CHAPTER 1

DESCRIPTION OF THE PROPOSED ACTION

A. PROJECT OVERVIEW

The New York City Department of Health (NYCDOH), in consultation with the New York State Department of Health (NYSDOH), the U.S. Centers for Disease Control and Prevention (CDC), and other Federal, State and local agencies and entities, is implementing a *Comprehensive Arthropod Surveillance and Control Plan* (*Comprehensive Plan).* One of NYCDOH's long-term goals is to prepare for the prevention and control of all arthropod-borne diseases that pose a threat to public health. Therefore, the *Comprehensive Plan* will attempt to prevent the infection of humans from pathogens (i.e., any disease-producing organism) carried by arthropods in New York City. The resultant diseases include, but are not limited to, encephalitis and meningitis caused by the West Nile virus. NYCDOH's immediate priority is to prepare for, and take preventive measures to reduce the potential for, a renewed outbreak of the West Nile virus. The *Comprehensive Plan* emphasizes routine surveillance and control of potential mosquito breeding sites to prevent adult mosquitoes from proliferating in the City. The *Comprehensive Plan* also addresses efforts to control adult mosquitoes to prevent disease throughout the City, if necessary. In addition, in response to community concerns about the quality of life for citizens who have been subjected to unbearable populations of mosquitoes (including aggressive human-biting salt marsh mosquitoes) in the Rockaways section of Queens, the *Comprehensive Plan* will include a component to control adult mosquito populations in the Rockaways. The *Comprehensive Plan* includes the following two major components:

1. *Routine Surveillance and Control Program* (the "*Routine Program*"), focusing on:
   - ?? Education;
   - ?? Comprehensive surveillance; and
   - ?? Mosquito breeding prevention and larval control activities.
2. *Adult Mosquito Control Programs*. This component of the *Comprehensive Plan* consists of two programs:
   - a) A *Mosquito-Borne Disease Control Program* focusing on control of adult mosquitoes for disease control City-wide; and
   - b) A *Mosquito Population Control Program in the Rockaways* focusing on control of adult mosquito populations in the Rockaways.

The Proposed Action is the adoption of the *Adult Mosquito Control Programs* to control adult mosquitoes that pose a threat to the public health by potentially spreading the West Nile virus and other emerging pathogens. Components of this plan may be partially reimbursed by NYSDOH pursuant to State Law. Although the City is conducting extensive education, surveillance and widespread larviciding under the *Routine Program*, there is still a potential for the West Nile virus (or

other mosquito-borne pathogens) to be present in and transmitted to humans by the adult mosquito population. Once these pathogens have been identified, without the *Mosquito-Borne Disease Control Program*, the West Nile virus and other pathogens causing diseases could threaten public health, causing unnecessary suffering and additional human deaths, particularly to vulnerable segments of the population. In addition, the City is also actively trying to reduce the breeding of mosquitoes in the Rockaways through the implementation of the *Routine Program*. Nevertheless, unbearable mosquito population levels may still materialize, triggering the need for the *Mosquito Population Control Program in the Rockaways*.

No permits or approvals have been required by New York State or federal agencies for the Proposed Action. Should future regulations require the NYCDOH to obtain permits from other agencies for adulticiding activities, NYCDOH would obtain such permits, and adulticide activities under the Proposed Action would be performed in accordance with any future permits.

As a discretionary action of a City agency, which may have significant adverse impacts on the environment, adoption of the *Routine Program* was subject to City Environmental Quality Review (CEQR). The *Routine Program* focuses on certain activities to prevent the recurrence of a disease outbreak, and to reduce significantly the mosquito population throughout the City including the Rockaways. These efforts, including public education, routine surveillance and control of larvae, are not expected to result in any significant adverse environmental impacts and have been addressed under CEQR in a separate Environmental Assessment Study (EA). On April 12, 2000, NYCDOH, acting as lead agency for CEQR review, determined that the *Routine Program* will not have the potential for significant adverse impact on public health or the environment and issued a Negative Declaration.

Given the scope of the *Adult Mosquito Control Programs*, which could include focused and/or City-wide truck and/or aerial applications of insecticides targeted at adult mosquitoes (i.e., adulticides), NYCDOH has determined that an EIS should be prepared and impacts of the potential adulticide applications should be considered before the *Adult Mosquito Control Programs* are adopted. The primary focus of this EIS is to address the use of insecticides to control adult mosquitoes. Since the *Comprehensive Plan* also includes possible adulticide spraying in the Rockaways to control adult mosquitoes, the EIS includes an assessment of the potential cumulative impacts from spraying adulticides under both program elements. It should be noted that although the proposed long-term adult mosquito control efforts taken to prevent a recurrence of a West Nile virus outbreak will be subject to assessment in this EIS, NYCDOH used adulticides in 1999 and 2000 to address such a recurrence because of the existence of a public health threat. This emergency response occurred prior to completion of this environmental review.

B. PROJECT DESCRIPTION

PROJECT PURPOSE AND NEED

In late August 1999, NYCDOH detected an unusual cluster of encephalitis cases in northern Queens. In collaboration with the CDC and the NYSDOH, an epidemiologic investigation was initiated which identified the cause as the West Nile virus, a mosquito-borne disease that had never before been recognized in North America. In 1999, 59 persons in the New York City Metropolitan Area, including 45 New York City cases, were hospitalized due to infections caused by West Nile virus. One of these 45 cases was a Canadian visitor who became ill after visiting Queens. The majority of the 59 cases were diagnosed with encephalitis. Some of the cases had meningitis without encephalitis. Five of the hospitalized cases had illness characterized by fever and headache. Seven elderly citizens,

who are among the population particularly vulnerable to the effects of the West Nile virus, died, including four New York City residents. Subsequently, NYCDOH conducted a voluntary blood testing program in northern Queens, the area where most human cases were clustered, and determined that many more individuals had been exposed to the virus (2.6 percent, i.e., 19 persons were found in the sample of 677), although most had experienced either mild symptoms or no symptoms at all. In 1999, the West Nile virus was identified and also found to have caused illness and death among animals, including hundreds of birds (of numerous species) in the New York City metropolitan area, horses in eastern Long Island, and a cat in New Jersey.

The virus is transmitted to humans and animals by the bite of a mosquito carrying the West Nile virus. A mosquito may become a carrier of the virus when it bites a bird, animal or human infected with the virus. West Nile virus has been identified, through 2000, in mosquitoes and birds in New York City, Long Island, the lower Hudson Valley, Connecticut, New Jersey, Massachusetts, Rhode Island, New Hampshire, Vermont, Maryland, Washington, D.C., Pennsylvania, Virginia, and North Carolina. The primary mosquito species identified as carriers of the virus in 1999 were *Culex pipiens* and *Culex restuans*, although another species, *Aedes vexans*, was identified as a carrier in Connecticut. As discussed later in this chapter, additional mosquito vectors were identified in 2000.

Once the cause of the 1999 encephalitis outbreak was recognized as a mosquito-borne disease, the City rapidly implemented mosquito control measures and a public health education campaign. The public health response at the Federal, State, and local levels was to closely monitor the extent of West Nile virus in humans, mosquitoes, and birds, in order to understand the problem, identify the disease and its causative agent and vectors (organisms that spread the disease), and institute control measures. These efforts were effective in limiting the impact of the outbreak. As a result of these rapid planning, coordination, and implementation efforts, the overall number of human cases in 1999 was relatively low compared to similar outbreaks worldwide. Although NYCDOH's emergency response was effective, the unprecedented disease event highlighted the City's need to strengthen the infrastructure for arthropod-borne and emerging infectious disease surveillance.

NYCDOH's decision to develop and maintain a *Comprehensive Plan* is underscored by two factors:

- Encephalitis caused by West Nile virus may reappear in the future due either to infected migratory birds or to infected mosquitoes that overwinter (the latter was proven to occur with the discovery of infected overwintering mosquitoes found in February 2000 in northern Queens, and with the reappearance of West Nile virus in the summer of 2000).
- West Nile virus is not the only mosquito-borne pathogen or new infectious disease threat to face the City. The West Nile outbreak highlighted the City's potential vulnerability to imported disease threats and the ongoing need to maintain a strong public health infrastructure that can quickly identify new infectious diseases in the City.

Adulticide applications under the *Adult Mosquito Control Programs* are expected to be intermittent and the adulticides are expected to have a relatively low persistence in the environment. The analyses of the potential impacts from the Proposed Action in the EIS are intended to address the concerns raised with respect to adulticide applications.

In addition to the emergence of the West Nile virus in New York City in 1999, NYCDOH has been made aware of community concerns about the quality of life for of citizens in the Rockaway Peninsula, who have been subjected to an unbearable population of aggressive, biting salt marsh mosquitoes.

The Rockaway Peninsula is bounded by the Atlantic Ocean on the south and Jamaica Bay (Rockaway Inlet and Beach Channel) to the north and west. The western end of the peninsula is part of the federally owned Gateway National Recreation Area. The peninsula is home to a wide array of plant and animal species and consists of some of the most ecologically significant saltwater marshes on Long Island. Over the years, development and filling of marshlands, along with other types of ecological degradation, have restricted the natural flushing of the saltwater marshes and contributed to an increase in artificial habitat for *Oc. sollicitans* (the major aggressive human-biting mosquito in the Rockaways) and other species (NYCDOH data, 2001).

To correct this ecological degradation, the New York District of the U.S. Army Corps of Engineers, has tentatively scheduled habitat restoration in Bayswater State Park, Dubos Point and Brant Point. Improvements are slated to begin in 2003 and will include construction of offshore breakwaters to accelerate the establishment of fringe salt marshes, removal of a damaged seawall, extending and/or unclogging tidal creeks to promote the free flow of salt water, removing unwanted vegetation and fencing to prevent excessive drifting of sand.

This restoration will contribute to mosquito control as tidal movement will allow fish to enter previously inaccessible areas close to shore where they can feed on salt marsh mosquito larvae. It will also disrupt the mosquito life cycle because as described below, mosquito larvae must have standing water to survive. However, given the immediate concern about health and well-being, NYCDOH's Office of Vector Surveillance and Control is committed to reducing the mosquito population of the Rockaway Peninsula so that quality of life (e.g., ability to sit outdoors or enjoy recreation at night) is restored.

HISTORICAL BACKGROUND AND PLANNING CONTEXT

New York City historically has had programs to control pathogen-carrying mosquitoes. These programs were largely directed toward elimination of breeding grounds, application of larvicide and initiation of adulticiding. Mosquito control in New York City began in the early 1900s. Creating ditches in marsh lands, larviciding, and adulticiding were conducted Citywide. NYSDOH prepared a programmatic EIS under State Environmental Quality Review (SEQR) in 1982 to address the issues surrounding and the potential impacts of various components of vector surveillance and control conducted in municipalities and counties throughout the State. This served as a framework for understanding the potential impacts of the application of larvicides (i.e., insecticides focused on controlling mosquito larvae or inhibiting larvae from developing into adult mosquitoes) and adulticides (i.e., insecticides that are intended to control adult mosquitoes) and included recommendations on minimizing potential impacts from the application of insecticides.

Mosquito Facts: Life Cycle and Virus Transmission

Mosquito Species

Mosquitoes belong to the Order Diptera and Family Culicidae. There are approximately 3,100 mosquito species worldwide. There are white, gray, brown, and black scaled mosquitoes. Like most insects, mosquitoes have three body parts: head, thorax, and abdomen. Two antennae are attached to the head, and six legs—three pairs on each side—are attached to the thorax. Some mosquito species can only breed once a year (univoltine), while others can breed several times in a warm weather season (multivoltine). According to *Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico,* there are 45 species of mosquitoes in New York City. Species found in New York City include: *Culex* (*Cx.*) *pipiens* and *Cx. restuans* (multivoltine species considered

to be the primary vector for West Nile virus in 1999 and 2000), *Cx. salinarius* (multivoltine), *Cx. territans* (multivoltine), *Ochlerotatus* (*Oc.*) *sollicitans* (multivoltine species construed to be the primary aggressive human-biting mosquitoes on the Rockaway Peninsula), *Oc.* (formerly Aedes) (*Oc.*) *canadensis* (univoltine), *Oc. cantator* (multivoltine), *Oc. taeniorhynchus* (multivoltine), *Oc. triseriatus* (multivoltine), *Aedes* (*Ae.*) *vexans* (multivoltine), *Anopholes* (*An.*) *punctipennis* (multivoltine) and *Psorofora* (*Ps.*) *ferox* (multivoltine). A species recently discovered in the region is *Oc. japonicus* (multivoltine) (V. Kulaskera, NYCDOH, personal communication).

Table 1-1 lists NYC species that are common in saltwater and freshwater environments.

Table 1-1
Mosquito Characteristics and Habitats

Species	Saltwater	Freshwater
Cx. pipiens		X
Cx. restuans		X
Cx. salinarius	X	
Cx. territans	X	
Oc. sollicitans	X	
Oc. canadensis		X
Oc. cantator	X	
Oc. taeniorhynchus	X	
Oc. triseriatus		X
Oc. japonicus		X
Ae. vexans		X
An. punctipennis		X
Ps. ferox		X

Source: Rutgers Entomology Department. New Jersey Mosquito Control Association (NJMCA).

Mosquito Life Cycle

In developing any type of control plan against a mosquito-borne disease, it is important to understand the breeding cycle of the mosquito and how a virus (like the West Nile virus) can be transmitted by the mosquito with the participation of animals as "hosts" for the virus. Figure 1-1 illustrates the four stages of mosquito development. Table 1-2 describes these four stages in the life cycle of a mosquito. Table 1-3 presents the characteristics that are generally common to the life cycle of a mosquito for different mosquito genera. Depending on the species, mosquitoes lay 30 to 300 eggs either on the surface of water (or the edge of the water surface), or on damp soil or mud. Depending on the species, the eggs may have to lie dormant through the winter (i.e., overwinter) to hatch in spring or may be able to hatch as soon as the environment floods (e.g., after rain or high tide). Some mosquito species overwinter as mated female adults (e.g., *Cx. pipiens* and *An. quadrimaculatus*). Other female mosquitoes that hatch in late summer search for warm, protected places to overwinter; however, most mosquito species overwinter in the egg stage (e.g., *Oc. sollicitans*). Very few species overwinter in the larval stage (Rutgers Entomology Department). Once the eggs hatch, the aquatic larvae pass through four molting stages. Larvae are saprophagous (feeding on decaying organic matter), predaceous on microorganisms, or eat other mosquito larvae. The larva obtains air from the water's surface through an abdominal siphon. During pupation, the mosquito transforms itself from the

Table 1-2
The Four Stages of the Mosquito Life Cycle

Stages of Metamorphosis	Habitat	Nourishment	Behavior
Stage 1: Egg	Eggs laid on surface of fresh or stagnant water,* or laid singly on damp soil or vegetation.	Egg does not feed.	Larvae hatch in water.
Stage 2: Larvae (wigglers)	Aquatic; use breathing tube (siphon) to obtain oxygen at water's surface.	Filter feeds on microorganisms organisms. Jaws have brushes that create currents to move food into the mouth.	Molts its exoskeleton 4 times (stages between molts called instars). After 4th Molt, becomes Pupae.
Stage 3: Pupae (tumblers)	Aquatic; floats at surface of water; obtains oxygen through two tubes (trumpets).	Does not feed. Has no mouth.	Takes a few days to transform into adult.
Stage 4: Adult	Terrestrial, Marshes, Woodlands, around human habitations.	Males and females feed on nectar. Females need blood meal for maturation of eggs. Females bite birds, other animals and humans.	Splits pupal case, rests until dry and wings hard.

Notes: *Depending on availability of water, eggs may hatch within a few minutes or lay dormant for years before they emerge as larvae (Source: Lee County Mosquito Control District).

Sources: Rutgers Entomology Department, NJMCA, 2000; Newsday, June 20, 2000 (reference: The American Mosquito Control Association (AMCA); World Book Encyclopedia; Milne and Milne, 1980; Gillette, 1972.

aquatic larval stage to an adult, with legs and wings. The time from egg hatching to adulthood varies with species and temperature, but generally ranges from one to three weeks.

Male mosquitoes usually emerge before female mosquitoes. Males have feathery antennae, which are sensory organs that sense the sounds from the rapid vibration of the female mosquito's wings. The male's bushy antennae detect the female's pheromones, enabling the male to locate the female to mate. Female antennae are less bushy. Antennae also direct mosquitoes to their food source. Females generally have an estimated life span of one to two months, whereas males only live a few weeks (i.e., they usually die a short time after mating).

As discussed earlier, some mosquito species (known as univoltine) can only breed once a year. Multivoltine mosquitoes (e.g. *Cx. pipiens*), however, can breed several times (up to seven) in a warm weather season. Mosquitoes usually mate in flight shortly after reaching adulthood, and the females store the sperm until they are ready to fertilize eggs. The male adult mosquito, and some females, feed on nectar and other plant juices. Only the female feeds on the blood from vertebrates, and uses a blood meal to nourish development of her eggs.

Female mosquitoes seeking a blood meal are attracted to perspiration, warmth, body odor, carbon dioxide, and light. Some mosquito control programs use carbon dioxide emitting devices as attractants to help determine the adult mosquito species present in an area and to decrease their population numbers. Several devices are sold that are supposed to attract, trap, and destroy mosquitoes and other flying insects. However, if these devices are attractive to mosquitoes, they

probably attract more mosquitoes into the area and may, therefore, increase rather than decrease mosquito annoyance (Rutgers, NJMCA, 2001).

Table 1-3 describes the life cycle characteristics for various groups of mosquitoes.

Table 1-3: Life Cycle Characteristics for Various Mosquito Genera

Mosquito Genera	Egg Laying	Larval Behavior	Adult Feeding Behavior
Culex	Lay egg rafts in fresh or stagnant water at night; female may lay raft of eggs every third night during life	Larvae perpendicular to surface	✍ Painful, persistent biters ✍ Feed at dusk and after dark ✍ Enter dwellings for blood meals ✍ Prefer domestic and wild birds over man and other mammals (e.g., cows, horses) ✍ Generally weak fliers, do not move far from breeding grounds; however, are known to fly up to two miles ✍ Live only a few weeks during warm summer months ✍ Females that emerge in late summer search for sheltered areas where they "hibernate" until spring
Anopheles	Lay eggs singly in water	Larvae parallel to surface; do not have breathing opening	✍ Transmit malaria to humans
Aedes/Ochlerotatus	Lay eggs in damp soil	Larvae perpendicular to surface	✍ Painful, persistent biters ✍ Day and night feeders ✍ Usually do not enter dwellings ✍ Prefer to bite humans rather than other mammals ✍ Short flight ranges for domestic and woodland species; many miles for many floodwater and salt marsh species
Culistea	Lay egg rafts		✍ Moderately aggressive biters ✍ Feed in evening hours or in shade during daytime
Mansonia, Coquillettidia	Lay egg rafts on marshes or lakes	After hatching, larvae descend below surface and insert air tubes in stems or roots of aquatic plants	✍ Becoming more pestiferous with loss of habitat by human encroachment
Psorophora	Lay eggs on ground		✍ Becoming more pestiferous with loss of habitat by human encroachment

Source: AMCA website reports

Mosquitoes as Virus Vectors

As defined by Prescott, et al., (1993), a virus is "an infectious agent having a simple acellular organization with a protein coat and a single type of nucleic acid, lacking independent metabolism, and reproducing only within living host cells." Arthropod-borne viruses (i.e., arboviruses) are viruses that are maintained in nature through biological transmission between susceptible vertebrate hosts by blood feeding arthropods (CDC, 1999).

If a mosquito bites an animal that is infected with the West Nile virus, the mosquito can become a carrier of the virus and can transmit it to other animals (including humans) by means of a subsequent bite. If this occurs, the mosquito is considered a vector for the virus. West Nile virus is an arboviral infection that can result in clinical manifestations ranging from no observable symptoms, to mild illness with fever and headache, to more severe illnesses including encephalitis (inflammation of the brain) and/or meningitis (inflammation of the lining surrounding the brain and spinal cord). The five major types of arboviral encephalitis in the United States are: Eastern equine encephalitis (EEE), Western equine encephalitis (WEE), St. Louis encephalitis (SLE), LaCrosse encephalitis (LAC), and Venezuelan equine encephalitis (VEE) (CDC, 1993). Jamestown Canyon and Cache Valley viruses are related to LAC and also found in the U.S., but these two viruses rarely cause encephalitis. Many arboviruses that cause encephalitis have a variety of different vertebrate hosts and may be transmitted by more than one vector.

Eastern Equine Encephalitis

Since 1964, 153 cases of Eastern Equine Encephalitis (EEE) have been confirmed in the U.S. (CDC, 1998). EEE is transmitted by mosquito species such as *Coquilletidia (cq.) perturbans* and *Oc. sollicitans*. *Ae. vexans* and *Cx. nigripalpus* can also transmit EEE virus. Where the virus resides or how it survives in the winter is unknown (it could possibly be introduced by migratory birds in spring or remain dormant). It usually takes 4-10 days after the bite of an infected mosquito for an individual to develop symptoms of EEE (CDC, 1999). EEE is the most deadly North American arbovirus, with 30 to 75 percent of human cases ending fatally and leaving a high proportion of the survivors with severe central nervous system damage. The fatality rate of EEE cases in infected horses and game farm pheasants is up to 90 percent. Bird-to-bird transmission is typically maintained by *Culistea melanura*, a mosquito that breeds in freshwater swamps. This is the usual cycle. If there is an epidemic, other species become infected with the virus.

Western Equine Encephalitis

This virus was first isolated in California in 1930 from the brain of a horse with encephalitis. WEE virus is mainly found in western parts of the USA and Canada. It has been found in states west of the Mississippi River, Wisconsin, and Illinois. *Cx. tarsalis, Oc. Dorsalis,* and *Oc. melanimon* are the important mosquito vectors of WEE. Death occurs in one to five percent of clinical cases. During 1997, 35 strains of WEE virus were isolated from mosquitoes in Nebraska. Children less than one year old are affected more severely than adults. Permanent damage has been seen in 5 percent to 30 percent of young patients, with a mortality rate of approximately 3 percent (CDC, 1999). The death rate in horses is considerably higher.

St. Louis Encephalitis

This disease was first recognized in 1933 in St. Louis, Missouri. Since 1964, 4,453 human cases of SLE have been reported in the United States, with an average of 128 cases reported annually (CDC, 2000). Notable outbreaks of thousands of cases have occurred in Houston, Chicago, Tampa Bay, Orlando, and Camden-Philadelphia. Cases have also appeared in Florida—where there were 213 cases and 11 deaths in the early 1990s (Mulrennan, 1991)—and California. The elderly are at greatest risk of showing symptoms and succumbing to this disease (CDC, 1999). SLE is transmitted by mosquito species including *Culex* species—the most important vectors being *Cx. pipiens pipiens, Cx. pipiens quinquefasciatus,* and *Cx. nigripalpus*.

Lacrosse Encephalitis

During an average year, approximately 75 cases of LAC encephalitis are reported to the CDC (CDC, 2000). LAC is transmitted by a daytime-biting species, *Oc. triseriatus*, and vertebrate hosts (chipmunks, tree squirrels) in deciduous forest habitats. This virus is maintained over the winter by transovarial transmission in mosquito eggs (i.e., the infected female lays eggs that will carry the virus and be able to transmit it to a vertebrate host). Most severe LAC encephalitis cases occur in children under 16 years of age. Death occurs in less than one percent of clinical cases (CDC, 1999).

Venezuelan Equine Encephalitis

Since 1935, VEE has been involved in extensive epizootics (i.e., affecting a large number of animals at the same time within a particular region) in horses and humans in Central and South America. Over 200,000 horses died in an outbreak that occurred in South America in 1969 and reached Texas in 1971, where 1,500 horses died. (CDC, 1999). "Occasionally, large regional epizootics and epidemics can occur resulting in thousands of equine and human infections" (CDC, 1999). During the period between 1972 to 1975, no reported cases of VEE activity occurred in humans or horses in the US. A VEE epidemic occurred in the fall of 1995 in Venezuela and Colombia with an estimated 90,000 human infections. Human infection with VEE virus is less severe than with EEE and WEE viruses, and fatalities are rare. "Adults usually develop only an influenza-like illness, and overt encephalitis is usually confined to children" (CDC, 1999). VEE vaccines are available for equines.

Virus Peaks

In the period from 1970 to 1991, the reported cases of SLE peaked in 1975 with 1,815 people infected in 30 states, the majority in the Ohio and Mississippi valleys. Other significant peaks of SLE were in 1976 and 1990, with 379 and 240 cases, respectively. Cases of WEE and LAC also peaked in 1975, with 133 and 160, respectively. The highest number of EEE cases was 14 in 1983. (CDC, 1993).

Other Mosquito-Borne Diseases

Mosquitoes transmit yellow fever, malaria, dengue fever, filariasis (common name for a threadworm that is parasitic on vertebrates, including humans), and several different viral strains to humans that lead to encephalitis. Worldwide prevalence of malaria (a protozoa parasite of blood transmitted by a mosquito) is estimated to be on the order of 300 to 500 million clinical cases per year, with over 1 million deaths (WHO, 1998). Over 90 percent of cases occur in sub-Saharan Africa.

Table 1-4 presents examples of the various mosquito vectors worldwide and the diseases they can transmit.

Prior to the introduction of the West Nile virus in the United States, the most common mosquito-borne diseases included Eastern Equine encephalitis, California encephalitis, St. Louis encephalitis, and Dog Heartworm. Because vaccines have not been developed for many of these pathogens (with the exception of heartworm and an equine vaccine for EEE, WEE, and VEE), the control of this type of arthropod-borne diseases has to rely on surveillance, prevention, and control of vectors, as well as personal protection.

As discussed above, the occurrence of West Nile virus in New York in 1999 was unprecedented. The West Nile virus, which is a member of the Japanese encephalitis complex of viruses, was first isolated in Uganda in 1937 and was subsequently found in other humans, birds, and mosquitoes. It occurs over a wide area and has been involved in human disease outbreaks in Africa, southwest Asia, and Southern Europe. The first recorded West Nile virus epidemic was in Israel in the 1950's. The first time West Nile virus was reported in North America was in 1999. Genetic sequencing of the virus

Table 1-4: Mosquito Vectors and Related Diseases

Infectious Disease	Transmitted Virus	Mosquito Vectors	Historical Geographic Region of Transmission	Number of reported human cases in US	Fatality rate in humans (percent)
EEE	Alphavirus	*Oc. sollicitans, Coquillettidia pertubans, Ae. vexans, Culiseta melanura*	Atlantic and Gulf coasts; Caribbean	153	30 to 75
SLE	Flavivirus	*Cx. salinarius, Cx. restuans, Cx. nigripalpus* (Florida), *Cx. Pipiens* (midwestern United States), *Cx. tarsalis* (western United States), *Cx. Quinque-fasciatus*	United States /Caribbean	4,453	2 to 10
Yellow fever	Flavivirus	*Oc. aegypti*	Central and South America, Africa		
Dengue fever	Flavivirus	*Oc. aegypti, Ae. albopictus*	South East Asia, South America, Mexico, Australia, Caribbean		5
WNV	Flavivirus	*Cx. pipiens, Ae. vexans,* and *Anopheles* species	Africa, Mideast, southern France, Eastern Europe, United States	21	
WEE	Alphavirus	*Cx. tarsalis, Oc. melanimon*	United States, Canada, South America	297	1 to 5
LAC	Bunyaviridae	*Oc, triseriatus*	Ohio, Indiana, Wisconsin, California	2,485	<1
VEE	Alphavirus	*Ps. columbiae, Ps. discolor, Oc. sollicitans, Oc. thelcter*, and other species of *Culex, Anopheles, Mansonia,* and *Deinocerites*	Texas, Mexico		
JE	Flavivirus	*Oc. japonicus*	Southeast Asia		0.3 to 60

Notes:
EEE – Eastern Equine Encephalitis
SLE – St. Louis Encephalitis
WNV – West Nile virus
WEE – Western Equine Encephalitis
LAC – LaCrosse Encephalitis
VEE – Venezuelan Equine Encephalitis
JE – Japanese Encephalitis
Source: CDC, 1993, 1999, and 2000 PubMed; Rutgers Entomology Dept.

responsible for the New York City outbreak in 1999 showed that it was most closely related to a strain of West Nile virus isolated from a goose in Israel in 1998. Bird-feeding mosquitoes are the primary carriers of

West Nile virus, although other insects and other bird-feeding arthropods, such as some species of ticks in Asia and Africa, have been found to be capable of carrying the West Nile virus. The role of ticks in transmitting and maintaining this virus is uncertain. The West Nile virus has also been isolated from a number of animals, such as mice, cattle, horses and dogs. The natural transmission cycle of West Nile virus includes a bird-mosquito (or sometimes a bird-tick) cycle, as illustrated in Figure 1-2. When a mosquito bites an infected vertebrate, the virus replicates in the mosquito's midgut, and then the virus goes into the mosquito salivary glands. When the mosquito bites another vertebrate, it deposits its saliva into the bite. West Nile virus has been isolated from over 40 mosquito species (including *Cx. pipiens*—the most common ornithophilic [attraction to birds] West Nile virus vector) in a variety of genera (e.g., *Aedes*, *Ochlerotatus*, *Anopheles*). In the 1999 and 2000 New York outbreaks, the West Nile virus was found primarily in *Cx. pipiens* (freshwater breeding) mosquitoes, but also in *Cx. restuans*, *Cx.* salinarius, *Oc. cantator*, *Oc. triseriatus*, *Ae. vexans*, *An. punctipennis* and *Ps. ferox* mosquitoes, and a large number of bird species (NYCDOH, 2001).

Public Health Impacts/Sickness from West Nile Virus

Although there is a Japanese encephalitis vaccine available in the United States, and an equine vaccine for EEE, WEE, and VEE, there is no vaccine available for West Nile virus. In severe cases, hospitalization and prevention of secondary infections are required. There is a spectrum of clinical effects on humans from arboviral infections. Some people may not be affected at all by such infections; some may exhibit mild symptoms of aching, sore throat, fever, and fatigue; occasional cases have permanent damage to the central nervous system; and in the rare instance, the disease may be fatal. Humans and domestic animals are usually "dead-end" hosts because they do not contribute to the transmission cycle. However, on October 25, 2000, United States Geological Survey (USGS) research scientists reported bird-to-bird transmission in a confined laboratory setting. Since this was a very controlled scientific experiment, the USGS scientists are unsure if or how it relates to what is happening in the wild (USGS, 2000).

The public health investigations and surveys conducted in 1999 and 2000 show that persons more susceptible to developing severe neurologic disease if infected with West Nile virus are people over 50 years of age. Younger people are less likely to be severely affected from exposure to this virus. There are approximately 100 to 200 asymptomatic (infected but not having symptoms) cases for every severe case of West Nile virus. West Nile virus can infect a wide range of vertebrates; in humans it usually produces either asymptomatic infection or mild febrile (feverish) disease, sometimes accompanied by rash, but it can cause severe and fatal infection in a small percentage of patients.

In addition to the human deaths caused by the West Nile virus since 1999 in New York State, the virus has caused deaths in birds, horses, bats, squirrels, chipmunks, rabbits, and raccoons. Table 1-5 presents the number of positive cases of West Nile virus found among humans, birds, mosquito pools, and horses in North America in 2000.

Table 1-5:
West Nile Virus Positive Test Results in the United States for Year 2000

Location	Hospitalized* Human Cases	Mosquito Pools	Birds	Horses
New York State Total	14	360	1,278	19
New York City	14	170	179	3
New Jersey	6	57	1,289	27
Connecticut	1	14	1,117	7
Delaware	0	0	1	4
Massachusetts	0	4	448	1
Pennsylvania	0	46	32	1
Rhode Island	0	0	87	1
North Carolina	0	0	1	0
New Hampshire	0	0	7	0
Maryland	0	0	50	0
Washington, D.C.	0	0	5	0
Vermont	0	0	1	0
Virginia	0	0	7	0
Maine	0	0	0	0
Totals	**35**	**651**	**4,502**	**63**

Note: In addition, 6 wild mammals (1 in Connecticut and 5 in New York State) were also classified as West Nile positive.

* Does not include cases identified through seroprevalence surveys.

Source: USDA Animal and Plant Health Inspection Service Update on the Current Status of West Nile Virus, Final Report? Year 2000.

As with other pathogens carried by mosquitoes, control of West Nile virus focuses on prevention and control of its vectors. As discussed above, once the cause of the outbreak was identified through a collaboration of Federal and State agencies and the City, the responsible agencies acted promptly to contain the outbreak. At the same time, the agencies began to frame a program for control of mosquitoes to reduce the potential for outbreaks in the future. Five fundamental approaches toward mosquito management or control were identified:

- Education to help the public understand how and where mosquitoes breed, what they look like, what steps can be taken to reduce breeding habitat and prevent breeding, and how to avoid mosquito bites, as well as providing information to the public and medical providers about mosquito control insecticide products;
- Reducing the opportunity for breeding by eliminating breeding habitats;
- Surveillance;
- Control of mosquitoes in the larval stage, when they are confined to standing water; and
- Control of adult mosquitoes.

The discussions below on the adulticiding applications undertaken for the 1999 and 2000 outbreaks of West Nile virus in New York City are intended to provide an overview of the actions undertaken in 1999 and 2000 to control the threat of mosquito-borne diseases to the residents and workers of the City. The discussion of these actions also demonstrates the City's changing understanding of the

threat to public health from West Nile virus, and how additional knowledge on the surveillance programs put into place under the Routine Program has helped the City to better understand the warning signs of when an outbreak of West Nile virus is imminent.

1999 Response to New York City West Nile Encephalitis Outbreak

As discussed above, in late August 1999, a cluster of encephalitis cases was identified among eight individuals in northern Queens. By September 4, NYCDOH, with support of the CDC and the NYSDOH, had confirmed three encephalitis cases, including one fatality, and was investigating over 30 potential cases of encephalitis caused by mosquitoes.

To eradicate the potential spread of the virus causing the disease, the Mayor's Office of Emergency Management (OEM), in collaboration with NYCDOH, NYSDOH, and CDC commenced mosquito control actions for northern Queens and southern Bronx. The surveillance operations undertaken by New York City in 1999 identified positive mosquito pools and reported human cases. Sentinel chicken flocks were not included until 2000 NYCDOH operations. These indicators determined when and where to spray adulticides. Spraying of adulticides took place citywide from September 3 through October 3, 1999. Adulticides, including those containing the active ingredient malathion (by helicopters) and synthetic pyrethroids (mostly by truck), were applied in 1999. Figures 1-3 (a) through 1-3(f) provide a general depiction of the areas within the City that were treated with adulticide products from both ground and aerial applications in 1999. NYCDOH issued public press releases and broadcasted facsimiles to health care providers about the outbreak. NYCDOH commenced a 24-hour hotline to provide information on the outbreak and spraying measures, and to take reports of stagnant water (i.e., potential mosquito breeding areas). By September 9, other cases had been confirmed for patients residing outside of northern Queens, and adulticide spraying was expanded Citywide. West Nile virus also appeared in other counties adjacent to New York City. For example, nine human West Nile virus cases occurred in Westchester County.

NYCDOH worked collaboratively with the NYSDOH and CDC to conduct vector surveillance during the outbreak, and monitored reports of dead birds, crows in particular, from the public. NYSDOH received reports of 17,339 dead birds, which included 5,697 crows. Between August and December 2000, 295 dead birds were laboratory-confirmed to have been infected with West Nile virus, 89% of which were crows (Eidson et al., 2001).

In concert with these actions in 1999, the City also distributed pamphlets, which were translated into 10 languages and were distributed at meetings, New York City Fire Department (FDNY) houses and New York City Police (NYPD) precincts. More than 800,000 pamphlets were printed and distributed. In collaboration with other City agencies, notably the New York City Department of Sanitation, mosquito breeding sites such as tire piles were cleaned up. Larvicides (Vectolex) were applied to areas of standing water. In addition, the City purchased more than 500,000 canisters of insect repellant and distributed this repellant and instructions for proper usage at FDNY houses, NYPD precincts and OEM mobile command centers.

In 1999, a serosurvey conducted in a northern Queens neighborhood (considered the center of the 1999 West Nile virus outbreak), estimated that the incidence of West Nile virus infection in New York City was 2.6 percent. On the basis of a Staten Island serosurvey in 2000, an estimated 1,574 residents greater than 12 years of age were infected with West Nile virus in 2000; an estimated 1 in 157 West Nile virus-infected Staten Island residents developed severe neurologic illness (MMWR, 2001).

Development of the Comprehensive Arthropod-Borne Disease Surveillance and Control Plan 2000

In coordination with the CDC and NYSDOH, NYCDOH developed a *Comprehensive Arthropod-Borne Disease Surveillance and Control Plan for 2000* (*Comprehensive Plan for 2000*). These efforts resulted in the development of the *Routine Program* (discussed in further detail below), which emphasized surveillance, education and larviciding efforts, and were directed at minimizing the known vectors of a potential West Nile virus outbreak in 2000, as well as a component to control adult mosquitoes, in the event of a public health threat despite preventive measures under the *Routine Program.* Also included in the *Comprehensive Plan for 2000* was a component that addressed monitoring for potential pesticide related health effects.

2000 NYC West Nile Encephilitis Outbreak and Response

In 2000, bird and mosquito testing indicated that West Nile virus had become established throughout much of the northeastern United States. Birds infected with West Nile virus were identified as far north as Vermont and as far south as North Carolina? representing a three-fold increase in the geographic area affected by the virus compared with 1999. The re-emergence of West Nile virus in New York City in 2000 resulted in 14 human cases, including two deaths attributable to contracting the virus in 2000. The center of West Nile activity in 2000 was Staten Island, where 10 of the City's 14 human cases occurred.

2000 Actions Under the Routine Program

Vector Surveillance

During the 2000 New York City mosquito season, mosquitoes were collected on a weekly basis from mosquito traps placed at approximately 90 locations throughout New York City. A Citywide network of traps was maintained throughout the year, and the number of sites, the frequency of trap placement, and the number of traps per site varied depending on where the West Nile virus had been detected. Mosquitoes were identified under the direction of a medical entomologist and tested at NYSDOH for the presence of pathogens. While the *Cx. pipiens* species of mosquito continued to be the primary West Nile Virus carrier in 2000, West Nile virus was identified in a total of seven species of mosquitoes in New York City: *Cx. pipiens*, *Cx. salinarius*, *Ps. ferox*, *An. punctipennis*, *Ae. cantator*, *Ae. triseriatus*, and *Ae. vexans*. Of the 2,474 mosquito pools submitted for testing, 170 mosquito pools tested positive (NYCDOH, 2001).

Vertebrate (Animal) Surveillance

In 2000, NYCDOH used three (complementary) methods of vertebrate host surveillance for early detection of West Nile virus or arthropod-borne infection and diseases: dead birds, live wild birds, and sentinel chickens. NYCDOH established sentinel chicken surveillance flocks in each of the five boroughs.

NYCDOH collaborated with the New York State Department of Agriculture and Markets (NYSDAM) in the testing of 14 sentinel chicken flocks. The New York State Office of Parks, Recreation and Historic Preservation also assisted in these efforts.

NYCDOH also monitored bird fatalities, especially among crows and sparrows, as a potential marker for West Nile virus activity. Dead birds infected with West Nile in 2000 were found in most Northeastern and Central Atlantic states. Many species of birds tested positive for West Nile Virus in 2000, but crows, sparrows, and blue jays remained the birds most closely monitored by the NYCDOH and state agencies. Birds infected with West Nile virus were found in all but one of New York State's

counties in 2000. Of the 1,263 birds (including 10 live ones) submitted to the New York State Department of Environmental Conservation (NYSDEC) for testing, 177 birds tested positive for West Nile virus. These numbers reflect only dead birds that were tested, not all potentially infected live and dead birds. Since 1999, 66 avian species have been detected as West Nile virus hosts in the United States.

In addition, NYCDOH worked with the veterinarian community to enhance surveillance of encephalitis and other arthropod-borne diseases in horses, dogs, cats, and other animals. In 2000, 10 horses, 3 squirrels, 1 raccoon, and 1 rabbit tested positive for West Nile virus in New York City. NYCDOH's animal surveillance efforts were assisted by a number of partner organizations, including the New York City Department of Parks and Recreation (NYCDPR), NYSDAM, the Animal Medical Center, the Staten Island Zoo, and the Bronx Zoo (which includes the Wildlife Conservation Society). The Staten Island Zoo provided additional assistance in enhanced surveillance of birds on Staten Island, and their efforts were integral to the completion of a serologic survey of live birds on Staten Island.

Human Surveillance

NYCDOH received reports from physicians and conducted active surveillance for West Nile virus by regularly calling physicians at hospitals throughout the summer of 2000. In all, 530 suspected cases of viral meningo-encephalitis were reported and tested for West Nile virus. Of the suspected cases, 14 persons tested positive, including 10 from Staten Island, 2 from Brooklyn, 1 from Manhattan, and 1 from Queens. Ages ranged from 36 to 87 years, with the median age being 62 years. Eight cases occurred in men and 6 cases occurred in women. There were two fatalities resulting from contraction of West Nile virus in New York City in 2000.

Serosurvey

To determine the prevalence of recently acquired West Nile virus infection and to assess associated risk factors for infection, random door-to-door household cluster serosurveys were conducted in Staten Island and portions of Fairfield County, Connecticut, and Suffolk County, New York, during October through November 2000. 634 households (877 people) in randomly selected neighborhoods volunteered to participate by answering questions and providing blood samples for testing for the presence of antibodies to West Nile virus. Of 871 residents of Staten Island surveyed, 4 had positive samples indicative of recent infection.

Of 176 persons reporting fever and headache during July-August 2000, 2 (1.1 percent) were infected recently, compared with 3 out of 2,222 (0.1 percent) persons who did not have these symptoms. However, persons recently infected with West Nile virus did not differ significantly from other surveyed residents by age or sex (Mostashari et al., 2001).

In 2000, hospital-based surveillance identified 10 Staten Island residents with severe West Nile Virus neurologic illness resulting from contraction of West Nile virus. On the basis of Staten Island serosurvey data, an estimated 1,574 residents older than 12 years of age were infected with West Nile virus in 2000; an estimated 1 in 157 West Nile virus-infected Staten Island residents developed severe neurologic illness.

Education and Outreach

Public Education and Outreach

NYCDOH established a toll-free West Nile Virus Information Line in English and Spanish in March 2000 to provide comprehensive information about the virus, including updated information about adulticide spraying schedules. From 8 AM until 9 PM, callers had the option of speaking to a live operator. From March to October, the West Nile Virus Information Line received more than 110,000 calls, 94,000 of which were received between July and October. Approximately 17,000 calls were handled by a live operator.

NYCDOH also provided updated information on West Nile virus through its Web site (www.nyc.gov/health) in the form of fact sheets, press releases, spraying schedules, and maps. This information was regularly faxed to City agencies, elected officials, community boards, the Board of Education, nursing homes, associations of green grocers, day camps, and community organizations.

In the spring of 2000, NYCDOH launched a public education campaign to increase awareness of West Nile virus. It highlighted the need for New Yorkers to take personal protection measures against mosquitoes and to eliminate mosquito breeding sites around their homes. With the message of "Mosquito-Proof New York City? The Bite Stops Here" in English and Spanish, a poster campaign appeared from May to October on New York City buses, bus shelters, and subways, telephone booths, community billboards, and sanitation trucks across the city. NYCDOH also aired television and radio public service announcements in English and Spanish and placed print advertisements in numerous publications.

As part of the public education campaign, NYCDOH developed posters and a brochure in English and Spanish, a general information fact sheet in 17 languages, and 14 fact sheets with specific information in 11 languages. With the help of community boards, elected officials, schools, and a number of community-based organizations, these materials were distributed throughout New York City.

NYDCOH's Speakers Bureau made more than 200 presentations on West Nile virus to community boards; elected officials; City agencies; civic, tenant, and homeowner associations; schools; and other community-based organizations. Presentations were conducted in languages other than English to accommodate the needs of each community.

Medical Provider Education and Outreach

As part of an active surveillance and education program, NYCDOH's Communicable Disease Program made more than 100 slide presentations to medical providers, encouraging the reporting of suspect cases of encephalitis and meningitis. Providers and laboratory personnel were also instructed on how to submit specimens for West Nile virus to the NYCDOH's laboratories.

In addition to these activities, NYCDOH sent weekly broadcast faxes and e-mails to all New York City hospitals providing updates on the City's West Nile virus surveillance findings. These updates also included information on how to report suspect or confirmed cases of West Nile virus infection and pesticide poisonings. In addition, two special issues of *City Health Information* (*West Nile Virus ? A Briefing*) were mailed to more than 46,000 physicians and other health care providers in New York City. One issue discussed how providers could detect human cases of diseases resulting from West Nile virus; the other provided detailed information on the pesticides being used and the potential adverse effects of pesticide exposure.

Mosquito Prevention and Larvae Control Activities

NYCDOH received information about areas of standing water that could serve as potential mosquito breeding sites from the City's West Nile Virus Information Line, NYCDOH's Web site, and from elected officials and community groups. From April to October, NYCDOH received more than 9,000 complaints from the general public regarding areas of standing water across the City. NYCDOH responded to each of these complaints and took direct action on 1,400 priority sites. Additional sites were handled by other City agencies, and at a minimum, every report led to a letter being sent to the property owner regarding the need to eliminate mosquito breeding sites.

Beginning on April, 15 2000, and continuing into the fall, NYCDOH conducted extensive activities to apply larvicide in catch basins (storm drains), sewage treatment plants, and large areas of standing water. NYCDOH worked with the New York City Department of Environmental Conservation (NYCDEP), the New York City Housing Authority (NYCHA), and NYCDPR to treat catch basins and other potential breeding sites for mosquitoes, and expand the use of larvae-eating fish at NYCDEP waste treatment plants.

Approximately 150,000 catch basins throughout the City (e.g., street storm drains, drains on NYCDPR and NYCHA properties, storm drains on Rikers Island, and highway storm drains) were treated at least twice by hand application of larvicides approved by the United States Environmental Protection Agency (USEPA) and NYSDEC. Larvivorous fish (*Gambusia*) were applied as a control measure in NYCDEP's Water Pollution Control Plants when mosquito larvae were detected. Larvicides were also applied to NYCDPR ponds and lakes—other potential mosquito breeding areas, as well as tidal and freshwater wetlands in New York City. In areas of Staten Island that were inaccessible by ground vehicles, the NYCDOH also conducted aerial applications of larvicide. The larvicides used in 2000 were Altosid (*Methoprene*), Vectolex (*Bacillus sphaericus*), and Bactimos (*Bacillus thuringiensis israelensis).*

Research and Evaluation

NYCDOH continued research to better understand where mosquito breeding occurs in New York City and how West Nile virus and other mosquito-borne diseases are maintained in the New York City environment.

2000 Actions to Control Adult Mosquitoes

In the event of a public health threat, which could occur despite preventive measures under the *Routine Program*, a protocol for controlling adult mosquitoes through the use of adulticides was provided in NYCDOH's *Comprehensive Plan for 2000.* While this EIS on *Adult Mosquito Control Programs* (which will include a long term examination of the potential future applications of adulticides to control future outbreaks of mosquito-borne diseases) will not have been completed until after the year 2000 mosquito season (April-October), NYCDOH's plan for the year 2000 mosquito season was designed to protect public health and the environment.

Adult Mosquito Control? Adulticide Spraying

As mentioned above, although various parts of the City were affected by West Nile virus, the center of the 2000 New York City West Nile virus outbreak was in Staten Island. In areas where West Nile viral activity was detected, NYCDOH conducted targeted, ground-based spraying of adulticide to reduce the adult mosquito population. In addition, aerial application of adulticide was completed in areas of Staten Island inaccessible by ground vehicles. These spraying activities were conducted in accordance with State-registered label recommendations using Anvil 10+10 (an adulticide product

containing the active ingredient sumithrin), an adulticide approved by the USEPA and the NYSDEC for use in adult mosquito control efforts. Adulticide spraying activities commenced on July 19, 2000 and were completed on September 25, 2000. Figures 1-4 (a) through 1-4 (k) provide a depiction of the areas of New York City that were sprayed with adulticides in 2000.

NYCDOH adulticiding actions in 2000 were quite different from those taken in 1999, not just based on geography, but also based on the areas that were subjected to adulticiding. In 1999, the City was caught unaware by a virus that was actively under transmission, and the adulticiding response was based on the identification of the first human cases of encephalitis in Queens. These actions were subsequently expanded to the entire City when multiple human illnesses from mosquito-borne viruses were reported, and the extent of the spread of the mosquito-borne virus within the City was unknown. In contrast, 2000 actions were focused on the detection of virus in mosquitoes, wildlife and humans, with targeted applications based on these surveillance data, and on the best understanding to date of the threat to public health from West Nile virus.

To inform the public about spraying operations in advance, spraying schedules were announced several times a day on WCBS Radio (880 AM). Several radio stations in New York City also ran public service announcements. In addition, NYCDOH posted spraying schedules and maps of spray zones on its website and regularly informed the media, elected officials, and community boards of upcoming spray activities. Information was also publicized through the City's toll-free West Nile Virus Information Line. Emergency departments in hospitals throughout New York City, day camps, the New York City Board of Education, nursing homes, associations of green grocers, and community organizations were also informed of spraying activities.

Monitoring Exposures to Mosquito Control Products

Since exposure to any pesticide may cause adverse reactions, particularly among those with pesticide sensitivity or respiratory conditions, NYCDOH made every effort to provide advance notification of spraying schedules. Prior to conducting adult mosquito control activities, product information on pesticides was sent to all emergency departments that included product information on pesticides. This information included Material Safety Data Sheets (MSDSs), and other information relevant to identifying possible exposures to pesticides. In addition, New York City Poison Control Center (PCC) calls were monitored during times of pesticide spraying. During the summer of 2000, NYCDOH recommended that all persons who experience adverse reactions to pesticides should call their doctor or the PCC. Doctors were advised to call the PCC for consultation and to report if a patient presented any suspected or confirmed pesticide-related illness. Doctors were also advised to report suspected and confirmed cases to the New York State Department of Health Pesticide Poisoning Registry (NYSPPR).

In 2000, PCC received calls from the public related to possible infection with West Nile virus, as well as reports of mosquito bites and reports of exposures to adulticides both human and animal. All reports related to adulticide exposure were forwarded to the Office of Disease Intervention at NYCDOH. NYCDOH then forwarded these reports to NYSPPR for additional review and follow-up.

There were 339 reports to the PCC related to adulticide exposures in 2000. Of these, 157 persons reported some type of symptom. As would be expected with the type of exposure that the general public would experience related to mosquito control, the majority of these symptoms were short term and minor in nature.

NYSDOH's NYSPPR has preliminarily determined that approximately 15 of these persons could be possible or probable cases to be included in their registry. NYCDOH also analyzed hospital data to assess the possible impact of spraying on human health.

Research and Evaluation

NYCDOH conducted preliminary studies to assess the efficacy of adult mosquito control. Preliminary results from examination of mosquito traps in the treated areas indicated an effectiveness of 82 percent (mean control) 24 hours after a spray event with Anvil 10+10, and 47 percent after 48 hours.

Development of NYCDOH's Long-Term Comprehensive Arthropod Surveillance and Control Plan

Routine Program

In response to concerns about mosquito-borne diseases, NYCDOH has implemented the *Routine Program*, a component of the NYCDOH's long-term *Comprehensive Plan*. Through the creation of the *Routine Program*, the City devotes considerable resources to a Citywide effort to control mosquito breeding while enhancing existing disease surveillance and public and medical provider education activities. The mission of the *Routine Program* is to prevent and reduce the potential for diseases carried by mosquitoes and to detect the West Nile and other arboviruses before there are human cases.

The *Routine Program* is designed to focus resources beginning early in the mosquito season to monitor and reduce the potential for a disease outbreak. The reduction of potential mosquito breeding sites combined with larviciding efforts will reduce the potential for outbreaks and, therefore, the type and extent of adulticides needed in the event of an outbreak. NYCDOH's primary efforts include an aggressive public health campaign to make residents and businesses aware of ongoing City efforts and how they can help to eliminate potential breeding areas, as well as actions to reduce breeding, and larval control activities.

Key activities in the *Routine Program* also include:

- A comprehensive surveillance program for vectors (e.g., larval and adult mosquitoes which may transmit diseases) and arboviral diseases in vertebrates, including humans.
- An education program for health providers and the general public.
- Mosquito prevention and larval control activities.
- A research and evaluation program on the West Nile virus and efficacy of larval control activities.

Vector Surveillance

The vector surveillance system for monitoring mosquitoes includes collecting mosquito larvae and trapping adult mosquitoes throughout the City to identify prevalent species, to test for evidence of viruses, and to gauge mosquito density. Monitoring mosquitoes involves working closely with other City, State, and Federal agencies to collect and map information on potential mosquito habitats and trapping mosquitoes in pre-selected sites throughout the City.

Vertebrate (Animal) Surveillance

The vertebrate surveillance program includes monitoring animals that may become infected with the West Nile virus, and focuses on both live and dead bird surveillance as well as surveillance among

horses and domestic animals. This program activity includes a system of monitoring infection and/or illness in other animals in pre-selected sites throughout the City; this is augmented by monitoring for infection in dead and wild birds. The public is involved in reporting dead wild birds. Based on the examination of data collected under this program in 2000, the NYCDOH is gaining better understanding of the surveillance methods which may serve as early indicators of a potential localized outbreak of West Nile virus. For example, based on data collected in Staten Island in 2000, "an elevated minimum infection rate (MIR) for *Culex pipiens* and increased dead bird density were present for two weeks before the first human illness began or, considering the incubation period, 0-10 days before the first human exposure. Elevated MIRs among *Culex pipiens*, *pipiens/restuans*, and *salinarius* and increased dead bird density persisted throughout the 8 week period when human infections occurred. Increasing mosquito MIRs and dead bird densities in an area may be indicators of an increasing risk for human infections" (Kulasekera, et al., 2001). Combining this type of new information with the latest guidance supplied by the CDC, the NYCDOH will continue to refine its methods for determining when adulticiding actions would be appropriate in the future with the Proposed Action.

Human Surveillance

The human surveillance program includes a system of detecting mosquito-borne diseases among humans and active monitoring for suspected cases of viral encephalitis in hospitals and laboratories. While encephalitis is already reportable to NYCDOH, the New York City Board of Health has proposed an amendment to the New York City Health Code to make acute arboviral infection also a reportable condition. NYCDOH's Laboratory is expanding its capacity to screen for West Nile virus and other arthropod-borne pathogens. The Human Surveillance program includes enhanced efforts citywide to ensure that healthcare providers promptly report all suspected cases of viral encephalitis (and meningitis in adults) during the adult mosquito season. In addition, more active surveillance will be conducted at sentinel hospitals and laboratories in areas deemed to be a higher risk for human transmission based on West Nile viral findings in mosquitoes or birds. Serologic (antibody) testing will be arranged at NYCDOH's Public Health Laboratories for West Nile and other arboviral causes of encephalitis for all suspect patients. In the long term, the program will complement physician reporting by establishing sentinel syndromic surveillance as an early warning signal, and monitor for infectious disease symptoms that could indicate new or emerging infections such as those associated with West Nile virus.

Education and Outreach

A system of professional and public education includes active educational programs to: increase collaboration with other City agencies on prevention activities; enhance medical professionals' knowledge of arthropod-borne diseases and mosquito control products; enhance the public's awareness of the risk for arthropod-borne diseases, methods by which exposure to mosquitoes can be avoided, need to eliminate potential mosquito breeding sites, and knowledge about mosquito control products.

Health providers are critical in detecting and preventing arthropod-borne diseases. NYCDOH is educating medical professionals regarding pathogens transmitted by mosquitoes, such as West Nile virus, and gaining cooperation of health care professionals in surveillance of arthropod-borne and communicable diseases.

NYCDOH is launching a multifaceted public education campaign about the critical role the public can play in eliminating potential mosquito breeding sites. NYCDOH is in the process of improving

the public's knowledge of risk factors for arthropod-borne diseases and ways to avoid exposure. In the event of a public health threat, NYCDOH will provide accurate and timely information about when, where, how, and what substances will be used. In addition, NYCDOH will continue:

- Advising the public on how to minimize the potential risk of aquiring a mosquito-borne infection, and
- Developing and distributing information packets and newsletters to health care providers on the clinical aspects of West Nile virus, criteria for reporting and laboratory testing, and the symptoms and indictations of poisoning from mosquito control substances, including mosquito repellants, larvicides, and adulticides.

Mosquito Prevention and Control Activities

The *Routine Program* controls mosquitoes through an intensive effort to reduce areas of standing water and to eliminate mosquito-breeding sites. NYCDOH is working with the public and other City and State agencies to eliminate standing water in empty lots, tire piles, and other vessels. This work is coordinated with NYCDOH Pest Control Services, which protects the public from rodent-borne disease and improves quality of life, through reduction of the rodent population. This preventive action is being augmented with application of larvicide in potential breeding grounds where water cannot be eliminated. NYCDOH is conducting these activities in compliance with Federal and State guidelines, laws, and regulations. The planned larval control system includes the following *Routine Program* activities:

- Actively working on the elimination of potential mosquito-breeding sites.
- Larval dipping (looking for the presence of larvae) at suspected/historical breeding sites.
- Application of larvicide in potential breeding grounds where standing water can not be eliminated (e.g., storm drains/catch basins, wastewater treatment plants, stagnant water) by certified applicators in conformity with labeling and permit requirements.
- Use of larvivorous fish (fish which eat mosquito larvae) in water which is contained (e.g., settling tanks at wastewater treatment plants).

The larviciding operations in the *Routine Program* include the application of larvicides in/near tidal and freshwater wetlands, and therefore, some of the following permits may be required from the NYSDEC: NYSDEC Aquatic Permit, Environmental Conservation Law (ECL) Article 15/Title 6 Part 329 of the New York Compilation of Codes, Rules and Regulations (6 NYCRR), which is required if any mosquito larvicide is to be used in or over any surface waters of the State, with limited exceptions. Waters are exempt from Article 15/Part 329 Aquatic Pesticide Permit requirements only if they meet all four specific criteria listed in the regulations.

- NYSDEC Freshwater Wetlands permit, ECL 70-0107 Article 24/Part 663. These permits are required from NYSDEC if regulated freshwater wetlands or their adjacent areas are potential target sites to receive application of larvicide in connection with any mosquito control activities.
- NYSDEC Tidal Wetlands permit, ECL 70-0107 Article 25/Part 661. These NYSDEC permits pertain if regulated tidal wetlands or their adjacent areas are potential target sites to receive application of larvicide in connection with any mosquito control activities.
- Fishstocking permits from the NYSDEC for the City's water pollution control plants.

Research and Evaluation

Research to understand better the transmission and pathogenicity of West Nile virus and other arthropod-borne diseases in urban settings is ongoing. Furthermore, NYCDOH will continue to assess the efficacy and effects of disease control measures and strategies for vector control.

Adult Mosquito Control Programs

As discussed above, in April 2000, NYCDOH determined (under CEQR review) that the *Routine Program* would not have the potential for significant adverse impact on the public health or the environment, and issued a Negative Declaration for this component of the *Comprehensive Plan*. For the *Adult Mosquito Control Programs*, which could include focused and/or Citywide truck and/or aerial applications of adulticides, NYCDOH issued a Positive Declaration and determined that an EIS should be prepared to assess the potential environmental impacts of adulticiding, before adopting the *Adult Mosquito Control Programs*, which is the Proposed Action for this EIS.

C. THE PROPOSED ACTION

As discussed above, in addition to the *Routine Program*, NYCDOH's *Comprehensive Plan* includes the *Adult Mosquito Control Programs*, defined as the Proposed Action for the EIS. The *Adult Mosquito Control Programs* consist of two components:

- A *Mosquito-Borne Disease Control Program*; and
- A *Mosquito Population Control Program in the Rockaways*.

The goals of the *Adult Mosquito Control Programs* would be to:

- Protect New York City's residents, workers, and visitors from a recurrence of a West Nile virus outbreak (or other mosquito-borne disease outbreaks that might occur in the future);
- Protect the environment from the potential adverse effects from the application of adulticides, should all of the preventive efforts under the Routine Program prove ineffective; and
- Control the adult mosquito population in the Rockaways.

A number of application mechanisms, including backpack, all-terrain vehicles (ATVs), truck or aerial spraying, may be used to apply adulticides. Federal and State laws require the registration of insecticides (both larvicides and adulticides). As part of these Federal and State laws, labels are provided for each product. As mandated under Federal and State law, all insecticide label directions, precautions and restrictions must be followed. Appendix 1 provides the labels and MSDSs for the adulticides under consideration for community-scale applications. In the event that spraying of adulticides becomes necessary, the City will monitor for adverse environmental and human health effects of the spraying.

MOSQUITO-BORNE DISEASE CONTROL PROGRAM

One of the goals of the *Mosquito-Borne Disease Control Program* is to protect public health by reducing the potential for the amplification of viruses in mosquitoes that have been identified as vectors of human disease. The Proposed Action is one component of an integrated pest management program that NYCDOH has proposed to prevent and reduce human health risk from mosquito-borne diseases.

The *Mosquito-Borne Disease Control Program* is based on the latest understanding of the transmission of West Nile virus and other emerging mosquito-borne pathogens, and the threat of diseases to the residents and workers of New York City from such pathogens. Given the recent outbreak of West Nile virus in the region, the science of surveillance for determining the optimum methods for deciding when to adulticide in a given year is still under development. NYCDOH will continue to stay up to date on the latest research with respect to the unfolding new science of better understanding how the amplification of West Nile virus (and other mosquito-borne diseases) progresses.

The comprehensive vector, bird and human data collected in 2000 have allowed NYCDOH to develop more sensitive surveillance criteria for determining the level of West Nile viral activity in birds and mosquitoes that indicate a significant risk for a human outbreak. In 2001, NYCDOH will monitor these indicators on a Citywide basis to identify areas at risk for human transmission.

NYCDOH has developed guidelines for a phased response to surveillance findings. Because there is recent historical evidence of West Nile virus, it is possible that New York City will experience a recurring outbreak of arboviral encephalitis in the future. Therefore, NYCDOH is conducting citywide enhanced surveillance, public education, and mosquito breeding prevention activities. Sporadic West Nile virus findings will trigger more intensive community-specific surveillance, public education, source reduction, and larviciding. Close tracking of dead bird reports will allow the City to further prioritize for enhanced control activity in those areas of the City where there is early evidence of recurrence of the virus. Evidence of dead bird clusters will prompt increased testing of birds and additional mosquito pool collections and testing in conjunction with intensive preventive control measures (e.g., larval source reduction and larval control).

Further evidence of increasing West Nile viral activity at a level to be of significant human health risk, despite aggressive preventive measures, will trigger the consideration of adult mosquito control, especially in nearby green areas (e.g., parks, cemeteries, golf courses, etc.) where amplification of the virus as a result of mosquito/bird transmission is most likely. Indicators that will be monitored include the overall number or clustering of dead birds reported, the positivity rates among dead birds and mosquitoes tested for West Nile viral infection, or escalating mammalian cases. Positive viral tests in bridge vectors (mosquitoes that serve as a main transmission of virus between birds and humans) will be of particular concern.

NYCDOH will work closely with Federal and State partners to assess the risk of an outbreak of human disease and the need to apply pesticides in a limited and targeted area to control adult mosquitoes by considering habitat; time of year; weather conditions; the level of documented virus; the distribution, density, age, and infection rate of the vector population; and the density and proximity of human population.

If an outbreak were in progress? with multiple confirmed cases in humans and conditions that favor continued transmission? adult mosquito control for a larger area of the city would be considered.

If the threat of human illness makes spraying necessary:

- Spraying will be concentrated in areas most at risk for disease occurrence.
- Adulticiding will be conducted by applicators meeting USEPA and NYSDEC requirements. As part *of the Mosquito-Borne Disease Control Program*, NYCDOH is proposing to maintain a 100-foot buffer around open waterbodies during application of

adulticides by truck and a 300-foot buffer around waterbodies during application of adulticides by means of aircraft.

- The City will continue to review available information on the health impact of pesticides. Any pesticide will be applied in compliance with City, State, and Federal laws and regulations.
- The public as well as City agencies with nighttime workers that could be exposed to adulticides will be notified of spray schedules in advance, which should allow sufficient time to take any necessary precautions to reduce pesticide exposure.
- Hospitals will be notified regarding the spraying schedule and information on the pesticide that will be used will be provided to the public and to physicians and other health-care providers.
- NYCDOH will monitor and assess control activities for any potential environmental and health effects through several measures, including pre- and post-spray environmental sampling and addressing pesticide exposure complaints received by NYCDOH.
- For quality assurance purposes, it is the intention of NYCDOH to contract with a qualified contractor, independent of the vendor applying pesticide, to assist NYCDOH in assuring that the technical elements of pesticide application are conducted according to plan and pursuant to applicable regulations.

MOSQUITO POPULATION CONTROL PROGRAM IN THE ROCKAWAYS

In response to community concerns about the quality of life for citizens in the Rockaways, NYCDOH has prepared, under the long-term *Comprehensive Plan*, the *Mosquito Population Control Program in the Rockaways.*

NYCDOH has received numerous correspondence and reports regarding the unbearable infestation of mosquitoes in the Rockaways during the summer months.

Individual residents, representatives of home owner associations, and elected officials including members of Congress, the State Assembly, City Council members, local community boards and the Queens Borough President have reported that large number of biting mosquitoes result in residents limiting outdoor recreation and routine activities. For example, it has been reported that, at times during the summer, sitting in yards, holding little league practice, attending outdoor parties and barbecues, gardening, playing outdoors, and enjoying area parks are not possible due to the presence of biting mosquitoes.

It should be noted that the primary salt marsh mosquito present in the Rockaways, is not currently considered a vector for West Nile virus. The goal of the *Mosquito Population Control Program in the Rockaways* is to minimize the detriment to quality of life for residents and visitors to the Rockaways, from uncontrolled, large populations of mosquitoes.

This program contains elements under both the *Routine Program* and the *Adult Mosquito Control Programs* of NYCDOH's long-term *Comprehensive Plan.* To consider all Rockaway-specific plan elements in one document, NYCDOH has combined these elements from both programs (*Routine Program* and *Adult Mosquito Control Programs*) into the recently published *Mosquito Population Control Program in the Rockaways, 2001.* Although this program name is used to describe the Rockaways' specific aspects of both programs, for the purposes of this EIS, the *Mosquito Population Control Program in the Rockaways* refers to the *adult* mosquito control portion only.

The elements of this program include the following:

- NYCDOH will carry out strategic applications of adulticides when necessitated by high numbers of mosquitoes in traps placed throughout the Rockaways Peninsula; and/or on receipt of a pattern of complaints from the public that indicate unacceptably high levels of biting activity, which can be subsequently documented by NYCDOH staff.
- If adult mosquito control becomes necessary, it will be scheduled when mosquitoes are most active (between dusk and dawn) and weather conditions are conducive to spraying.
- Adult mosquito control will be conducted in a hierarchical manner depending on the acreage involved and expected effectiveness of spray operations. With the program's emphasis on surveillance and targeted control measures, NYCDOH expects to apply adulticides to specific localized areas of the Peninsula via a truck mounted with a cold aerosol generator.
- Information about adulticide spraying days and times will be released 48 hours in advance through the media, the NYCDOH Web site and West Nile Virus Information Line and pertinent City and community organizations.
- NYCDOH will monitor and assess control activities for any potential environmental and health effects through several measures, including pre- and post-spray environmental sampling, and addressing pesticide exposure complaints received by NYCDOH.

The *Mosquito Population Control Program in the Rockaways* will not be implemented at Breezy Point or on any other Federal- or State-owned properties, which would minimize the potential impacts to endangered species in these areas. With respect to the Rockaway Beach area, the City would minimize impacts by maintaining at least a 100-foot setback from the landward edge of the dune habitat where such breeding habitats have been identified.

The Dubois Wildlife Sanctuary, administered by the New York City Audubon Society, and the Bayswater Point State Park, a State-owned land, would also not be sprayed with adulticides as part of the *Mosquito Population Control Program in the Rockaways*.

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