1.0 Watershed Management

1.1 Watersheds and Water Quality

A watershed is the land area that drains water to a common point such as a stream, river, lake, wetland, or ocean. Watersheds can be very small, such as part of a park that drains to the creek in your neighborhood. Many of these small watersheds combine to form much larger watersheds, such as major river basins that drain large portions of states, and in some cases, cover large portions of countries or continents. For example, several sub-watersheds make up Village Creek, which is itself part of the Trinity River basin (Figure 1-1).

No matter where you are on the Earth, you’re in a watershed. As runoff water from storms flows across the landscape, it picks up and carries sediment and various other substances as it flows to a waterway. This means that everything we do on the land has an effect on both water quality and quantity, and the cumulative effects of these actions can have an impact on the function and health of the watershed as a whole.

For a watershed management strategy to be truly effective, it must show a measureable effect on the quality of the water in the receiving waterbody. To accomplish this, the strategy must account for and examine the full scope of human activities and natural processes that occur within the watershed’s boundary. These activities and processes can be grouped into two categories, based on their origin:

Point source pollution is a discharge that can be traced back to a single point of origin. This can be a pipe, drain, or outfall and is typically discharged directly into a waterway. Because point sources are tied to human activity, they regularly contribute flow to a system regardless of the native flow conditions. In fact, point sources may constitute most or all of the baseflow in some systems, particularly in urban watersheds where large or regional wastewater treatment facilities (WWTFs) provide consistent effluent flows.

Point source pollution is regulated through a permitting process; in Texas this is administered through the Texas Commission on Environmental Quality (TCEQ). One example of a permitted discharge from a point source is effluent from WWTF. Here, the treated effluent must remain within specific pollutant limits so that the facility’s impact on the receiving waterbody is minimized. Other examples include malfunctions in wastewater infrastructure, such as a break in a wastewater pipeline, or a sanitary sewer overflow. These are unregulated point sources, and can have either acute (short-term) or chronic (long-term) effects on water quality.

Nonpoint source pollution, by contrast, tends to be more challenging to manage since it cannot be traced back to a single point of origin. Instead, pollutants that are dispersed over the land (either through human activity or natural processes) are carried into waterways with runoff from storm events. Several factors may influence the
types and amounts of pollutants that ultimately end up in a waterway, but they are primarily dependent on land use and land cover. Sources of pollutants may include excess agricultural or residential fertilizers, fluids from leaking vehicles, pet waste from yards or urban public areas, or waste from wildlife, livestock, and feral hogs in rural or undeveloped areas.

1.2 The Watershed Approach
Watershed boundaries are defined by physical geography and rarely, if ever, follow political boundaries. Watersheds often contain parts of many municipalities and counties, and may even cross state lines. This often makes it difficult for any one entity to approach and solve water quality concerns on their own. To address this constraint, many state resource agencies, in partnership with federal agencies, have adopted a watershed approach for managing water quality, which involves assessing the sources and impacts of water quality impairments at the watershed level. That information can then be used to develop and implement best management practices (BMPs) that are applicable throughout the entire watershed.

In Texas, the watershed approach is managed through the combined efforts of the TCEQ and the Texas State Soil & Water Conservation Board (TSSCWB). In addition to regulating point sources, TCEQ’s responsibilities typically focus on management programs targeting reductions in urban nonpoint source pollution. In contrast, TSSWC’s focus is geared toward management programs that seek to prevent or reduce agricultural and silvicultural (forestry) nonpoint source pollution.

Utilizing a watershed approach greatly improves the chances of identifying and evaluating all potential pollution sources to a waterway. A key component of the watershed approach is the input from stakeholders, who may be anyone that has an interest in the watershed. These stakeholders may offer unique insights and experiences gained from either working, living, or engaging in recreation in the watershed. These insights and experiences will supplement any water quality monitoring data taken from the watershed to help inform management decisions that are put into practice. As users of the watershed, stakeholders have a vested interest in the water quality, and will also be affected by the management decisions used to address water quality issues that are present throughout the watershed.

1.3 Watershed Protection Planning
To support stakeholders who wish to utilize this watershed approach, the U.S. Environmental Protection Agency (EPA) has developed a list of nine key elements necessary for developing a successful watershed protection plan (WPP) capable of addressing water quality issues. A WPP document outlines the coordinated efforts of all stakeholder groups as they plan to implement a prioritized set of water quality protection and restoration strategies. Details about these elements, as well as the WPP chapters they correspond to, are provided in Appendix A.

The intent of the Village Creek-Lake Arlington (VCLA) WPP is for stakeholders to implement these strategies through voluntary participation in pursuit of the environmental goals they set themselves. Public participation is a critical component throughout the process, as it will be up to stakeholders to select, design, and implement management strategies best suited for the watershed from the standpoints of economic feasibility, social acceptability, and scientific credibility. The success of the VCLA WPP (Plan) is dependent on the continued commitment of residents, landowners, businesses, and elected officials to act as good stewards of the natural resources of the watershed.

1.4 Adaptive Management
Over time, and as we learn more about the watershed, pollutant sources, and the effectiveness of the applied BMPs, stakeholders may see a need to modify the Plan to better address environmental goals. These changes will be implemented through an adaptive management approach. At its core, adaptive management is based on
modifying behaviors based on what was learned through past experiences. This approach is particularly useful for environmental science applications, where high levels of uncertainty are the norm (Stankey et al. 2005). Through continued monitoring, evaluation of BMPs, and incorporation of lessons learned along the way, a perpetually-evolving management strategy can be developed that will be responsive to both environmental and societal needs (USEPA 2000). This will provide stakeholders the flexibility to make multiple, and often iterative, decisions needed to address water quality-related environmental issues for years to come (Williams et al. 2009).
2.0 Watershed Overview

2.1 Regional History

2.1.1 Early Settlers

One of the earliest known records of human civilization in Texas, and perhaps the entire continental U.S., comes from a site in the nearby community of Lewisville, in Denton County, which was found during excavation during the construction of the Lewisville Lake dam. Relics from the site, consisting of several hearths and spear points, are often associated with other cultural relics from what is known as the Llano complex, which has been dated to about 12,000 years ago. More recent records from written accounts cite the Wichita subgroup of the Caddo culture as the most notable inhabitants of much of the North Texas area between the Red River and the headwaters of the Trinity. Originating somewhere in Kansas, the Wichita were driven south by the Osage and the Comanche during the 17th century. By the mid-1700s, they had garnered an alliance with local Comanches and established several substantial villages and a trading center on the Red River. Unlike many of their counterparts that became more nomadic after the introduction of the horse, the Wichita remained more sedentary and were known for their gardening. They harvested beans, maize, plums and pumpkins, which were regularly stored in appreciable quantities. They were often known to raise substantial cattle herds as well. (Newcomb 1961).

2.1.2 Western Expansion

As early European exploration gave way to Western expansion throughout Texas, the present DFW Metroplex became a hotbed for conflict. This was spurred by settlers and military detachments traveling down from the Red River in search of new territory in the Trinity headwaters as they crossed paths with the indigenous peoples of the Village Creek area as early as the 1830s. In 1838, General Thomas J. Rusk took 450 men into what is present day Lake Arlington, only to find a deserted Kickapoo village, which was promptly burned (Figure 2-1). In early May of 1841, in response to several accounts of attacks by natives on settler families in his district, General Edward H. Tarrant returned to the area with nearly 70 volunteers from the Red River counties and gathered at Fort Johnson, near present-day Bonham. On May 24, working on information from one

Figure 2-1. Maps of important historical sites and events in the Arlington area.

Source: Joyner 1976.
captured native, Tarrant and his men overtook a small outskirt village. A string of other villages was in immediate sight, with the largest close by. The large camp offered no resistance, and it was later learned that the men from this and other nearby camps had departed for a buffalo hunt. Tarrant’s men decided to use this to their advantage, and sent out scouting parties to several other villages. Captain John B. Denton led one such party, which was ambushed by an armed camp. Several men were wounded, Captain Denton was killed, and the scouting party retreated back to Tarrant’s main expedition force.

With his men demoralized, and with the prospect of 70 volunteers facing as many as 1000 warriors from the combined camps, Tarrant thought it best to retreat. He returned with a larger force in July, only to find that the camps had been largely abandoned. With his men starving due to a loss of their beef stock from disease, Tarrant decided it best to return to the Red River. At the time, Tarrant and his men viewed the skirmish as little more than the plundering of several villages, but in truth the minor skirmish proved to be quite a decisive victory for the settlers, as it convinced the tribes present in the Village Creek area to abandon their villages and move further south and west, into the lower Trinity and Brazos River basins (Joyner 1976, Moore 2007, Sanders 1973).

This proved to be the major event that opened up the area for large-scale occupation by settlers. Bird’s Fort, first erected in 1840, was the site of the first planned trading post, but it failed after many deaths and denial of military relief forced Bird’s party to return to their homes further north. Marrow Bone Spring came later in 1843 after Tarrant’s expedition, and became a successful trading post and meeting grounds (Figure 2-1). By 1876, several stores had been erected around Johnson Station, the local post office. However, when the train line connecting Dallas to Fort Worth was erected to the north, both the Station and its associated stores migrated to the area near the rail lines. To avoid confusion, the new location was named Hayter Station, but in 1877 it was renamed Arlington, after Robert E. Lee’s hometown in Virginia. (Joyner 1976).

Due to Tarrant’s efforts, settlements in the southern extent of the watershed also began to grow. European settlers began to farm near the Deer Creek area around 1848, near present-day Crowley. A local post office was established in 1882, and the first railroad depot appeared soon after in 1885 (Burke 1879, Massengill 1936). Around the same time in 1881, the settlement of Burleson began as a rail depot, which soon brought several stores, churches, and eventually schools (BHC 1981). Ranching, dairy farming, the railroad, and associated ancillary businesses were the prominent economic drivers in the area (Burke 1879).

By 1884, Arlington had officially become a town and had an estimated population of 800 with a handful of established churches. By 1890, there were 18 recorded businesses, several of which were stores. At its beginnings, Arlington was reported to have had as many as five cotton gins, which proved to be the major source of agricultural revenue early on. Hay, oats, corn, peanuts, potatoes, sorghum, and other produce items were also prevalent, as were dairy cattle and other livestock. From this production grew a distribution center, and thus Arlington became a functional link in shipment to neighboring towns. Another popular export was the mineral water from a well near the town’s center that was dug in 1891. The mineral water it yielded was bottled and sold, while the crystals it produced were sold for medicinal purposes. A sanitarium was also built nearby that utilized the water for treating various illnesses. (Joyner 1976, Sanders 1973, Schmelzer 1985).

### 2.1.3 Into the 20th Century

By 1910, the citizens of Arlington had an electric plant, a water system, natural gas lines, telephones, and a public school system. The electric plant, located in the footprint of the historic Handley neighborhood, began generating power in 1902. Successive iterations of power supply plants were constructed at this same site, continuing with the natural gas plant of present-day operated by Excelon. To cool this initial plant, a small creek was dammed to create Lake Erie. This became a popular tourist attraction for residents of the area after a trolley park was built, where many other attractions quickly sprang up. In addition to a holiday resort (Figure 2-2), the
area was home to several restaurants, an amusement ride, a roller skate rink, and a dance hall. In 1925 the number of residents was estimated at 3,031. Arlington Downs, a greyhound racetrack built in 1933, drew thousands of gamblers from all across Texas, until pari-mutuel betting was declared illegal in Texas in 1937. This, coupled with a fire that severely damaged the main pavilion of the resort and the eventual closing of the trolley line in 1934, led to an economic downturn in the immediate area.

By World War II, the population of Arlington had grown to 4,240. Post-war expansion in the area included a General Motors assembly plant that opened in 1951, along with the creation of the Great Southwest Industrial District in 1956. This business boom attracted many new residents, and by 1961 the population was estimated at around 45,000, with 1978 figures pegging the estimate closer to 122,200. (Joyner 1976, Sanders 1973, Schmelzer 1985).

To meet the drinking water needs of the growing populating, construction on Lake Arlington began in 1956, near the end of the most severe drought of record to hit Texas. Luckily, construction of the reservoir was completed in time to catch heavy rains in April and May of 1957 that totaled nearly 25 inches and filled the lake almost instantly, while simultaneously reducing the risk of catastrophic floods to residents downstream in communities near the West Fork Trinity. Completion of the lake attracted all manner of new development for residential and recreational purposes in the late 1950s and 1960s. Several new subdivisions were built, along with a boat and country club that included a golf course, Olympic pools, tennis courts, picnic areas, and boat launches (Figure 2-3).

Burleson did not experience the same population boom in the first half of the century, even briefly going into a decline before rebounding in the 1940s. Only then did the population boom finally hit, until Burleson sustained such growth that it eventually became a suburb of Fort Worth. As the community began to rely less on agriculture, the 30 businesses present in the 1930s grew to 62 by the 60s, including seven manufacturers, three feed companies, and a brass manufacturer. (BHC 1981).
2.1.4 Modern Development

By 1988, Arlington had an estimated 213,832 residents and 4,105 businesses. By 1990, the former Arlington College had evolved into the present-day University of Texas at Arlington (UTA). UTA is accompanied by nearby Arlington Baptist College as Arlington’s two schools of higher learning. Additional recreational, social, and cultural facilities have been constructed around the lake, including many public parks, several public swimming pools, public and private golf courses, tennis courts, auditoriums, libraries, theaters, youth centers, seniors’ facilities, and a community center. The lake’s importance as a drinking water source was further solidified with the opening of several recreational attractions from the 1960s onward, including two amusement parks and stadiums for major and minor league sports teams. Restaurants, hotels, motels, and many retail businesses have since moved to the area to take advantage of these tourist attractions that exist in close proximity and constitute a recreational hub for the Metroplex (Shannon 2010). Latest estimates place the population at nearly 379,577 as of 2013.

Southern population centers also experienced immense growth during this time, which tracked with the expansion of business and trade in the area. By the 2000s, Burleson had grown to 20,976 residents, with Crowley reporting 7,467, and Joshua reporting 4,250. Manufacturing in the area includes glass production, aluminum products, and leather goods, as well as boat trailer, mobile home, camper top, and metal building fabrication (Maxwell 2010a, Maxwell 2010b, Yockstick and Futch 2010).

2.2 Geography

The Village Creek-Lake Arlington watershed extends approximately 28 river miles from its headwaters near the City of Joshua in Johnson County to the Lake Arlington dam in Tarrant County. Population centers in the watershed include 10 municipalities and one census-designated place (CDP) (Table 2-1). Elevations in the watershed range from 1,065 ft above mean sea level (MSL) at Caddo Peak in the headwaters of Willow Creek.
west of Joshua in Johnson County, down to 550 ft above MSL at the normal conservation pool elevation of Lake Arlington.

Table 2-1. Population centers in the VCLA watershed.

<table>
<thead>
<tr>
<th>Name</th>
<th>2015 Population Estimate</th>
<th>% of City Limit in Watershed</th>
<th>Population in Watershed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arlington</td>
<td>388,125</td>
<td>3.61%c</td>
<td>14,024</td>
</tr>
<tr>
<td>Briaroaks</td>
<td>496</td>
<td>100.00%</td>
<td>496</td>
</tr>
<tr>
<td>Burleson</td>
<td>43,625</td>
<td>89.16%</td>
<td>38,894</td>
</tr>
<tr>
<td>Cross Timber</td>
<td>275</td>
<td>100.00%</td>
<td>275</td>
</tr>
<tr>
<td>Crowley</td>
<td>14,853</td>
<td>100.00%</td>
<td>14,853</td>
</tr>
<tr>
<td>Everman</td>
<td>6,352</td>
<td>100.00%</td>
<td>6,352</td>
</tr>
<tr>
<td>Forest Hill</td>
<td>12,881</td>
<td>99.95%</td>
<td>12,874</td>
</tr>
<tr>
<td>Fort Worth</td>
<td>833,319</td>
<td>10.42%</td>
<td>86,856</td>
</tr>
<tr>
<td>Joshua</td>
<td>6,066</td>
<td>49.28%</td>
<td>2,989</td>
</tr>
<tr>
<td>Kennedale</td>
<td>7,715</td>
<td>84.08%</td>
<td>6,487</td>
</tr>
<tr>
<td>Rendon CDP</td>
<td>13,577d</td>
<td>48.29%</td>
<td>6,556</td>
</tr>
</tbody>
</table>

(a) U.S. Census Bureau estimate based on 2010 census projections.
(b) Calculated using TXDOT 2015 municipal boundary dataset.
(c) Does not include the percentage of Arlington's city limits that lie within Lake Arlington's footprint.
(d) Based on the 2010 population and average 2010-2015 projected population increases for nearby municipalities.

The watershed consists of only two TCEQ-monitored segments, Lake Arlington (0828), a classified segment, and Village Creek (0828A), an unclassified segment. The entire drainage area behind the Lake Arlington dam consists of approximately 143 mi², or 91,402 ac. The VCLA watershed is composed of a series of smaller watersheds that are defined by 12-digit hydrologic unit codes (HUC). These smaller HUCs then combine to form larger HUCs that are defined by 10, 8, 6, or 4 digits. For example, the VCLA watershed is actually composed of several subunits of the Village Creek watershed (10-digit hydrologic unit code (HUC): 1203010204). This is part of the Lower West Fork Trinity subbasin (HUC 12030102) which is part of the Upper Trinity River basin (HUC 120301) and the Trinity River subregion (HUC 1203) (Figure 2-4).

While Lake Arlington receives the majority of its natural flow from Village Creek, it will occasionally receive storm flows from other smaller tributaries along its perimeter. Wildcat Branch and Prairie Dog Creek are the largest tributaries on the west side of the lake, but both they and the majority of the other direct lake tributaries are largely ephemeral in nature, aside from a few smaller tributaries on the east side that drain housing subdivisions where runoff from yard irrigation provides steady baseflow.

Village Creek itself is fed by several named tributaries, with Winding Creek, Kennedale Creek, and Elm Branch draining the area in the vicinity of Kennedale. Deer Creek drains Crowley and parts of northern Burleson, while Booger Creek, Shannon Creek, and Willow Creek drain the western portion of Burleson around IH-35. To the east, Quil Miller Creek drains a large rural area containing eastern Burleson, along with the towns of Briaroaks and Cross Timber.
2.3 Geology and Soils
The Village Creek-Lake Arlington watershed is largely located within the Grand Prairie physiographic province according to the Physiographic Map of Texas (Bureau of Economic Geology 1996). The majority of the watershed is underlain by units from the Washita and Woodbine groups, with some fluviatile terrace deposits and alluvial floodplain deposits in areas underlying Lake Arlington and Village Creek. Soils in the vicinity of the lake are composed mainly of fine sandy loams, with silty clays near the transitional zone within Village Creek. Some of the more common upland soil groups in the watershed include Crosstell fine sandy loams, Sanger clays, Crosstell-Urban land complex, and Ponder clay loam. Several hydric soils occupy the bottom land areas of the watershed, with Frio silty clays, Puleexas fine sandy loam, and Hassee fine sandy loam being most common (USDA 2015a, USDA 2015b). For a more comprehensive list of soils in the watershed, visit the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Soils Surveys developed for Johnson and Tarrant counties available online at: https://websoilsurvey.sc.egov.usda.gov/.

2.4 Land Use and Land Cover
The downstream portions of the subwatershed surrounding the lake are urbanized, while the upstream portions of the subwatershed have remained generally rural with some pastureland and row-crop agriculture. Major population centers include the City of Burleson and the communities of the southwest DFW Metroplex, which includes portions of Fort Worth and Arlington. These population centers compose the majority of the developed land in the area, shown as red areas in Figure 2-5. Land use within the watershed from 2013, based on data collected by the North Central Texas Council of Governments (NCTCOG), is depicted in Figure 2-6, which relates a use category (residential, industrial, undeveloped, etc.) to the land cover information. The urban centers previously mentioned are characterized by a high percentage of single family homes, but a significant percentage of industrial complexes are shown to exist immediately south and west of the lake. Outside of these urbanized areas, ranch land is dominant, with pockets of farm land and undeveloped open lots being typical.
Figure 2-5. 2012 NLCD land cover classes in the Village Creek-Lake Arlington watershed.

Data source: Multi-Resolution Land Characteristics Consortium; Basemap: ESRI World Imagery.
Figure 2-6. 2013 NCTCOG land use classifications in the Village Creek-Lake Arlington watershed.
2.5 Ecology

The watershed is wholly situated within the Cross Timbers ecoregion. All of segment 0828 is located in the Eastern Cross Timbers ecoregion (29b). Here, post oak (Quercus stellata) and blackjack oak (Q. marilandica) are common overstory trees, with minor representation from species like black hickory (Carya texana), plateau live oak (Quercus fusiformis), eastern redbedar (Juniperus virginiana), and various sumac species (Rhus spp.). Native grasses such as bluestem (Schizachyrium spp.), yellow Indiangrass (Sorghastrum nutans), and tall dropseed (Sporobolus asper) are represented in the understory and within prairie inclusions. In disturbed areas, honey mesquite (Prosopis glandulosa) and prickly pear (Opuntia spp.) are common.

The majority of segment 0828A also falls within 29b, but the western portion of the watershed, including several smaller tributaries, is encompassed within the Grand Prairie ecoregion (29d). The upland area is dominated by tallgrass prairie species. In undisturbed areas, this includes big bluestem (Andropogon gerardii), yellow Indiangrass, little bluestem (Schizachyrium scoparium), sideoats grama (Bouteloua curtipendula), and Texas cupgrass (Eriochloa sericea). However, the occurrence of buffalograss (Buchloe dactyloides), Texas wintergrass (Stipa leucotricha), and grama (Bouteloua spp.) tends to increase with overgrazing and disturbance. In riparian bands, woody species such as elm (Ulmus spp.), pecan (Carya illinoensis), and hackberry (Celtis spp.) are common. With the onset of European settlement, brush/fire control, and urbanization, invasive species such as Ashe juniper (Juniperus ashei) and honey mesquite are now also common (Griffith 2007).

Although no instances of critical habitat occur within the watershed for any federally-listed threatened and endangered species, a review of data from the U.S. Fish and Wildlife Service (FWS) and Texas Parks and Wildlife Department (TPWD) data indicated the possible presence of several threatened and endangered species that may occur intermittently throughout the watershed. Of note were several endangered or threatened avian species, including the Black-capped Vireo (Vireo atricapilla), Golden-cheeked Warbler (Dendroica chrysoparia), Least Tern (Sterna antillarum), and Whooping Crane (Grus americana). The list also included one species of clam, the Texas Fawnsfoot (Truncilla macrodon), which is currently listed as a Candidate species.

Additional avian and mollusk species appear within the state list produced by the TPWD. These county-level species lists also includes several fish, mammal, reptilian, and plant species, which are not present in Federal lists (TPWD 2016a, TPWD 2016b).

2.6 Fish and Macroinvertebrate Communities

2.6.1 Lake Arlington

Due to its relatively urban locale, Lake Arlington has long been a popular venue for sport and recreational fishing for south-central portions of the Metroplex. As such, populations of Largemouth Bass, White Crappie, and Channel Catfish are managed by the Texas Parks & Wildlife Department (TPWD). In particular, Lake Arlington is a popular destination for Channel Catfish, and regularly boasts the highest catch rates amongst all the lakes within its district. Largemouth Bass are also very popular and are stocked frequently, with the latest occurrence in 2016. However, stocking of hybrid striped bass (Palmetto Bass) was discontinued in 2003.

Prey species include abundant populations of Gizzard and Threadfin Shad, along with sustainable numbers of Bluegill and Longear Sunfish. Channel Catfish are, as previously mentioned, very abundant in the lake, but Flathead Catfish are also present. Largemouth Bass are usually abundant, but the latest population numbers are lower than in past surveys. To combat this population sag, the 2016 restock is expected to be followed up with a second event in 2017. White Bass numbers tend to be perennially low, perhaps in response to a recent boom in the Yellow Bass population. White Crappie are also well-represented in the lake, but recent catch rates have been lower than in previous years.
Emergent vegetation within the lake is typically sparse, so fish habitat usually consists of native vegetation such as water willow and buttonbush, although there have been human efforts to enrich habitat through artificial structures constructed from bamboo. Fish also utilize a number of artificial rocky shorelines and riprap for cover.

In recent years, two invasive species have posed a threat to the lake. These include zebra mussels, which have received extensive media coverage, as well as an aquatic plant known as Giant Salvinia. TPWD worked with the City of Arlington to install awareness signage near boat launches and public areas around Lake Arlington to educate anglers and boaters of the threat, and to date no reports of either species have been documented in the lake. (Brock and Hungerford 2015).

2.6.2 Village Creek Aquatic Life Monitoring
The portion of Village Creek upstream of Lake Arlington is classified as an intermittent stream with perennial pools that are sufficient to support significant aquatic life use. Intermittent streams are automatically presumed to have ‘limited’ aquatic life uses, with poor habitat availability that would yield low species diversity and overall population counts for any species that happen to be present. However, data collected in the summer and fall of 2016 indicated that the stream exceeded this presumed use level.

For fish, events conducted in both the critical summer months and the cooler index period produced ‘Exceptional’ fish scores for both species diversity and population. Several of the notable species identified include catfish (Yellow Bullhead, Flathead, Channel), sunfish (Bluegill, Longear, Redear, Green), Largemouth bass, white crappie, topminnow (Blacksotted, Blackstripe), Bullhead minnow, shiner (Red, Blacktail), Gambusia, and Bluntnose Darter.

The benthic macroinvertebrate score increased from Intermediate during the critical period to High during the index period. This was due to a shift in the populations that were found between the two samples, where there was an increase in the number of species that are intolerant to poor water quality. Genera represented during the sampling included caddisflies, damselflies (rubyspot, dancer), riffle beetles, flatworms, dragonflies (amberwing, spinyleg, ringtail), mayflies, water striders, non-biting midge flies, horse flies, and black flies. One species of scud (amphipod) was also identified, *Hyalella azteca*. Sampling for freshwater mussels was not a component of the study, but species such as Tapered pondhorn, Threeridge, and Asian clam have been observed in the watershed by both residents and TRA’s field sampling team.

2.7 Climate
County-level data for areas within the watershed characterize the climate as ‘humid subtropical,’ with hot, humid summers and generally mild to cool winters (IVPH 2012). Mean annual daily temperature from the National Weather Service database for the Dallas/Fort Worth (DFW) Metroplex ([https://www.weather.gov/fwd/dfwclimo](https://www.weather.gov/fwd/dfwclimo)) is 65.9 °F for the entire period of record (POR) between 1899 and 2015. Temperatures are generally lowest in January and highest in July, with POR daily annual averages of 45.5 °F and 85 °F, respectively.

The watershed generally receives between 32 and 36 inches of precipitation annually, while the mean annual precipitation for the entire DFW area is 33.1 inches for the entire period of record (POR) between 1899 and 2015. The lowest yearly total came in 1921, with only 17.9 inches, with the highest yearly total occurring in 2015, when prolonged storms brought 62.8 inches of rain, along with historic flooding.

2.8 Groundwater
Two major aquifer groups exist within the VCLA watershed: the Trinity group and the Woodbine group. Data provided by the Texas Water Development Board (TWDB) indicate that groundwater from both aquifer groups is captured for a variety of uses (Figure 2-7). Public water supply wells are the most common water use type, with examples found throughout the watershed. Domestic use wells are also very common, but are more frequently
found in the southern extent of the watershed, mainly within Johnson County. There are also a few irrigation and industrial use wells spread throughout the watershed.

2.8.1 Trinity Group
The subcrop region of the Trinity aquifer underlays the entirety of the watershed (Figure 2-7). The ongoing development within the general DFW Metroplex has significantly impacted water availability in this aquifer, with levels in some areas dropping more than 550 ft from historic levels. As a consequence, many public water supply wells have been abandoned since the mid-1970s in favor of surface water supply sources. This has translated to a slight recovery for the aquifer, but areas of Johnson County still remain as much as 100 ft below normal depth (Ashworth and Hopkins 1995).

2.8.2 Woodbine Group
The outcrop region of the Woodbine group is represented along the eastern and southern edges of the watershed, along with a small sliver of the subcrop region, which is located in the far southeast corner of the watershed (Figure 2-7). Only the lower two of the three zones of the Woodbine are suitable for public water supply or domestic use. Water within the upper zone, also called the outcrop, often contains excessive levels of iron, and is not recommended for these uses. Although the chemical quality of the water deteriorates quickly in well depths greater than 1,500 ft, the areas above this depth and below the outcrop zone are considered to be of overall good water quality, assuming that steps have been taken to seal off portions of the upper Woodbine that contain excessive amounts of iron (Ashworth and Hopkins 1995).

2.9 Surface Water
2.9.1 Lake Arlington
In the early 1950s, City of Arlington staff were met with the challenge of providing water to a growing city and expanding industrial area. To meet this need, the construction of a new reservoir was proposed which would dam water from Village Creek and incorporate the already-existing Lake Erie, which provided cooling water to a nearby power generation plant. Construction on the reservoir was completed in 1957. Once completed, the reservoir filled at an unprecedented rate, thanks in part to a 100-year storm event that took place in the spring of 1957. This sudden influx of water filled the lake in a short 30 days, which was a welcome relief for residents.
considering that most of Texas has just suffered through the worst drought in recorded history, which occurred from 1946 to 1957 (Malcolm Pirnie 2011).

Today, yields of the reservoir from Village Creek are supplemented with water piped in from two other reservoirs in East Texas, Richland-Chambers and Cedar Creek Reservoirs (Figure 2-8). This allows Lake Arlington to be used as a terminal storage reservoir in the Tarrant Regional Water District’s (TRWD) Trinity River Diversion Water Supply Project. The outlet for this pipeline is situated just downstream of the Village Creek bridge on Everman-Kennedale Road (32°38'19.90"N, 97°14'32.30"W), shown on the inset map in (see ‘Arlington Outlet’) on Figure 2-8. From the Lake Arlington outlet, the pipeline continues on to Lake Benbrook and from there to Eagle Mountain Reservoir. Occasionally, flow in the pipeline is reversed to deliver water from Lake Benbrook to supply Lake Arlington. Lake Arlington covers 2,275 acres and impounds Village Creek from the Lake Arlington dam in Tarrant County up to a normal pool elevation of 550 feet. Water rights permits for Lake Arlington are held by the City of Arlington and TXU Electric/Excelon Power. Prior to the construction of the Lake Arlington Dam, Lake Erie inhabited an area in the northwestern corner of the lake. Although it retains some of Lake Erie’s former utility as an industrial cooling water source, Lake Arlington water is presently used primarily for municipal purposes, providing drinking water to over half a million residents in the City of Arlington, as well as
some surrounding communities in Tarrant County. Drinking water from the lake is treated at two facilities: the Pierce-Burch Water Treatment Plant (WTP), owned and operated by the City of Arlington, and the Tarrant County Water Supply Project (TCWSP) WTP, owned and operated by TRA. Water from the Pierce-Burch WTP is supplied to the citizens of Arlington, while water from the TCWSP WTP meets the needs of the citizens of Bedford, Colleyville and Euless, along with portions of Grapevine and North Richland Hills. Withdrawals for these uses are provided below in Table 2-2. The lake is also used regularly for public recreation, with several public and privately owned docks allowing for boat entry for fishing and other recreational activities (Malcolm Pirnie 2011).

Table 2-2. Sources of supply and uses of water in Lake Arlington.

<table>
<thead>
<tr>
<th>Lake Arlington Supplies and Uses</th>
<th>Average Annual Inflows (acre-ft)</th>
<th>Average Annual Withdrawals (acre-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural supply from watershed</td>
<td>50,995(1)</td>
<td>N/A</td>
</tr>
<tr>
<td>City of Arlington Pierce-Burch WTP</td>
<td>N/A</td>
<td>32,800(2)</td>
</tr>
<tr>
<td>TRA TCWSP WTP</td>
<td>N/A</td>
<td>34,000(2)</td>
</tr>
<tr>
<td>Excelon Handley Power Plant</td>
<td>N/A</td>
<td>4,000(3)</td>
</tr>
<tr>
<td>TRWD Discharge from Cedar Creek and Richland-Chambers Reservoirs to Village Creek</td>
<td>43,500(4)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

N/A - not applicable

(1) Based on rainfall data from 1992 - 2009 and PLOAD model projections. Estimated annual inflow includes baseflow from Village Creek (2,735 acre-ft) and estimated surface runoff.
(2) Average annual withdrawal between 2009 and 2010.
(3) Projected 2010 net demand, taking into consideration diversion and return flows (Source: TRWD, 1998).

Adapted from: Lake Arlington Master Plan, Malcolm Pirnie 2011.

Land uses surrounding the lake are classified as urban, interspersed with open greenspaces. The east side of the lake is almost completely urbanized, with the majority of land use being residential. However, two large parks do exist near the lake. On the west side of the lake, some undeveloped land exists just south of the power generation plant operated by Excelon Handley (Exelon), but land use again turns to residential near the southern end of the lake (Figure 2-5, Figure 2-6).

Holders of water rights on Lake Arlington are authorized to impound a total of 45,710 acre-feet of water behind the dam. In contrast, TRA diverts water for their TCWSP plant through contractual agreements with TRWD, utilizing the imported water brought in to Village Creek from TRWD’s Trinity River Diversion Water Supply pipeline, instead of the yield from Village Creek itself. In a given year, inflows from the pipeline can be expected to contribute approximately 46% of the total average annual inflows to the lake (Table 2-2).

Lake Arlington’s operations are based on 4 major factors:

1) Normal inflows from Village Creek;
2) Additional inflows supplied from the TRWD pipeline;
3) Surface evaporation from the lake; and
4) Diversions/withdrawals from the lake by the City of Arlington, TRA, and Excelon/TXU.

The normal conservation pool elevation for Lake Arlington is 550 ft above MSL, which coincides with the elevation of the drop inlet spillway that drains the lake, located near the east end of the Lake Arlington dam. The dam itself is an earthen structure with a total length of 6,482 ft (1.2 mi) and a height of 83 ft. A flood storage
Easement held by the City of Arlington allows for additional storage up to 560 ft above MSL, and the dam itself reaches a total height of 577.5 ft above MSL, which accounts for a parapet wall that was added to the dam after initial construction was complete. During flood events, water may be released from an uncontrolled emergency spillway, which has a crest elevation of 559.7 ft above MSL and a width of 882 ft (Malcolm Pirnie 2011). Historical lake elevations from 1988 to 2016 are provided in Figure 2-9 below.

![Daily Observed Water Surface Elevation at Lake Arlington Dam - USGS Station #08049200](chart.png)

_Day source: USGS._

**Figure 2-9. Daily Observed Water Surface Elevation in Lake Arlington, 1988-2016.**

The management of the lake’s pool elevation relies heavily on the contractual relationships with TRWD, particularly in the summer months. Under a 1971 agreement, TRWD agreed to maintain a minimum lake elevation of 540 ft MSL during the summer months (from June 1 to September 1) and a minimum of 535 ft MSL during the remainder of the year.

2.9.2 Lake Tributaries

Two named tributaries feed Lake Arlington: Wildcat Branch, along with several other unnamed tributaries, drains areas of Fort Worth to the west of the lake, while Village Creek drains the majority of the watershed, which is to the south. Several small unnamed tributaries drain the thin corridor of the watershed that exists to the east of the lake.
Flow data for Village Creek is tracked continuously by a U.S. Geological Survey (USGS) gaging station at the Village Creek bridge on Rendon Road (USGS Gage #08048970). This station is situated upstream of TRWD’s Arlington Outlet (Figure 2-8), and therefore does not record inputs from the Richland-Chambers and Cedar Creek Reservoirs. This flow dataset only dates back to July 2007, but additional flow data exists within SWQMIS from previous years and for other stations throughout the watershed that will be used to supplement the USGS data.

### 2.10 Permitted Discharges

Seven permitted discharges exist in the VCLA watershed. Of these, two are inactive or have had their permit cancelled. The Handley Power Plant is also a discharger, but their effluent is characterized as industrial cooling water used within the plant, and is not expected to be a contributor of *E. coli*. Details about the four active permitted WWTFs is provided in Table 2-3. Of these, only one is considered a municipal discharger, the Johnson County Special Utility District (SUD), with a permitted average daily discharge for effluent of 0.7 million gallons per day (MGD). The effluent from this WWTF flows into Village Creek, near the southwestern extent of the City of Burleson (Figure 2-10). The remaining three facilities are small package plants that treat water from either housing subdivisions, mobile home parks, or recreational vehicle (RV) parks. All maintain a permitted average daily discharge of < 0.1 MGD. The Mayfair wastewater treatment plant (WWTP) is found west of the City of Crowley, where it drains to Deer Creek, and from there to Village Creek. The last two WWTFs are located within the drainage area of Quil Miller Creek, which also drains to Village Creek. RV Ranch WWTP treats wastewater from various RV hookups, and as such may be intermittent in nature. Oak Ridge MHP treats wastewater from a mobile home park that uses similar wastewater hookups, but which typically experience more consistent inflows of wastewater, and thus is expected to have more consistent effluent outflows. The significance of the WWTF locations in this watershed is that effectively all monitored reaches of the watershed may contain some portion of wastewater effluent constituting their baseflow throughout the year.
Table 2-3. Active WWTFs in the VCLA watershed.

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>NPDES Permit Number</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Permitted Average Daily Discharge (MGD)</th>
<th>Receiving Waterbody</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson County Special Utility District WWTP</td>
<td>TX0124923</td>
<td>32.497105</td>
<td>-97.35191</td>
<td>0.7</td>
<td>Village Creek</td>
</tr>
<tr>
<td>Mayfair WWTP</td>
<td>TX0105872</td>
<td>32.566778</td>
<td>-97.40083</td>
<td>0.0963</td>
<td>Unnamed trib of Deer Creek, Village Creek</td>
</tr>
<tr>
<td>Oak Ridge Square MHP WWTP</td>
<td>TX0102806</td>
<td>32.48851</td>
<td>-97.27464</td>
<td>0.0195</td>
<td>Quil Miller Creek</td>
</tr>
<tr>
<td>RV Ranch WWTP</td>
<td>TX0128490</td>
<td>32.498855</td>
<td>-97.28572</td>
<td>0.048</td>
<td>Quil Miller Creek</td>
</tr>
</tbody>
</table>
3.0 The Village Creek-Lake Arlington Watershed Protection Partnership

Individuals, groups, and organizations within a watershed can and should become involved as stakeholders. Stakeholder involvement is critical for selecting, designing, and implementing management measures to achieve the goals of this WPP and successfully improve water quality. Effective WPPs utilize local knowledge and expertise to guide the planning process, ensuring that the best management practices (BMPs) selected for implementation are relevant to the watershed’s issues, applicable to the environmental setting of the watershed, and feasible for the watershed residents, given the resources they have available. If this process is followed, local stakeholders are more likely to modify their behaviors and adopt the BMPs identified in the Plan.

3.1 Formation

The VCLA Watershed Protection effort was initiated to address water quality concerns in both Lake Arlington and its tributaries. Drinking water from Lake Arlington is utilized by over half a million people in both the city of Arlington and other communities throughout Tarrant County. Although Lake Arlington is currently fully supporting its drinking water use, several portions of Lake Arlington are listed on the TCEQ 2014 Water Quality Inventory—Water Bodies with Concerns for Use Attainment and Screening Levels for chlorophyll-a and nitrate. The lake’s main tributary, Village Creek, has been listed on TCEQ’s Texas Water Quality Inventory-303(d) List as impaired for bacteria since 2010.

Rapid development around the lake and within the watershed has and will continue to negatively affect water quality over time, as indicated by previous studies conducted for the watershed, namely the 2011 Lake Arlington Master Plan (LAMP) (Malcolm Pirnie 2011), the 2011 Greenprinting Study conducted by the Trust for Public Land (TPL 2011), and the Village Creek Master Plan and Flood Study developed for the City of Kennedale (Halff 2012). To combat this degradation, local stakeholders have elected to take a proactive approach to ensure that appropriate management measures are in place to ensure that the water quality in the lake is protected.

As part of the process for developing LAMP, stakeholders were identified and stakeholder participation was elicited. Bimonthly meetings of the various stakeholders within Lake Arlington’s watershed to discuss opportunities to collaborate on watershed protection initiatives were held beginning in 2011, and was instrumental in creating the Clean Water Act Section 319(h) grant application. An assessment of the LAMP was undertaken in May 2012 by these stakeholders to identify and prioritize the suggested projects. During the development of the LAMP, the results of the sampling and modeling efforts identified nutrients and chlorophyll-a as important parameters of concern. While well-suited to the objectives of the LAMP, the sampling and modeling performed was not of sufficient quantity and specificity to allow for load reductions to be calculated for existing impairments. To address this need and ensure eligibility for federal assistance through the Clean Water Act 319(h) grant program, the group made the recommendation to pursue a watershed-based plan effort. This, along with support from those parties involved with the Greenprinting Study and the Village Creek Master Plan, provided the support base needed to begin orchestrating a concerted stakeholder effort in the watershed.

3.2 Structure

The public effort for the Village Creek-Lake Arlington Watershed Protection effort consists of three stakeholder groups, each with its own set of responsibilities and focus areas (Figure 3-1). Membership is dependent on these elements, as is meeting content, group size, and meeting frequency. To ensure that watershed interests are well-represented, there is a continued effort by the project team to ensure that stakeholder representation is well-distributed, both spatially throughout the watershed, and topically amongst multiple users with varying needs.
3.2.1 General Membership

The VCLA Watershed Protection Partnership (Partnership) functions as the overall stakeholder group, consisting of all stakeholders, including subgroup members and general members. As such, there are no formal membership requirements, and members may come and go as they please, attending meetings at their leisure. Partnership meetings serve as a public forum for stakeholder concerns and updates on project progress.

No formal meeting ground rules were adopted for the Partnership meetings, but attendees are asked to abide by a few simple rules of etiquette during meetings. At a minimum, Partnership meetings are held semi-annually, with content generally focusing on high-level overviews of project components, data collection/pollutant source identification analysis updates, and general project progress updates.

The Partnership will be responsible for many of the decisions towards the beginning of the project’s lifespan, and acted as the initial coordinating body responsible for electing the initial Steering Committee members. Once formed, the Steering Committee became the main decision-making body of the Partnership, although some minor decisions are still left to the Partnership to decide as a whole during public meetings. If any decision topic becomes contentious, either the meeting facilitator or the Partnership may motion to have the topic deferred to the Steering Committee for a decision.

![Figure 3-1. Village Creek-Lake Arlington Watershed Protection Partnership group structure.](image)

3.2.2 Steering Committee

To facilitate the decision-making process, a core group of stakeholders presently act as the voting body of the Partnership, known as the Steering Committee (Committee). The Committee will vote on key watershed decisions and review potential water quality improvement BMPs for applicability in the watershed. Many of
these recommendations were eventually recommended as part of the Plan, which the Committee reviewed on a chapter-by-chapter basis.

The intent of the Committee is to continue fostering a wide representation of varied focus groups, including local landowners, businesses, and government officials. The initial group composition will be selected from and approved by an initial coordinating body (the Partnership) by a panel vote. Periodically, the initial Committee group will assess its membership, adding, removing, or replacing members internally by a group vote. The initial panel of members and focus groups is provided in Figure 3-2.

At any point during the lifetime of the project, the Committee may see a need to create a special subcommittee to address a specific resource or contaminant source concern. Creation/dissolution of these subcommittees and approval of members for any such subcommittees will be left to the discretion of the Committee. If such action is proposed by the Committee, consultation of the watershed coordinator, the Technical Advisory Group (TAG), and TCEQ is recommended to ensure that all available resources are identified to assist the proposed subcommittee in their mission.

The Committee is required to abide by a set of ground rules, which was presented for approval at the first Committee meeting. An overview of these ground rules was presented to the Partnership prior to approval of the initial Committee group, and a full copy was provided to potential Committee members for review.

Finally, to indicate their approval and commitment to the plan and its long-term success through implementation, Steering Committee members signed the final version of the Plan, once all chapters have been reviewed and approved.

Steering Committee (17 members)

Municipalities (4)
- City #1 (Lake Arlington)
- City #2 (Village Creek)
- City #3 (at large)
- City #4 (at large)

Private Landowners (4)
- Rep #1 (Lake Arlington)
- Rep #2 (Village Creek)
- Rep #3 (Ag/Rancher)
- Rep #4 (Ag/Rancher)

Local Resource Agencies (2)
- SWCD Rep (Dalworth or Johnson)
- Ag Extension Agent (Johnson or Tarrant)

Regional Authorities (2)
- Tarrant County Water Supply Project (TRA)
- Tarrant Regional Water District (TRWD)

Industry (2)
- Food/Beverage
- Energy

Education (2)
- UT-Arlington
- Tarrant County College

Figure 3-2. Initial Steering Committee membership and focus groups.

3.2.3 Technical Advisory Group

During initial Partnership meetings, TRA recommended the creation of a second stakeholder subgroup that would provide technical guidance, resource information, and funding opportunity information to both the Committee and the Partnership. Partnership members were presented with candidate agencies to be considered for this TAG, and asked to recommend any additional agencies/organizations which may benefit the WPP process. The TAG will serve strictly in an advisory capacity and have no formal voting power, making
recommendations to the Partnership and Committee as needed. The initial list of recommended entities is provided in Figure 3-3.

### Technical Advisory Group (12 members)

- North Central Texas Council of Governments (NCTCOG)
- Natural Resource Conservation Service (NRCS)
- Railroad Commission of Texas (RRC)
- Texas AgriLife Extension & Research (AgriLife)
- Texas Commission on Environmental Quality (TCEQ)
- Texas Institute for Applied Environmental Research (TIAER)
- Texas Parks & Wildlife Department (TPWD)
- Trinity River Authority of Texas (TRA)
- Tarrant Regional Water District (TRWD)
- U.S. Environmental Protection Agency (EPA)
- U.S. Fish & Wildlife Service (FWS)
- U.S. Geological Survey (USGS)

*Figure 3-3. Preliminary Technical Advisory Group membership.*

Formal meetings for the TAG were not anticipated, but the group reserved the right to adopt such a schedule if deemed necessary. The majority of TAG correspondence is conducted via phone/email coordination, with the occasional formal group meeting when the group deems necessary, or at the direction of the Partnership or Committee.

### 3.3 Coordinated Development of the Plan

Development of the Plan was achieved through the combined efforts of the Steering Committee, TAG, and general Partnership over the course of an X-month period. Where the Partnership members were instrumental in calling attention to specific BMPs and strategies that proved useful from their diverse experiences, the TAG was useful in providing technical information towards these practices’ potential impacts. The Committee used information from both groups to recommend which BMPs were the best fit for the VCLA watershed and its residents, with respect to environmental considerations.

Ultimately, this information was used by the Committee to evaluate the extent to which these BMPs may need to be implemented to achieve the anticipated goals for water quality improvement and protection. This process involves continued communication between all three groups as they endeavor to identify measureable endpoints for these goals and prioritize specific practices and broader programs to achieve both water quality and programmatic goals. This may require review and revision of the Plan, as well as the effective communication of valuable information about the impacts of the Plan to other interested or affected entities, both within and outside of the watershed.

Improvements in water quality will not be a short-term task, however, and will continue long after the initial planning period is complete. Even after the Plan’s water quality goals are achieved, continued preservation of these goals and long-term protection of the watershed is necessary. As such, the Steering Committee will continue to be a functional group throughout the implementation period of the Plan, as successive components of the Plan are put into practice throughout the VCLA watershed. These programs and practices will require periodic evaluation of their results through the use of continued water quality monitoring, which will be targeted to interim and long-term milestones. Through these evaluations, adaptive management techniques will be used to reassess the recommended strategies used in the watershed.
Appendix A

Key Elements of Successful WPPs
Appendix A:  Key Elements of Successful WPPs

USEPA’s *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (USEPA 2008) describes the ‘Element of Successful Watershed Plans’ that must be sufficiently included in the WPP for it to be eligible for implementation funding through the Clean Water Act Section 319(h) grant funding program. These elements do not preclude additional information from being included in a plan.

**A. Identification of Cases and Sources of Impairment**

An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the water-based plan (and to achieve any other watershed goals identified in the WPP). Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed. Information can be based on a watershed inventory, extrapolated from a sub-watershed inventory, aerial photos, GIs data and other sources.

*Insert relevant chapters*

**B. Expected Load Reductions**

An estimate of the load reductions expected for the management measures proposed as part of the watershed plan. Percent reductions can be used in conjunction with a current or known load.

*Insert relevant chapters*

**C. Proposed Management Measures**

A description of the management measures that will need to be implemented to achieve the estimated load reductions and an identification (using a map or description) of the critical areas in which those measures will be needed to implement the plan. These are defined as including BMPs and measures needed to institutionalize changes. A critical area should be determined for each combination of source BMP.

*Insert relevant chapters*

**D. Technical and Financial Assistance Needs**

An estimate of the amounts of technical and financial assistance needed, associated costs and/or the sources and authorities that will be relied upon to implement this plan. Authorities include the specific state or local legislation that allows, prohibits or requires an activity.

*Insert relevant chapters*

**E. Information, Education and Public Participation Component**

An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing and implementing the appropriate NPS management measures.

*Insert relevant chapters*
Key Elements of Successful WPPs

F. Schedule
A schedule for implementing the NPS management measures identified in the plan that is reasonable expeditious. Specific dates are generally not required.

*Insert relevant chapters*

G. Milestones
A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented. Milestones should be tied to the progress of the plan to determine if it is moving in the right direction.

*Insert relevant chapters*

H. Load Reduction Evaluation Criteria
A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the watershed-based plan needs to be revised. The criteria for the plan needing revision should be based on the milestones and water quality changes.

*Insert relevant chapters*

I. Monitoring Component
A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the evaluation criteria. The monitoring component should include required project-specific needs, the evaluation criteria and local monitoring efforts. It should also be tied to the state water quality monitoring efforts.

*Insert relevant chapters*