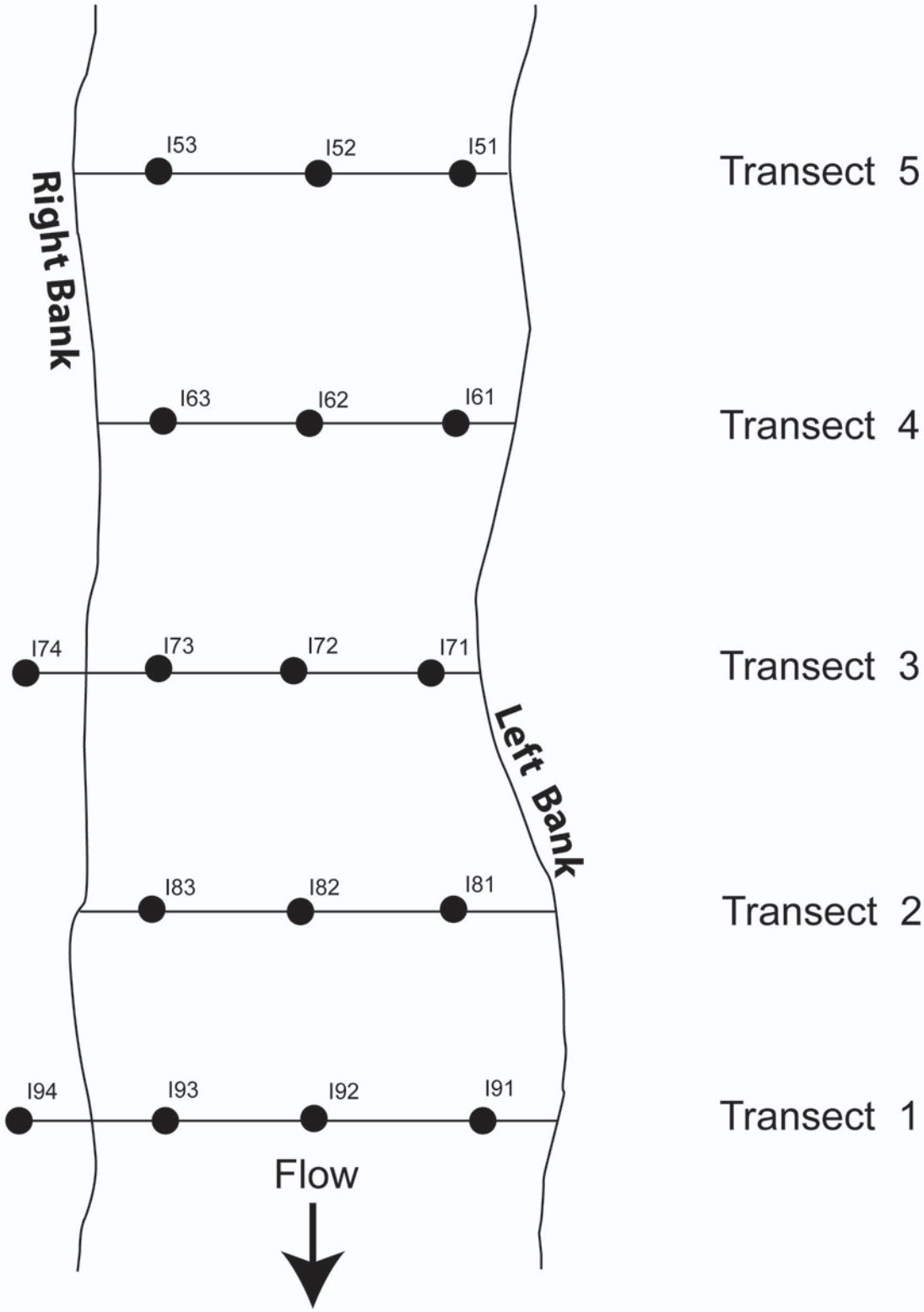


Figure 3 – Maps of the study sites in Maryland

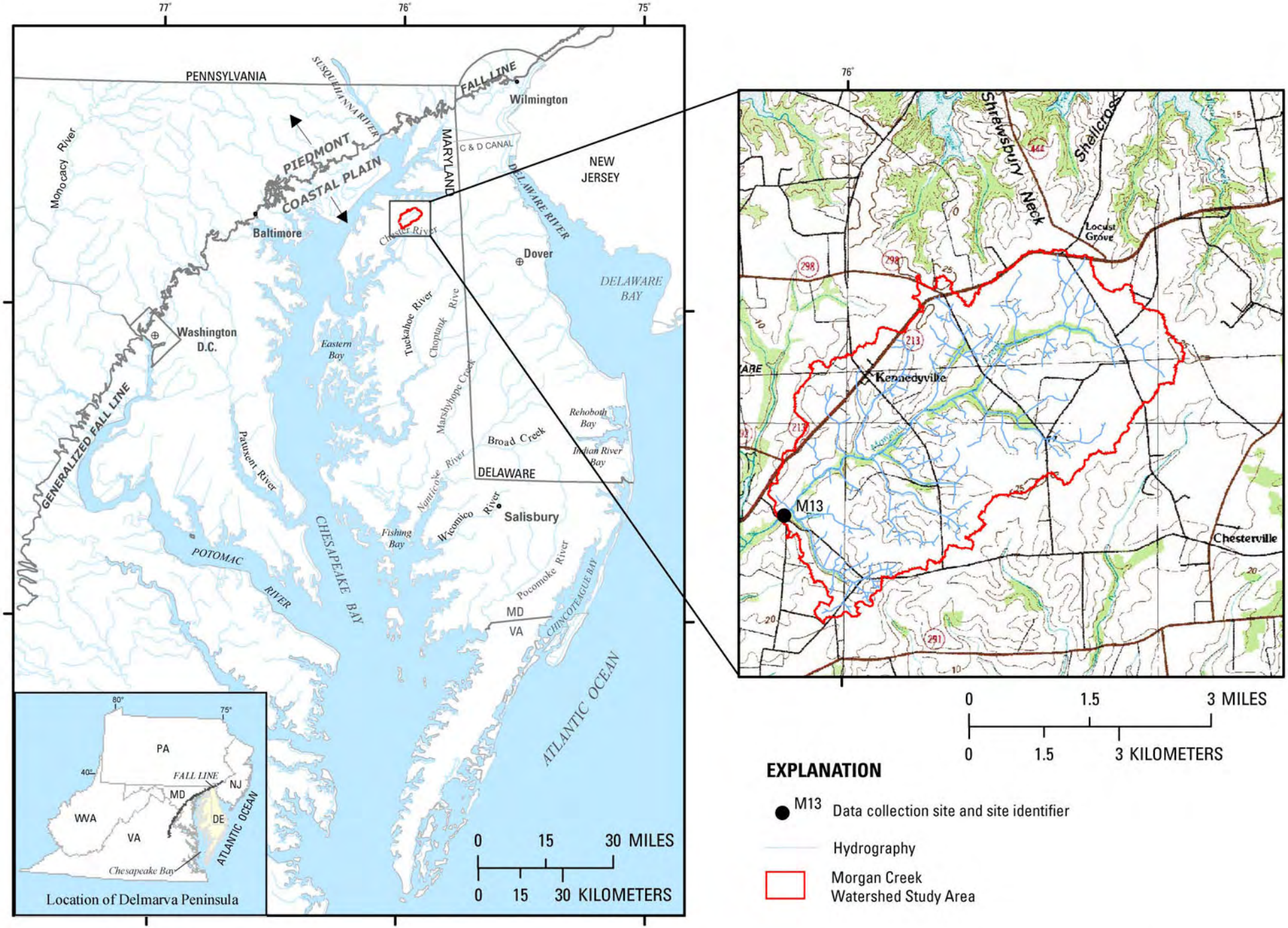
a. Location of the study area

b. Contour map of the Morgan Creek watershed and sampling locations

c. Map of the ground water-surface water interaction study area

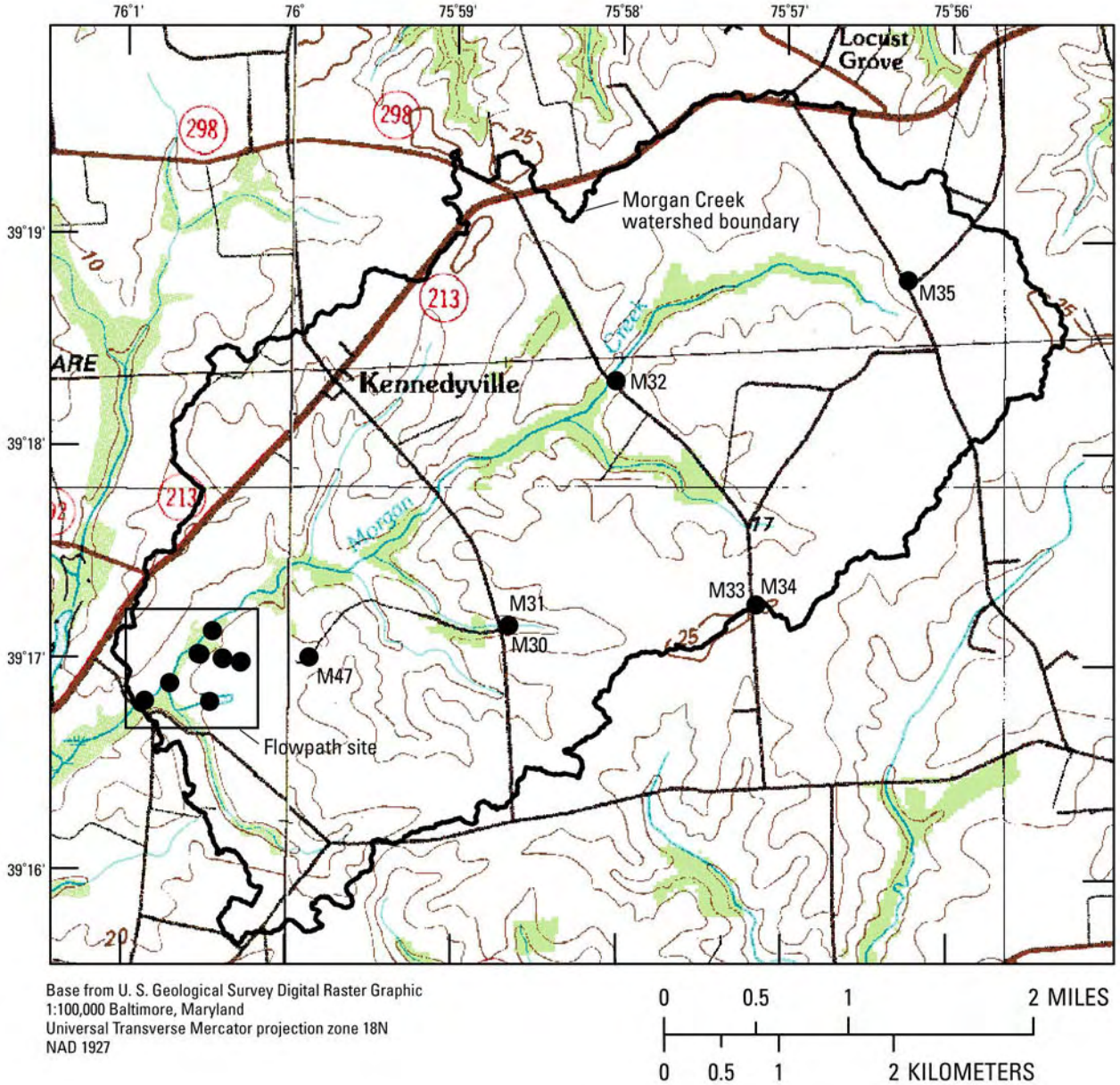
d. Cross section of the ground-water flow system and unsaturated zone study area

e. Planar view of the ground water-surface water interaction study area



Base map from USGS 1:100,000 DLG

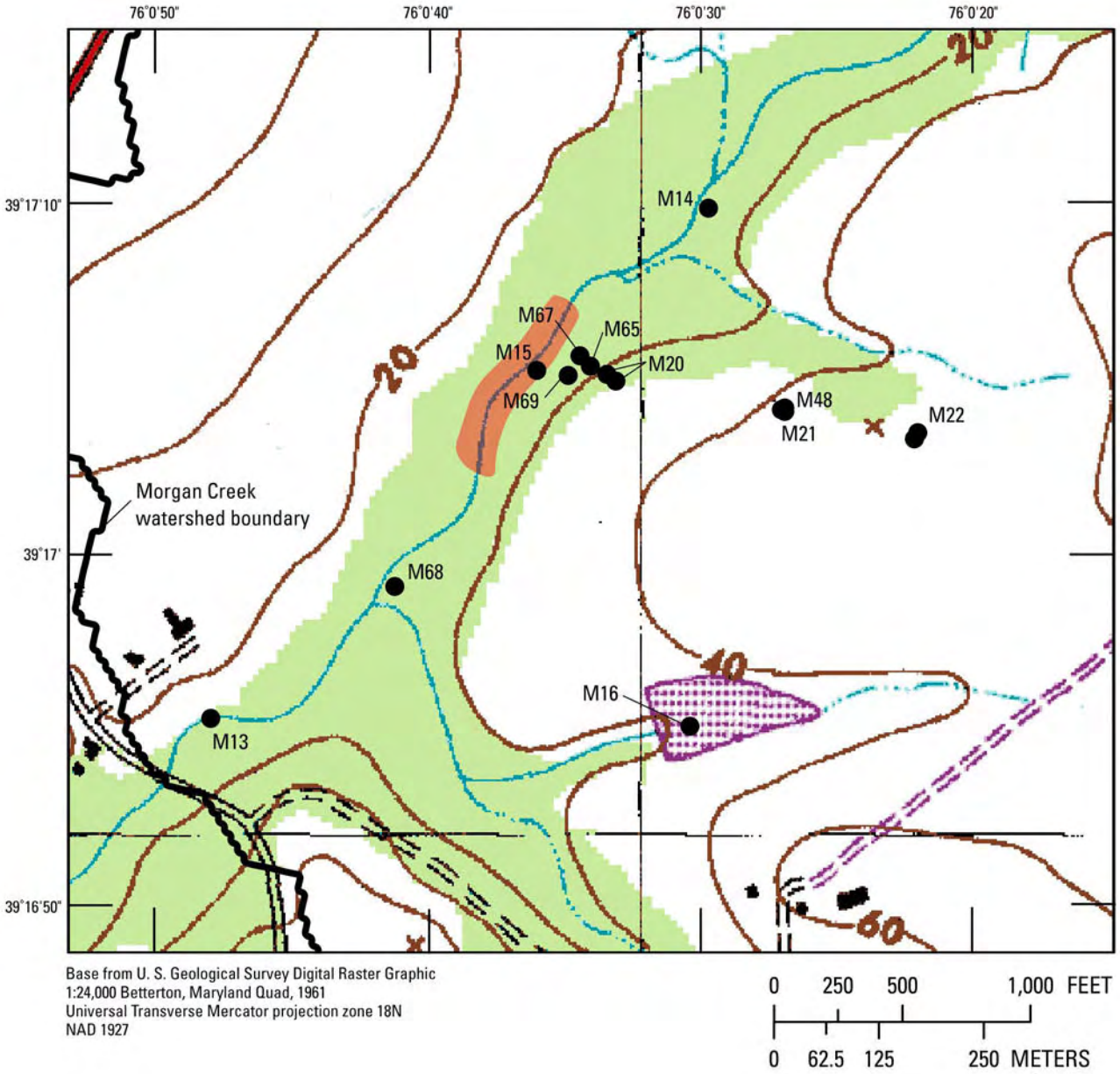
Figure 3.a: The Delmarva Peninsula and Morgan Creek Basin, Maryland (modified from Shedlock and others, 1999; Bachman and others, 2002).



EXPLANATION

M31 Data collection site and site identifier

Figure 3.b. Contour maps showing data collection sites in the Potomac River/Delmarva Peninsula (PODL) study unit within the Morgan Creek study watershed.



EXPLANATION

M21 Data collection site and site identifier

Ground-water Surface water interaction study site

Figure 3.c. Contour maps showing data collection sites within the flowpath study area in the Potomac River/ Delmarva Peninsula (PODL) study unit.

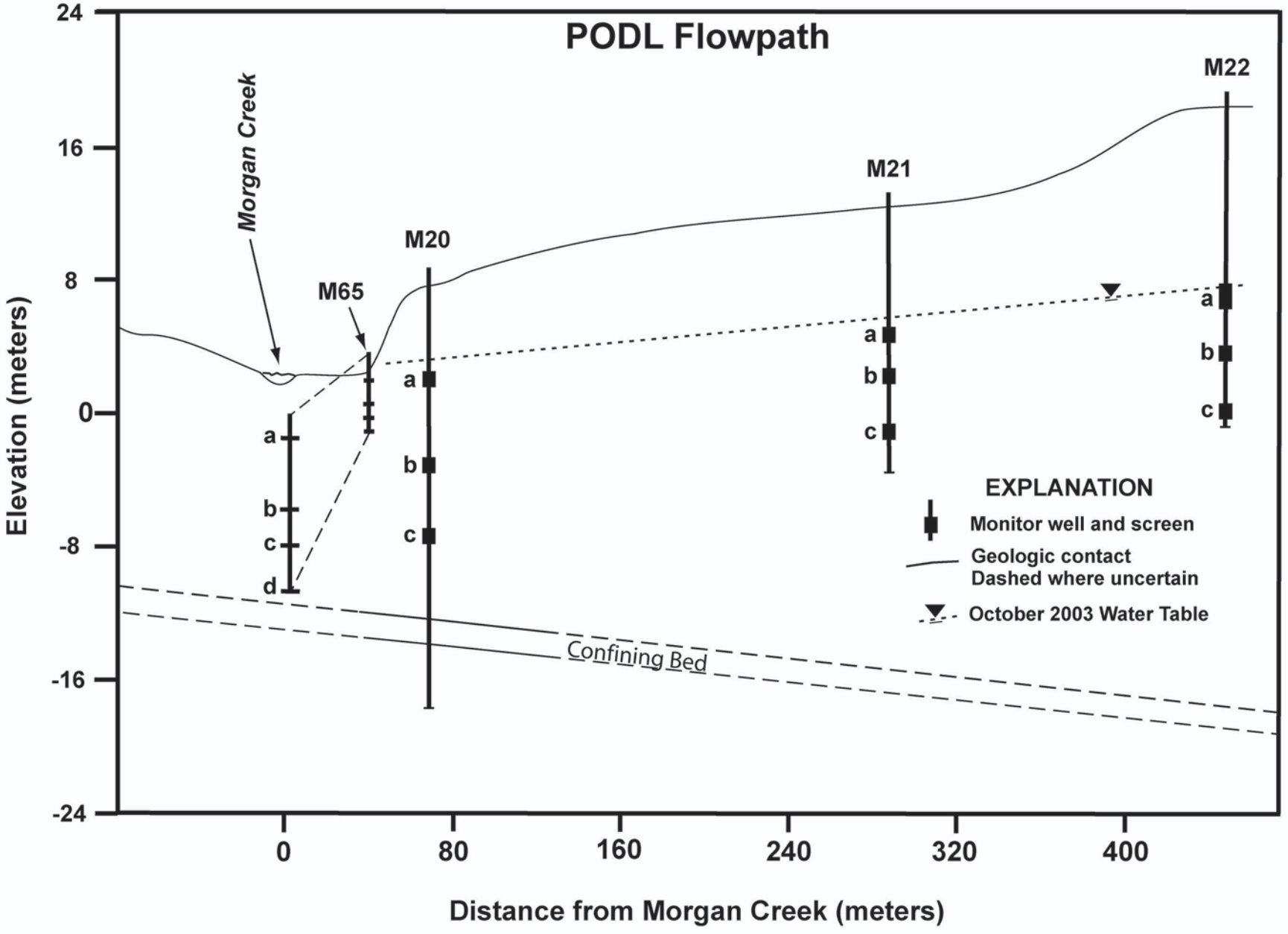

PODL Flowpath
Morgan Creek
M65
M20
M21
M22
a
b
c
d
Confining Bed
EXPLANATION
Monitor well and screen
Geologic contact
Dashed where uncertain
October 2003 Water Table
Elevation (meters)
24
16
8
0
-8
-16
-24
0
80
160
240
320
400
Distance from Morgan Creek (meters)

Figure 3.d

PODL Ground-water/Surface-water interaction study site, Morgan Creek

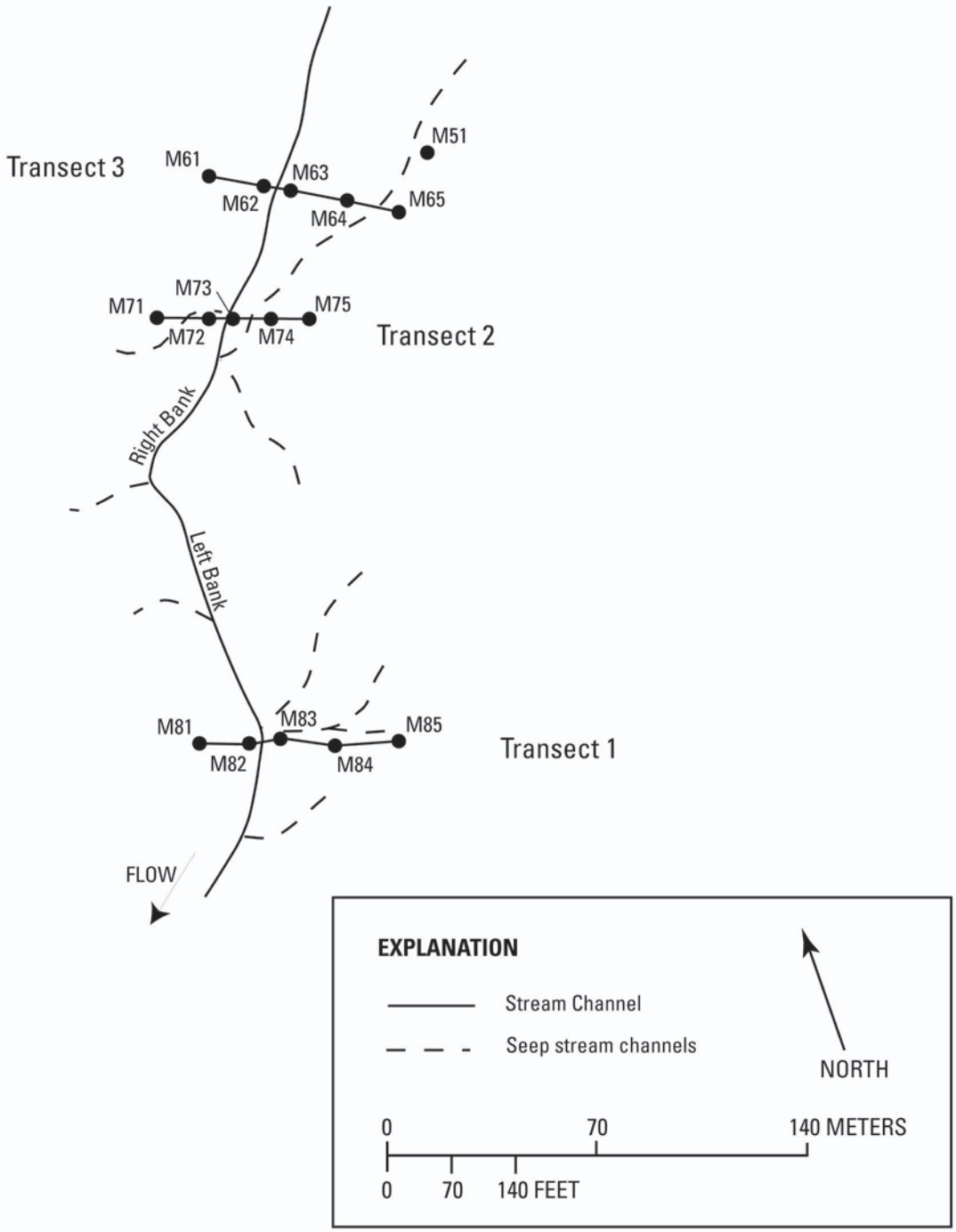


Figure 3.e

Figure 4 – Maps of the study sites in Nebraska

a. Location of the study area

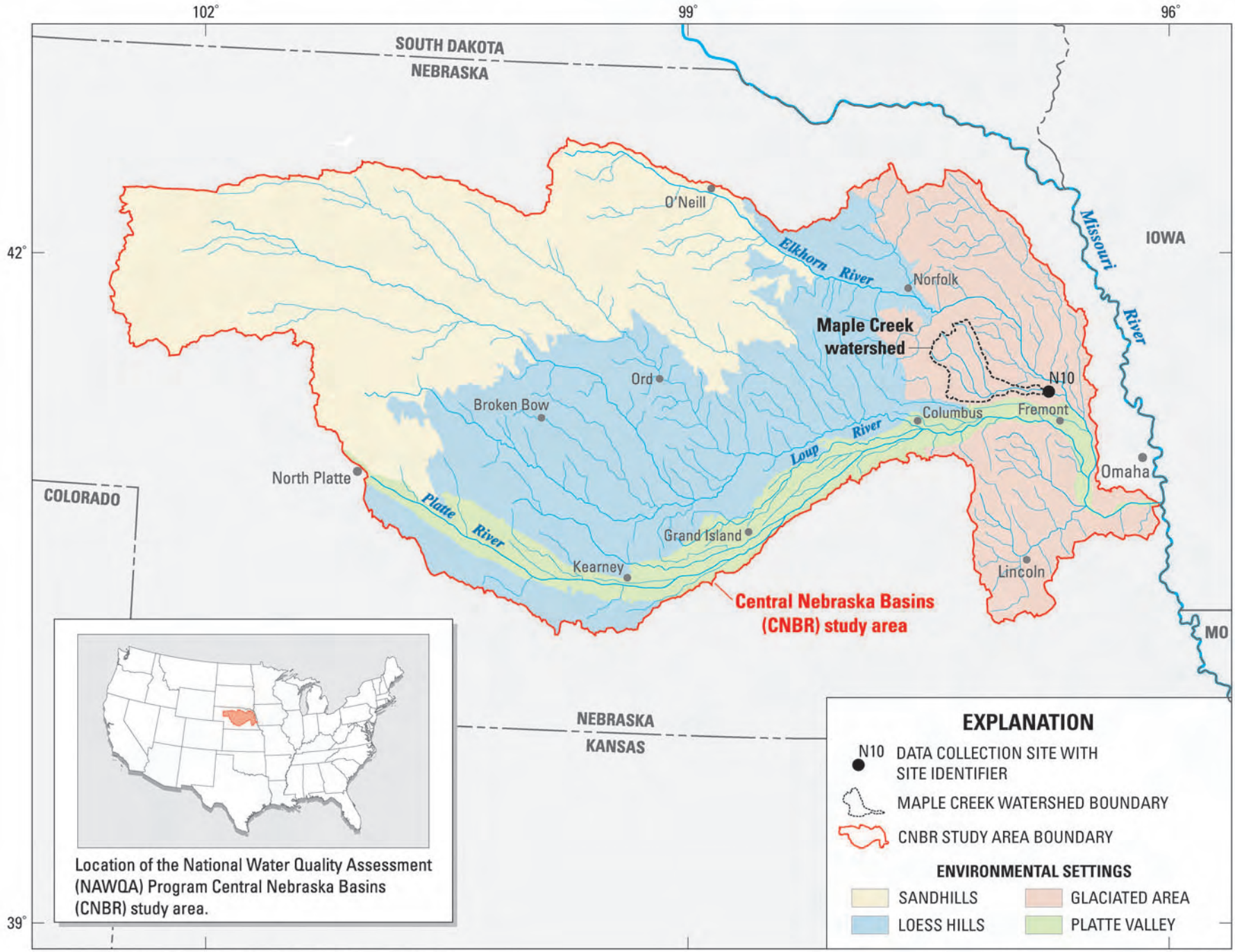
b. Map of the Maple River watershed with the un-named tributary (small watershed) outlined

c. Contour map of the un-named tributary (small watershed) and sampling locations

d. Map of the ground water-surface water interaction study area

e. Cross section of the ground-water flow system and unsaturated zone study area

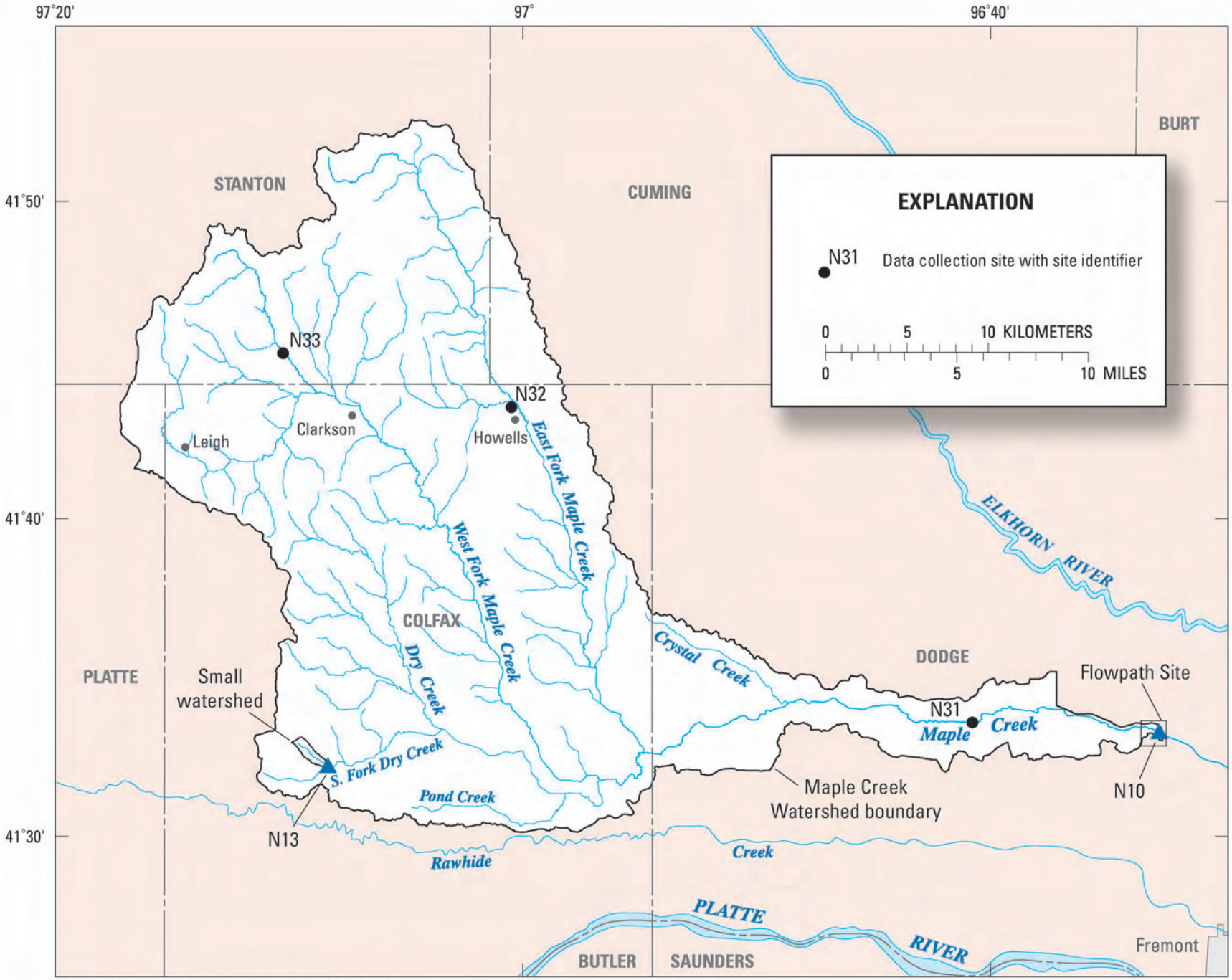
f. Planar view of the ground water-surface water interaction study area



Location of the National Water Quality Assessment (NAWQA) Program Central Nebraska Basins (CNBR) study area.

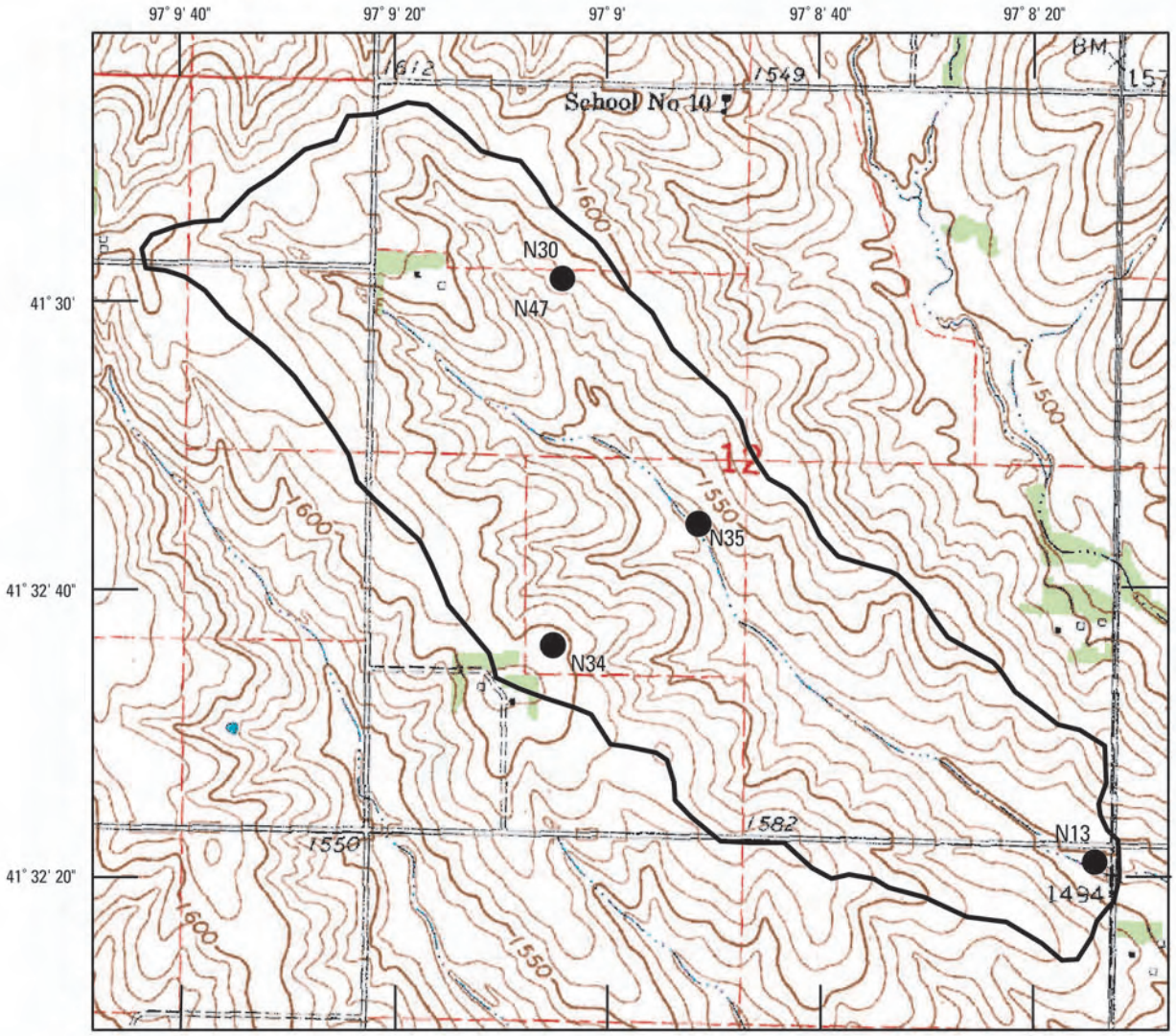
Base from U.S. Geological Survey digital data, 1:500,000, 1999, and 1:100,000, 1993
Albers Equal-Area Conic projection, Standard parellels 29°30' and 45°30'.

Figure 4.a



Base modified from U.S. Geological Survey digital data, 1:500,000, 1999
Albers Equal-Area projection, Standard parallels 29°30' and 45°30'

Figure 4.b



Base from U. S. Geological Survey Digital Raster Graphic
1:24,000 Clarkson SW, Nebraska Quad, 1966
Universal Transverse Mercator projection zone 14N
NAD 1927

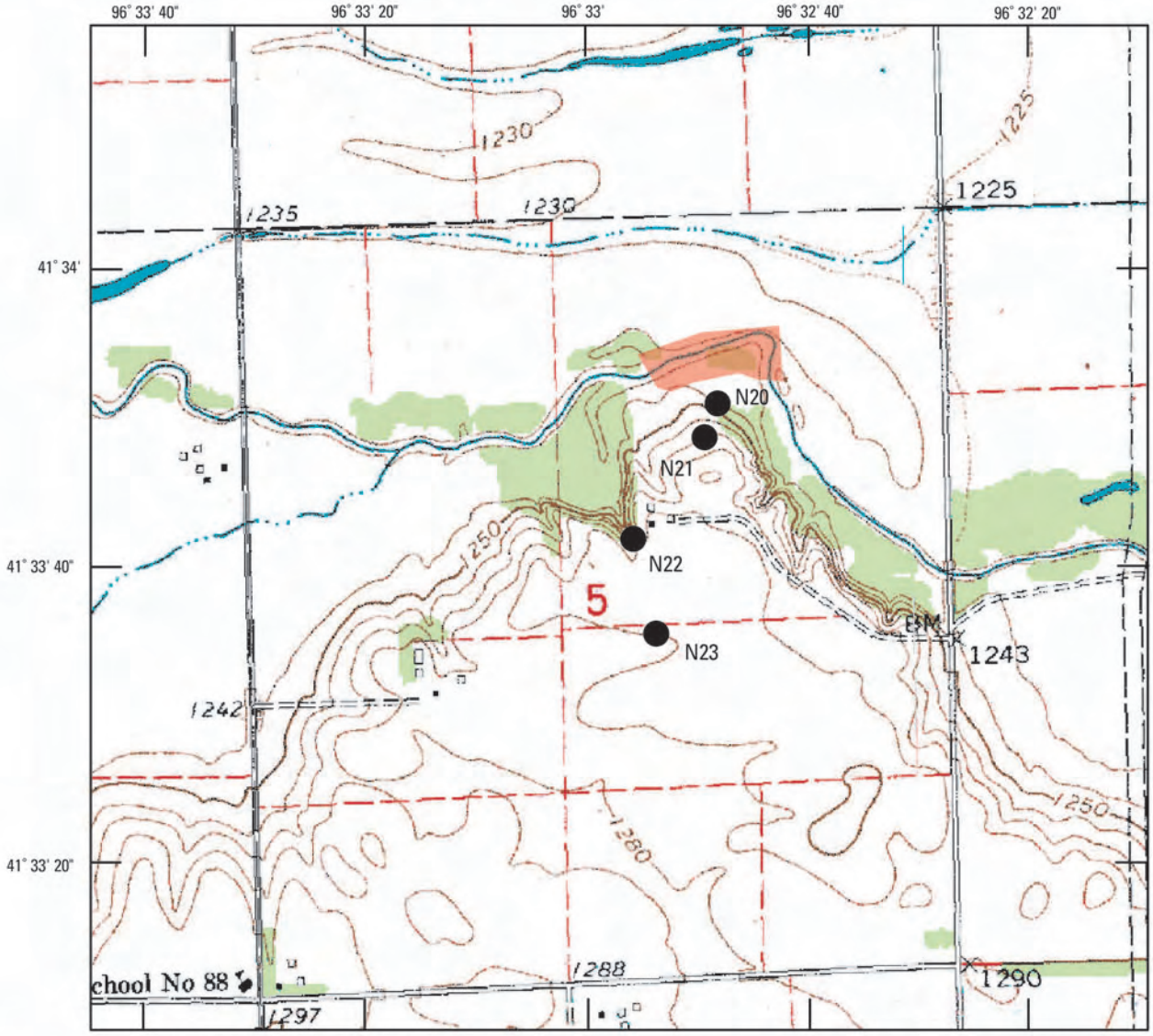
0 625 1,250 2,500 FEET

0 125 250 500 METERS

EXPLANATION

N34 Data collection site and site identifier

Figure 4.c



Base from U. S. Geological Survey Digital Raster Graphic
1:24,000 Hooper, Nebraska Quad, 1966
Universal Transverse Mercator projection zone 14N
NAD 1927

0 500 1,000 2,000 FEET

0 125 250 500 METERS

EXPLANATION

N34 Data collection site and site identifier

Ground-water surface-water interaction study site

Figure 4.d

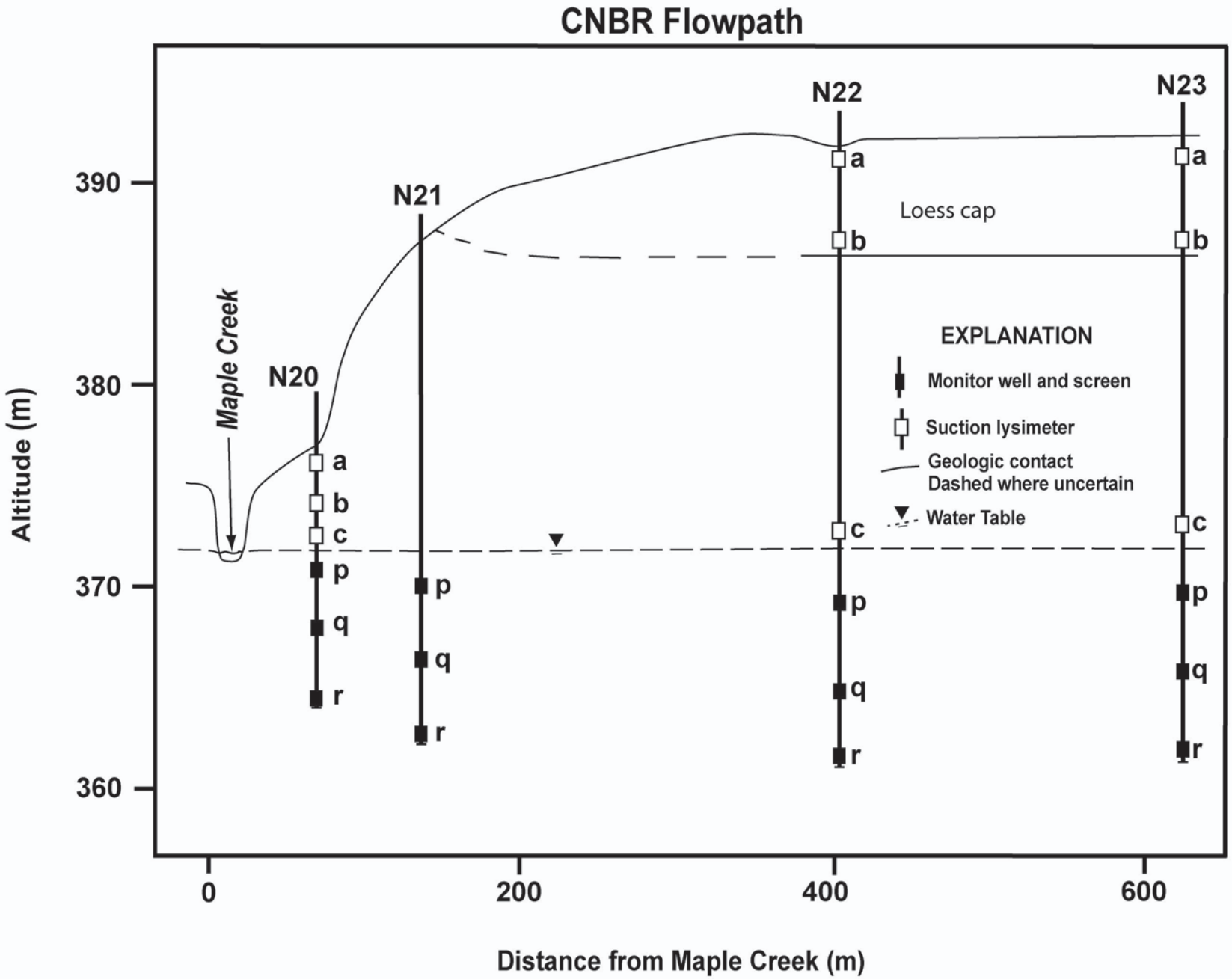

CNBR Flowpath
N20
N21
N22
N23
Maple Creek
Loess cap
a
b
c
p
q
r
EXPLANATION
Monitor well and screen
Suction lysimeter
Geologic contact
Dashed where uncertain
Water Table
390
380
370
360
Altitude (m)
0
200
400
600
Distance from Maple Creek (m)

Figure 4.e

CNBR Ground-water/Surface-water interaction study site, Maple Creek

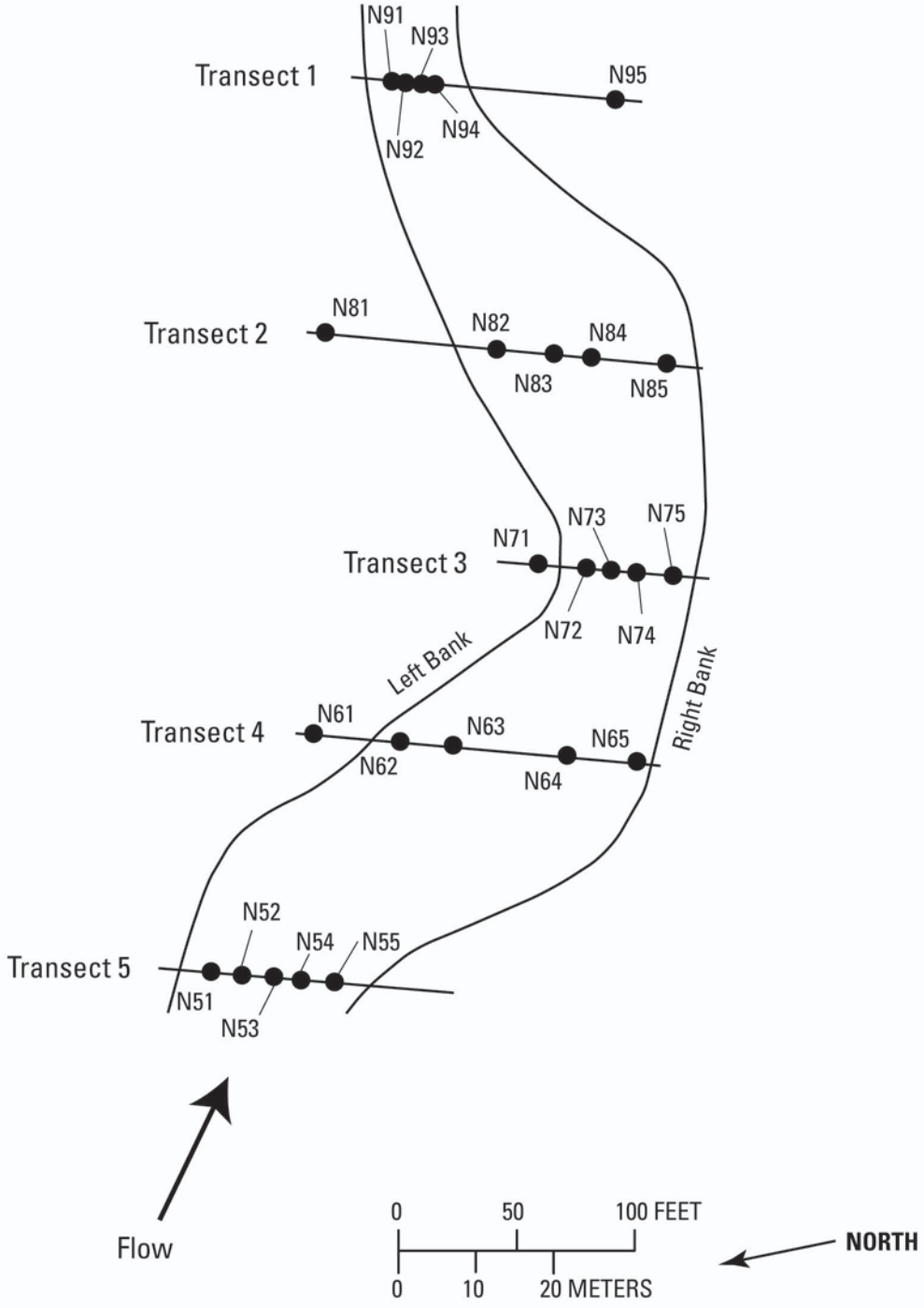


Figure 4.f

Figure 5 – Maps of the study sites in Washington

a. Location of the study area

b. Contour map of the DR2 watershed and sampling locations

c. Map of the ground water-surface water interaction study area

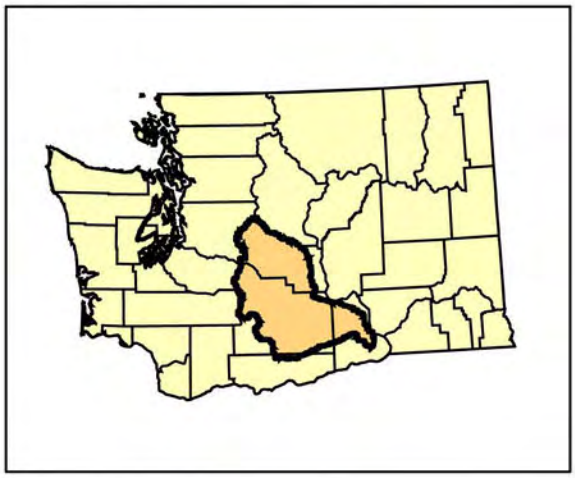
d. Cross section of the ground-water flow system and unsaturated zone study area

e. Planar view of the ground water-surface water interaction study area

U. S. Geological Survey Digitasl Data 1:100,000
Universal Transverse Mercator projection zone 10N
NAD 1927

0 25 50 MILES

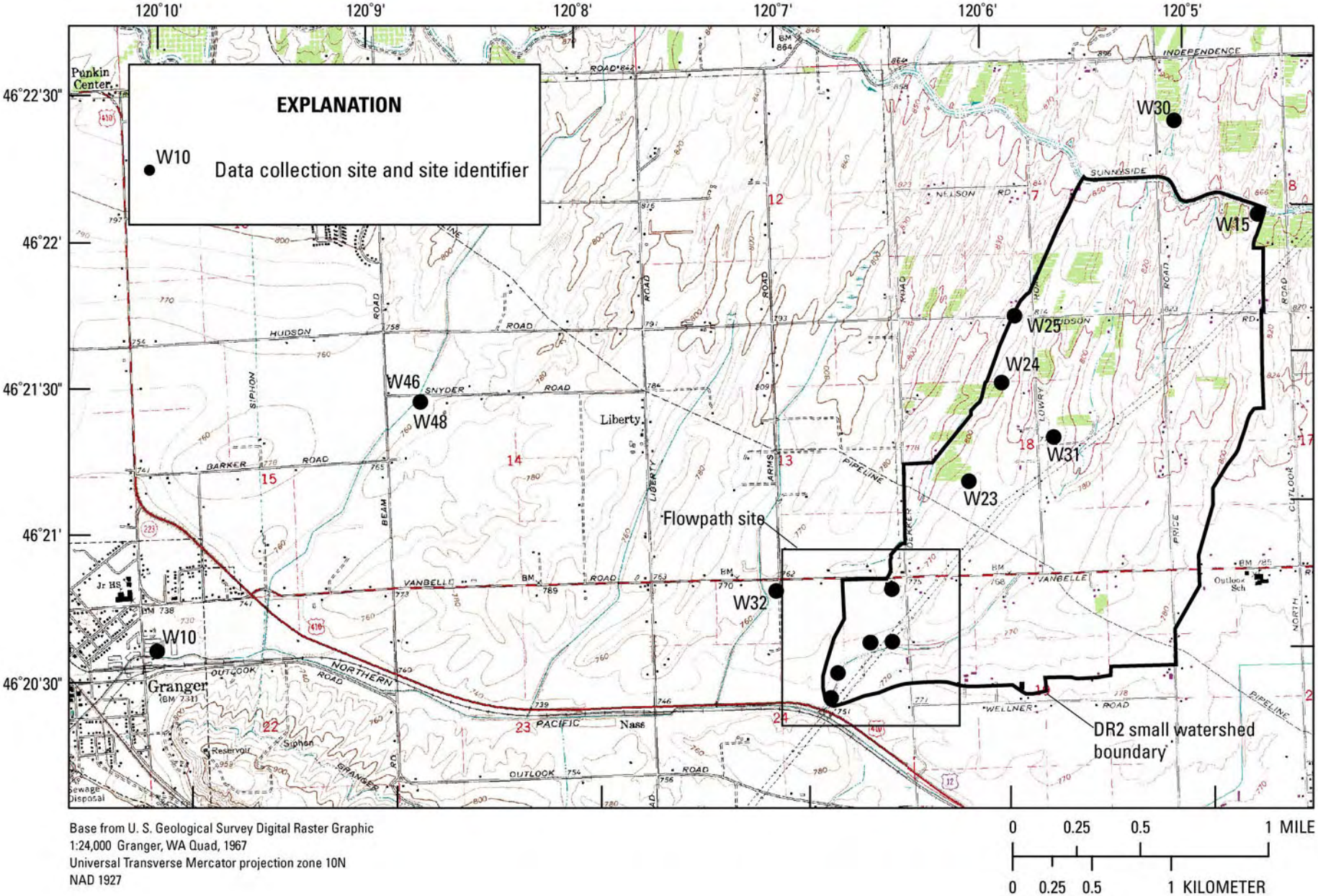
0 25 50 KILOMETERS



EXPLANATION

W10 Data collection site and site identifier

Figure 5.a

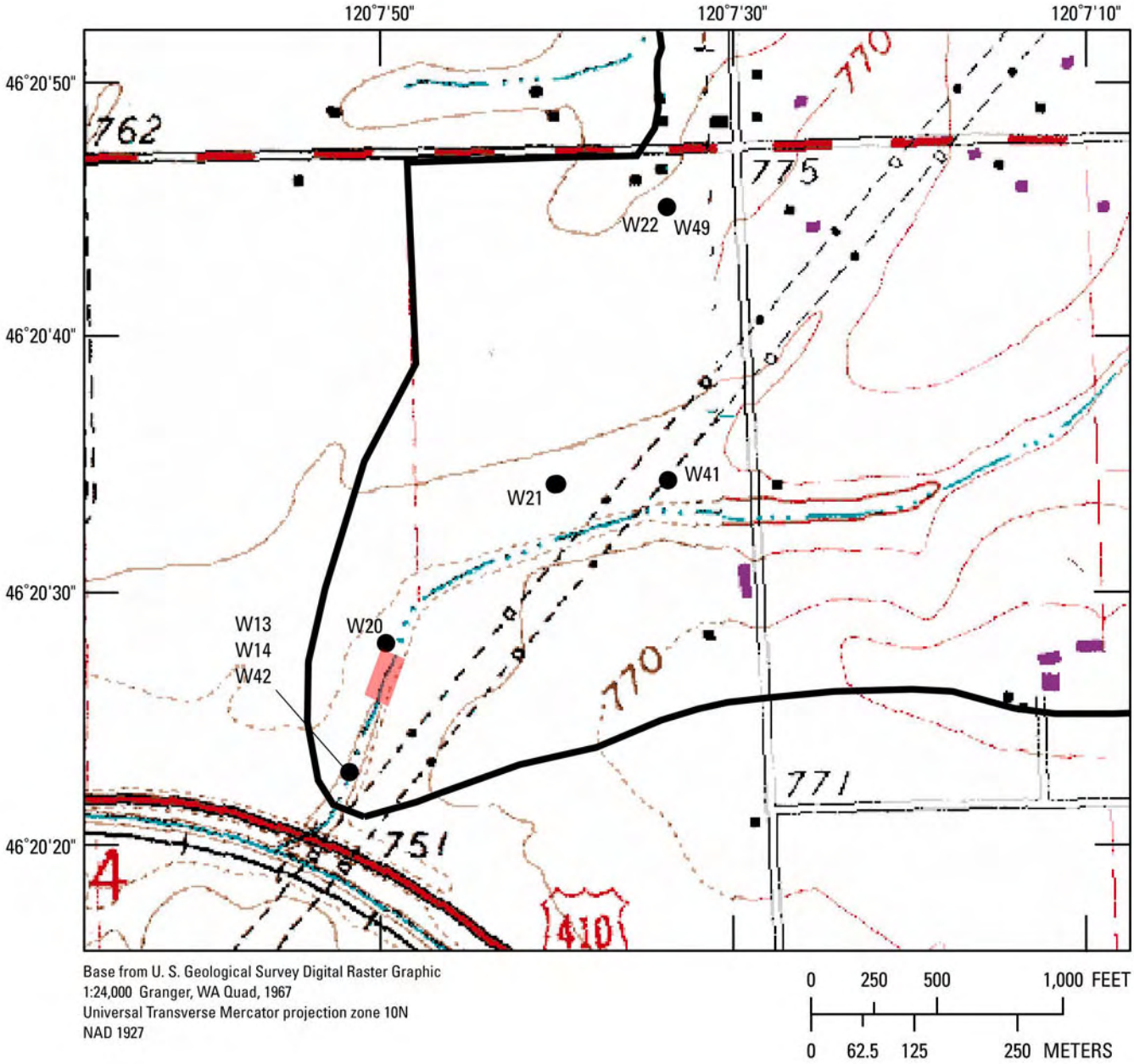


Base from U. S. Geological Survey Digital Raster Graphic
1:24,000 Granger, WA Quad, 1967
Universal Transverse Mercator projection zone 10N
NAD 1927

0 0.25 0.5 1 MILE

0 0.25 0.5 1 KILOMETER

Figure 5.b



EXPLANATION

W41 Data collection site and site identifier

Ground-water surface-water interaction study site

Figure 5.c

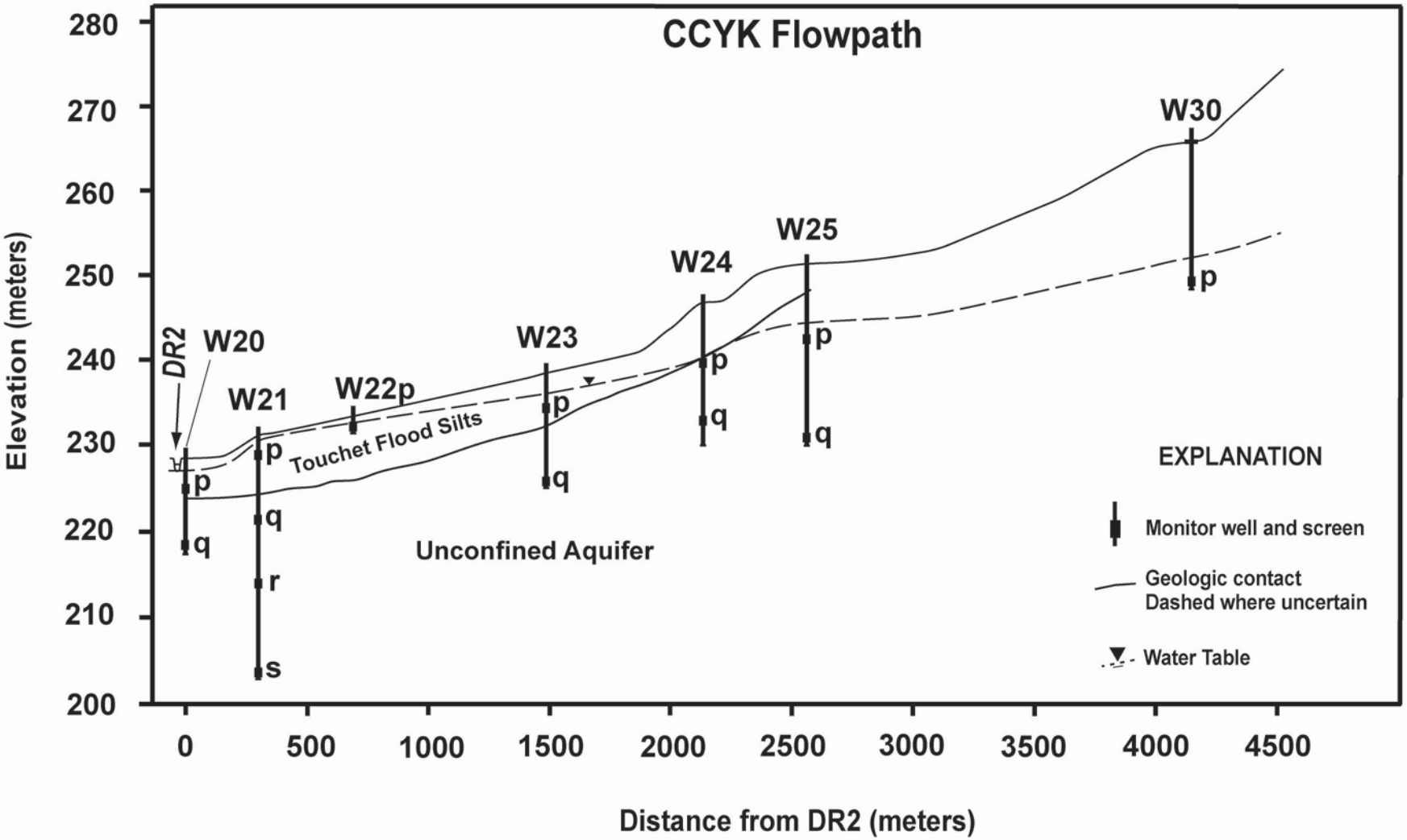

CCYK Flowpath
Elevation (meters)
Distance from DR2 (meters)
280
270
260
250
240
230
220
210
200
0
500
1000
1500
2000
2500
3000
3500
4000
4500
DR2
W20
W21
W22p
W23
W24
W25
W30
p
q
r
s
Touchet Flood Silts
Unconfined Aquifer
EXPLANATION
Monitor well and screen
Geologic contact
Dashed where uncertain
Water Table

Figure 5.d

CCYK Ground-water/Surface-water interaction study site, DR2

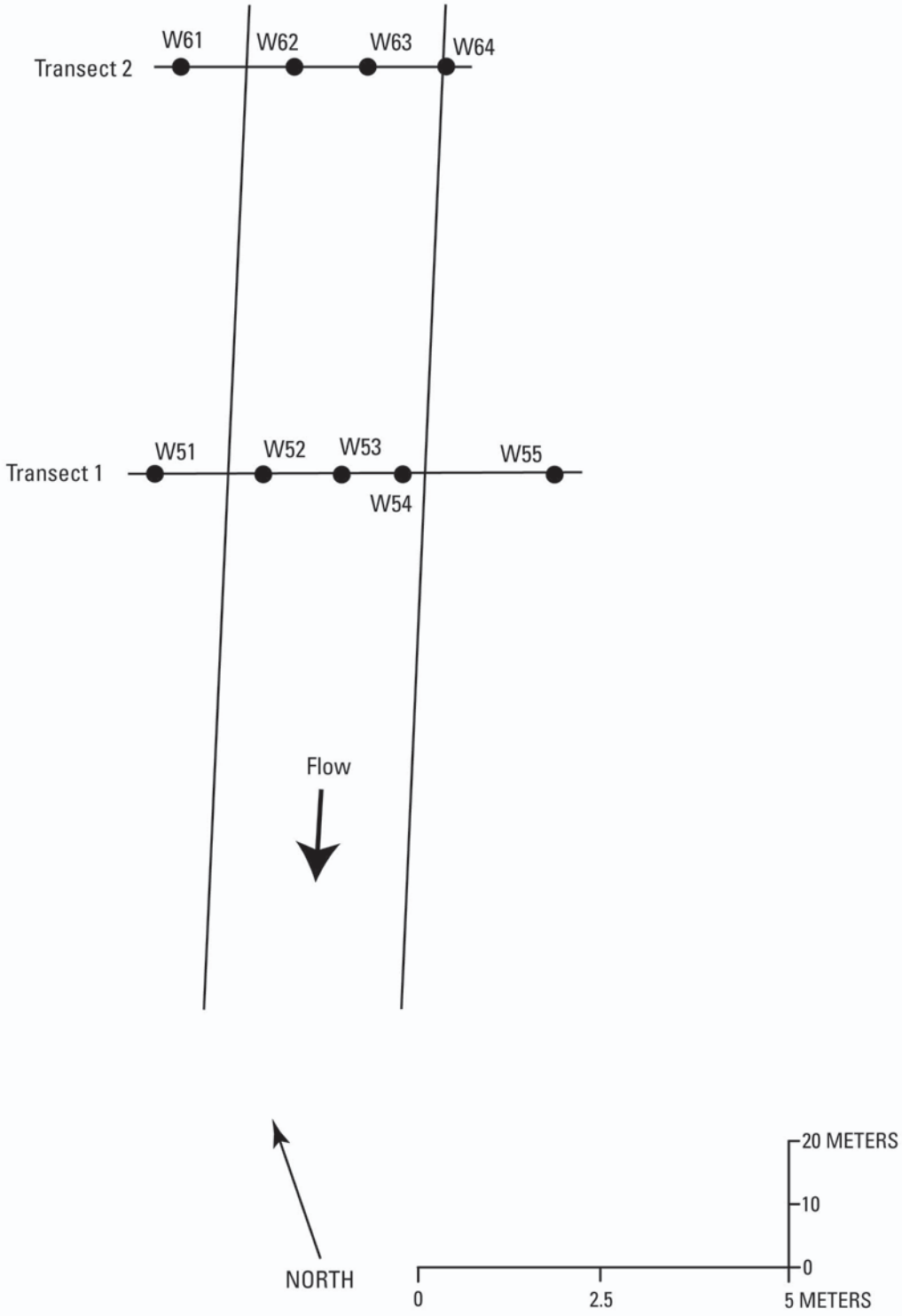


Figure 5.e

Figure 6 – Principal transformations of atrazine in the environment. The portion of the molecule that undergoes transformation is shown in red. The numbers in brackets refer to the original sources of information as follows: [1] Kaufman and Kearney, 1970; [2] Armstrong et al., 1967; [3] Beynon et al., 1972: [4] Kruger, et al., 1993; [5] Kruger et al., 1996; [6] Pelizzetti et al., 1990; [7] Hapeman-Somich, 1991.

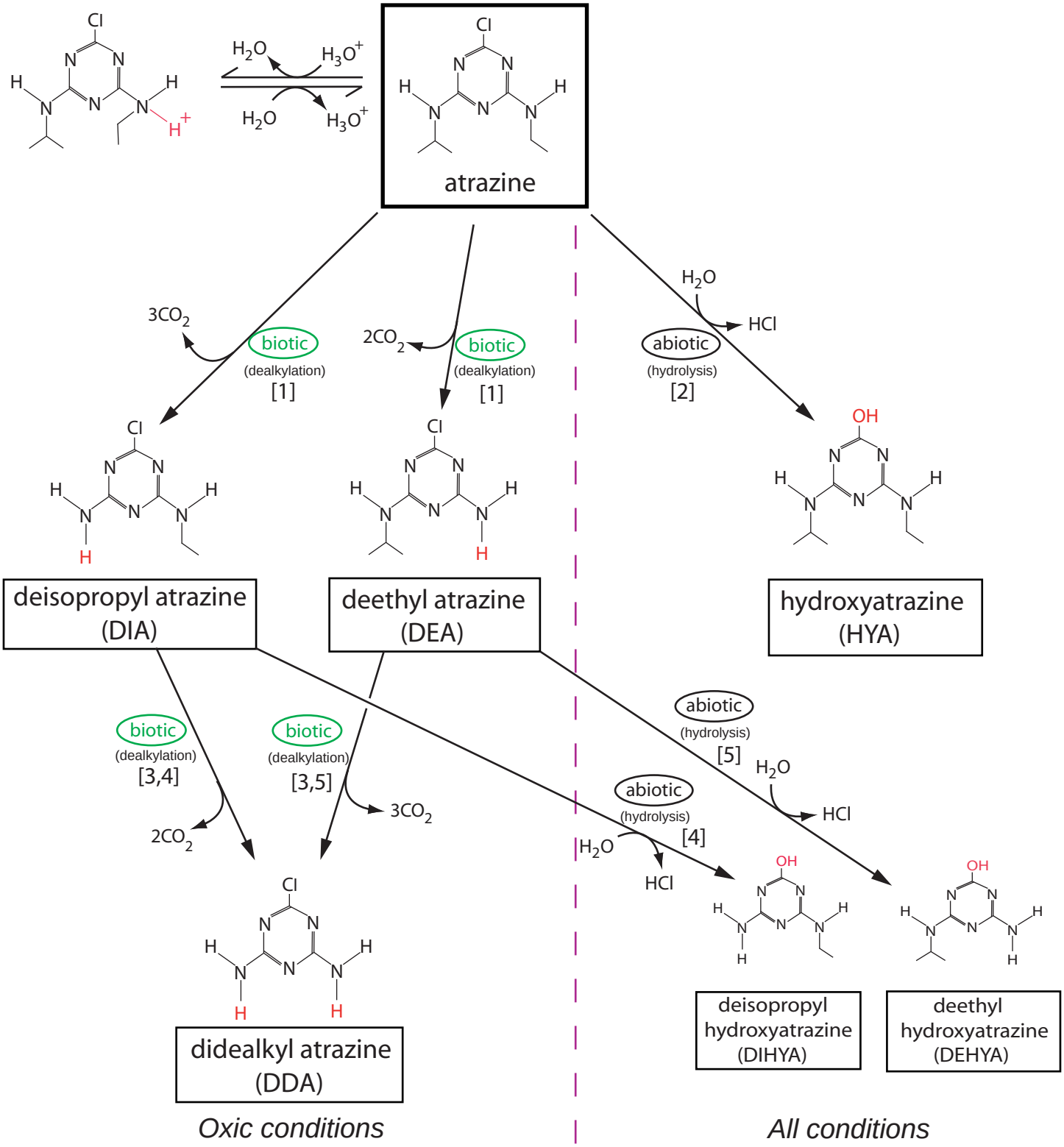

atrazine
H_2O
H_3O^+
H_2O
H_3O^+
H^+
biotic
(dealkylation)
[1]
$3CO_2$
biotic
(dealkylation)
[1]
$2CO_2$
abiotic
(hydrolysis)
[2]
H_2O
HCl
deisopropyl atrazine
(DIA)
deethyl atrazine
(DEA)
hydroxyatrazine
(HYA)
biotic
(dealkylation)
[3,4]
$2CO_2$
biotic
(dealkylation)
[3,5]
$3CO_2$
abiotic
(hydrolysis)
[4]
H_2O
HCl
abiotic
(hydrolysis)
[5]
H_2O
HCl
didealkyl atrazine
(DDA)
deisopropyl
hydroxyatrazine
(DIHYA)
deethyl
hydroxyatrazine
(DEHYA)
Oxic conditions
All conditions

Figure 6

Figure 7 – Principal transformations of metolachlor in the environment. The portion of the molecule that undergoes transformation is shown in red. The numbers in brackets refer to the original sources of information as follows: [1] Kochany, and Maguire, 1994; [2] Carlson, 2003; [3] Field and Thurman, 1996; [4] Graham et al., 1999; [5] Lee and Strahan, 2003. All of the transformation products shown have also been observed to be produced by photolysis [6,7].

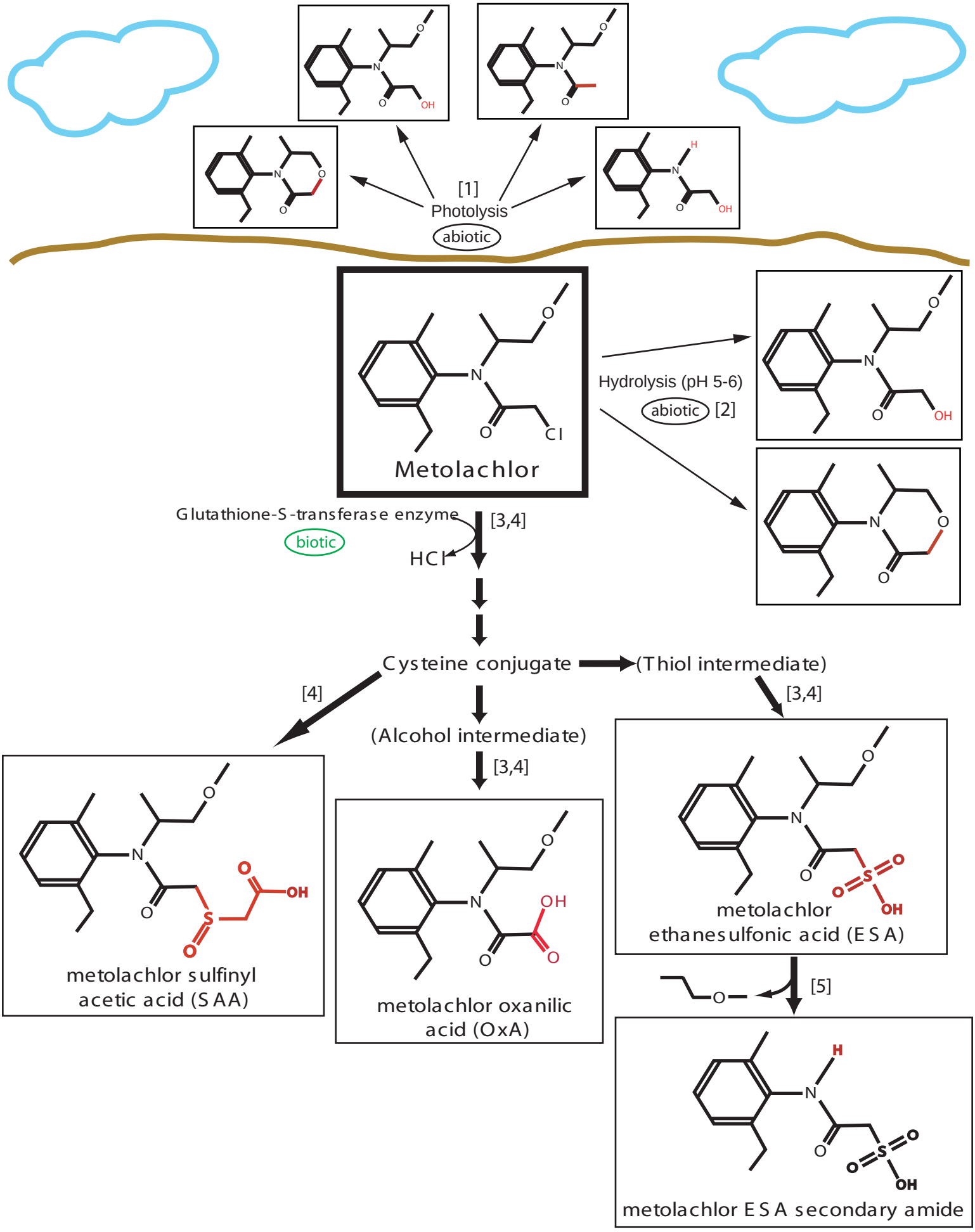

[1]
Photolysis
abiotic
Metolachlor
Hydrolysis (pH 5-6)
abiotic [2]
Glutathione-S-transferase enzyme
biotic
[3,4]
HCl
Cysteine conjugate
(Thiol intermediate)
[4]
[3,4]
(Alcohol intermediate)
[3,4]
metolachlor sulfinyl acetic acid (SAA)
metolachlor oxanilic acid (OxA)
metolachlor ethanesulfonic acid (ESA)
[5]
metolachlor ESA secondary amide

Figure 7

Figure 8 – Flowchart documenting the sequences of steps used for the computation of the octanol-water partition coefficient (K_{ow}) and the organic-carbon normalized solid-water distribution coefficient (K_{oc}). Encircled letters denote different possible sequences of steps for different circumstances, depending on data availability. The footnotes in Table 14 utilize these letters.

Procedures used to obtain values of K_{ow} and K_{oc}

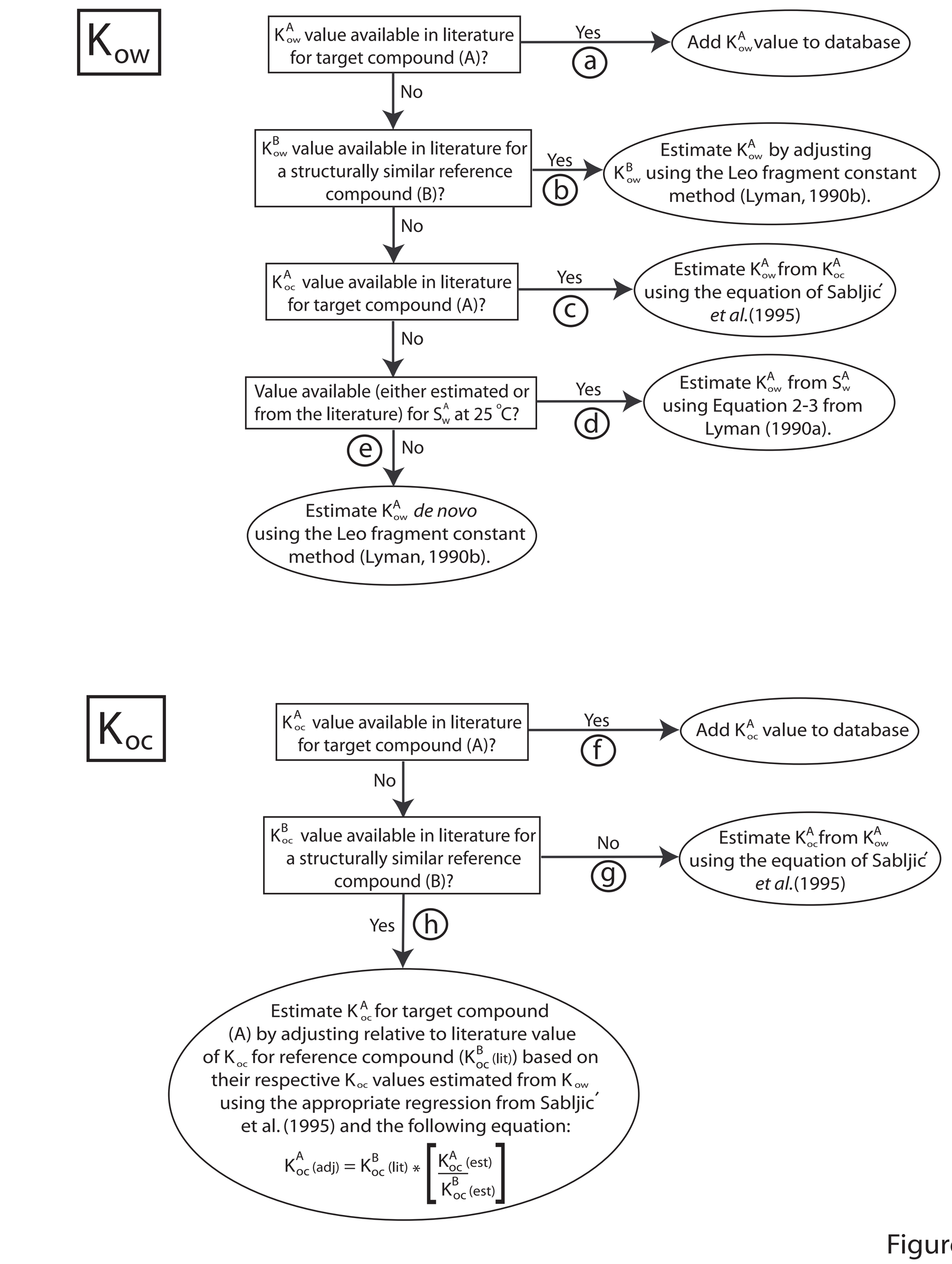


Figure 8

Figure 9 – Flowchart documenting the sequences of steps used for the computation of water solubility (S_w), vapor pressure (P_v) and Henry's Law constant (K_H). Encircled letters denote different possible sequences of steps for different circumstances, depending on data availability. The footnotes in Table 14 utilize these letters.

Procedures used to obtain values of K_H, P_V and S_W (25°C)

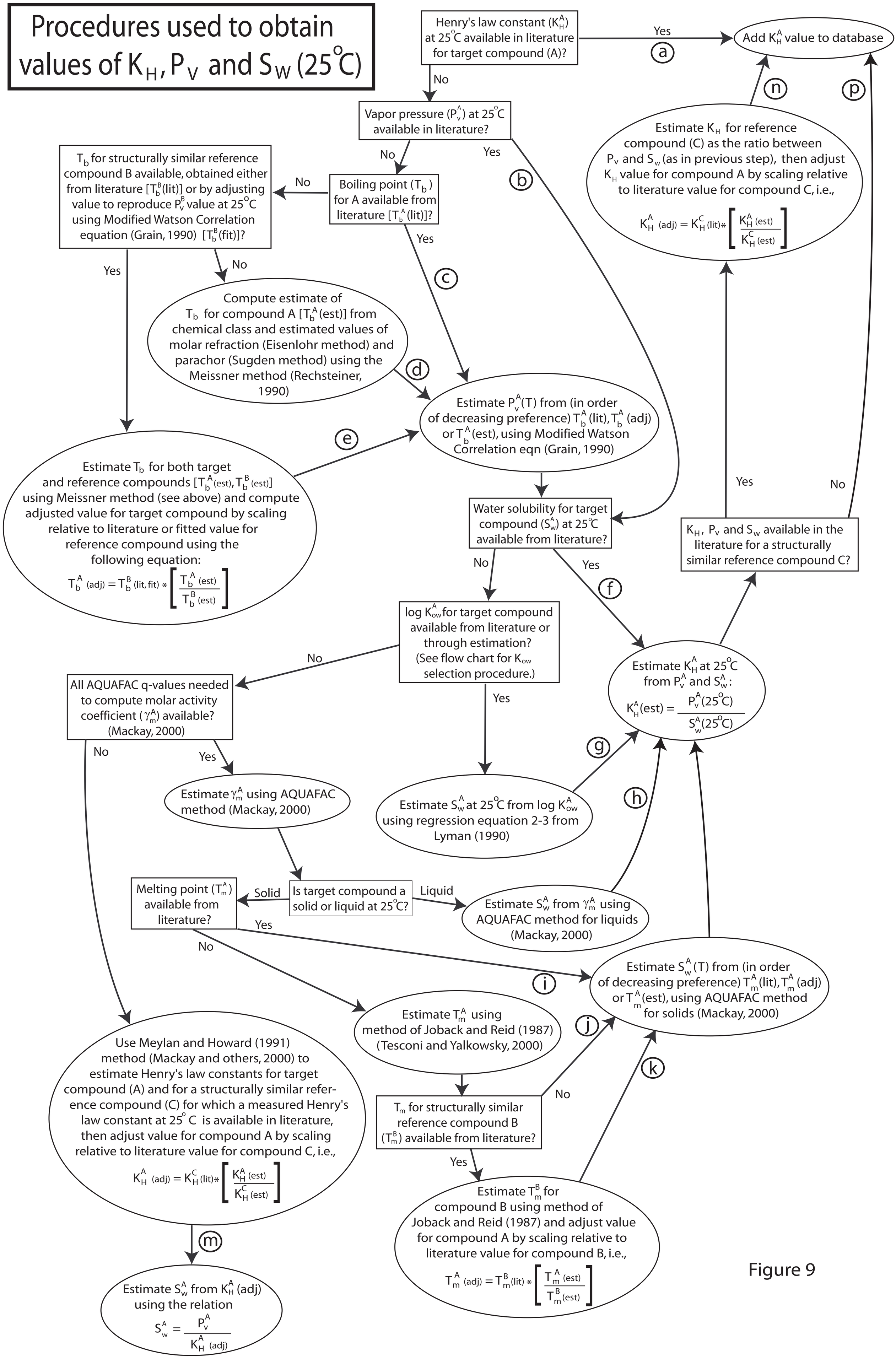


Figure 9