SAN DIEGO COUNTY VECTOR DISEASE AND DIAGNOSTIC LABORATORY

SUMMARY

The 2014/2015 San Diego County Grand Jury (Grand Jury) found the San Diego County Vector Disease and Diagnostic Laboratory to be an underutilized County resource. Currently, there is approximately 6,000 square feet of biological safety level three lab space for lease. The highest level is 4.

The San Diego County Department of Environmental Health is a leader in the detection and prevention of vector-borne diseases. However, there are many more diseases in South and Central America and other areas of the world that could spread to the United States, as did West Nile Virus in 1999.

As recently as March 2015, San Diego County Department of Environmental Health officials announced that their Department found evidence in the County of the *Aedes aegypti* mosquito which may carry diseases endemic to other countries.

The Grand Jury recommends that the laboratory be expanded to study these diseases proactively to minimize the possibility of a major outbreak. Early identification of vector pathogens allows time for the mobilization of public health efforts to reduce negative health outcomes.

The recommended expansion does not necessarily require an increase in funding. The necessary lab space is state-of-the art and available. Instead of leasing it out at market level rent, the lab space could be used by a local research university at minimal or no rent in exchange for research performed in a field related to the work of the present lab staff. This could lead to a synergistic collaboration resulting in positive scientific research benefiting public health.

If such collaboration is not feasible or draws no interest, the cost of additional staff and equipment required could be covered by a small increase in the benefit assessment funding the Vector Control Program receives. The increase would not have to be approved by the voters, as the current levy per parcel is less than the amount previously authorized by the voters.

There are three interrelated facts that underlie the possibility that previously undetected vector-borne diseases will spread to this country. First, modern transportation makes it easy for organisms to move quickly from continent to continent; we are no longer protected by our oceans. Second, people are moving into previously uninhabited areas and coming into contact with unknown organisms and their vectors. Third, climate change makes it possible for species that were foreign to San Diego County to survive

here. West Nile Virus moved from Africa to the East Coast and recently to California as an example.

Last year's news was dominated by the outbreak of Ebola, a zoonotic disease, in West Africa. In six months, over ten thousand lives were lost. A few individuals with the Ebola virus have been treated in the United States with various degrees of success.

INTRODUCTION

The Grand Jury ordinarily reports the results of its investigations together with recommendations and/or commendations. Sometimes the Grand Jury evaluates a complaint and in its investigation finds the agency at issue was farsighted, innovative and worthy of commendation. The San Diego County Vector Disease and Diagnostic Laboratory is one such case.

The Grand Jury began its investigation of the Vector Disease and Diagnostic Laboratory in response to two citizen complaints. The theme of both complaints was that some or all of the services provided by the lab's predecessor, the Animal Disease Diagnostic Laboratory, should be restored.

We found that the Animal Disease Diagnostic Laboratory was unsustainable due to decreased funding coupled with a decreased need for its services. The agricultural industry in the County has declined. Moreover, many of the services provided by the former lab were voluntary and not mandated by government regulations.

Our investigation revealed that the County is still providing services performed by the former lab which were mandated by State regulations, including rabies testing and forensic necropsies (animal autopsies). Most necropsies are currently contracted out by the Department of Animal Services to a private contractor, Animal Mobile Laboratory Services. Rabies is now the responsibility of the Department of Health Services and the Vector Disease and Diagnostic Laboratory still performs some DNA testing on the brains of dead animals believed to be rabid. The non-mandated services provided by the former laboratory are no longer being performed by the County.

In addition, the Animal Disease Diagnostic Laboratory in the Department of Agriculture, Weights and Measures was funded primarily out of the County's General Fund. The fees for some services provided to private citizens were relatively small. For example, the former lab charged a fee of $60 for a necropsy, which did not cover the average cost of necropsies.

The Vector Disease and Diagnostic Laboratory is primarily funded, as is the rest of the Vector Control Program, by a special benefit assessment on all parcels in the County. The services that can be funded with this assessment are strictly limited to activities related to vector control.

The Grand Jury focused its research on the migration of past human epidemics, and the ways other diseases could spread to this geographic region. This could happen through the interaction of climate change, international travel or human contact with unknown pathogens as man puts new lands under cultivation.

The Vector Disease and Diagnostic Laboratory acts as our early warning system for identification of arriving harmful vector-borne zoonotic diseases.

PROCEDURE

Members of the Grand Jury:

- Toured the Vector Disease and Diagnostic Laboratory;
- Received an overview presentation from Vector Control Staff;
- Reviewed documents justifying ongoing funding;
- Interviewed staff who worked at the former Animal Disease and Diagnostic Laboratory;
- Interviewed staff from the Department of Public Health;
- Interviewed staff of the current Vector Disease and Diagnostic Laboratory;
- Reviewed publications written by Vector Disease and Diagnostic Laboratory staff;
- Consulted websites of the World Health Agency, Center for Disease Control and California State Department of Health Services for technical information on various diseases;
- Interviewed Office of Emergency Services personnel; and
- Interviewed County Department of General Services personnel.

DISCUSSION

Diseases that spread from animals to man are called zoonotic diseases. Over 70 percent of new and emerging afflictions result in the transmission of pathogens from animals to man. Of particular concern is species movement accelerated by climate change and international travel.

Climate change is a hotly debated topic. However, there clearly is ample evidence of interglacial cycles and glacial periods in earth's history; this is a fact. How it will intersect with disease pathogens is unknown. However, it is widely anticipated that there will be a significant reaction.

Travel: There is speculation that the West Nile Virus made its way to New York by air travel. The San Diego- Tijuana border is reported to be the most heavily crossed in the world.

Medical doctors initially mistakenly concluded that West Nile Virus was St. Louis encephalitis. A veterinarian discovered a link between bird deaths and humans infected with the disease.

Food Supplies: As populations increase the pressure on food supplies has caused man to venture farther to secure new supplies. In West Africa bats have become a protein supplement to the human diet. The bats are harvested in the forests of this area. Vector specialists believe Ebola, which is a zoonotic disease, spread from bats to humans. Humans are depleting rain forests for cultivation in many areas of the world. Whether harmful pathogens are located in these areas is unknown.

A Brief Overview of Pathogen Movement: The following are just a few of the zoonotic diseases with which everyone is familiar. When you review them, note the number of deaths caused by these illnesses.

Bubonic plague swept through Europe in the 14th century and killed an estimated twenty-five million people which was approximately thirty to fifty percent of the population. England had frequent out breaks of the disease for over a hundred years. The bacterium was spread by fleas which traveled on the bodies of rats. Centuries earlier, during the time of Roman Emperor Justinian, a pandemic killed an estimated fifty million people.

The **Flu pandemic of 1918** which killed between fifty to one hundred million people is hypothesized to have originated in birds, spread to pigs and then mutated to humans. The death toll is estimated to have been 3 to 5% of the population of the world at that time.

Malaria: In 2012 the World Health Organization reported malaria caused illness in two hundred seven million people and killed six hundred twenty-seven. This disease is spread by the *anopheles* mosquito. Malaria was a common disease in the United States and Europe until the late 1800s.

The Vector Disease and Diagnostic Laboratory uses the marriage of necropsies, molecular and DNA investigative approaches to determine if a previously unknown zoonotic disease is present in our environment. This is much faster and more accurate then multiple necropsies which was the primary investigative method used prior to molecular and DNA tools that are now available.

An example of the lab's innovative DNA methodology is the testing of seawater at the San Diego beaches after a storm. Storm water runoff into the ocean often carries disease-causing pathogens to contaminate the water. That makes it dangerous for swimmers and beach goers.

The Public Health Lab can take between twenty-four and forty-eight hours to determine the existence of disease bearing pathogens. The Vector and Diagnostic Laboratory can shorten that process through DNA testing to between 2 hours to 4 hours.

On March 13th, 2015 in an article entitled "Invasive mosquito larvae confirmed in North County for first time" the Coast News reported that *Aedes aegypti* mosquitoes, which can transmit yellow fever, is present in North County.

There is a tendency to think that we are insulated from diseases endemic to other countries due to our temperate climate and the oceans as barriers. Consider that California is projected to experience drought conditions for the next six years as a minimum. Scientists predict this will result in species movement. This means that zoonotic disease reservoirs will accompany the species. The scientists do not know what this effect will have on public health, only that there will be one.

Chikungunya, a disease that was originally located in the Caribbean area, has migrated to the United States. Also, there have been outbreaks of Chikungunya in Italy and France which have similar climates to California. The mosquitoes that carry this virus are not wide spread in the United States. If the virus mutates to be carried by the *A. Albopicus* mosquito, which is more common in the United States, this disease will become a more serious threat to public health.

Air travel is not the only method of species migration; the Asian tiger mosquito was introduced from Asia into Texas via ocean travel. This species is believed to have been introduced in Texas from Asia in used tires. This mosquito can transmit Dengue Fever and has the potential to be a carrier of Yellow Fever, Encephalitis and Heartworm. The Asian tiger mosquito's climate of origin was sub-tropical, but it has adapted to more temperate climate zones.

The Crimean-Congo Hemorrhagic Fever first detected in Crimea and then later found to be prevalent in Africa and the Middle East is fatal in 80% of the cases. California currently does not have the tick species that carries this disease. Early identification is the key to protecting our citizens. This is a role that the Vector and Diagnostic Laboratory, in conjunction with our research universities in San Diego, is uniquely suited to fill.

Appendix A contains a list of vector-borne diseases for which the lab tests. Appendix B contains a list of zoonotic diseases that are not as well-known but have the potential to migrate to this region from Central and South America, as well as other areas of the world, via a land bridge, air travel or ships. This migration may be facilitated by climate change, rapid international travel and the cultivation of newly habitable land from formerly uninhabitable forests.

Vector Control Program: The Vector Disease and Diagnostic Laboratory became part of the Vector Control Program of the Department of Environmental Health January 1, 2011, under County Ordinance number 10098 adopted on December 8, 2010. At that time its name was also changed from the Animal Disease Diagnostic Laboratory to the Vector Disease and Diagnostic Laboratory.

The County's Vector Control Program is authorized by the State Health and Safety Code, Sections 2000, et seq. Among other things, State legislators recognized that California's connections to the wider national and international economies increase the transport of vectors and pathogens; also that invasions of the United States by vectors such as the Asian tiger mosquito and by pathogens such as the West Nile virus underscore the vulnerability of humans.

The Health and Safety Code authorized the formation of vector control districts. In most counties in the State, they are governed as special districts. Sometimes these districts cover a whole county, while other counties have multiple vector control districts. Los Angeles County, for example, has eight.

The California Government Code, section 25842.5, stipulates that a County Board of Supervisors may establish a department which provides the same services and exercises the same powers as vector control districts. This is the case with the County of San Diego and about five other counties in the State. One advantage of having vector control in a county department is access to support services, such as legal and financial services. Another is that it facilitates the relationship with agencies having missions related to vector control, such as the Department of Public Health and the Department of Animal Services.

The Vector Control Program provides the following services, among others:

- Monitors disease- carrying insects such as mosquitoes and ticks, and potentially harmful animals such as rats;
- Reduces the population of mosquitoes and other vectors through control and abatement; for example, by the aerial application of larvicide on mosquito larvae;
- Tests for diseases carried by insects and small mammals;
- Responds to requests for property inspections for the control of rats, flies, ticks and mosquitoes on properties throughout the County;
- Conducts public education and outreach activities;
- Participates in emergency response, especially to an outbreak of vector-borne diseases; and
- Conducts surveillance for new, emerging and historical vector-borne diseases.

Vector Disease and Diagnostic Laboratory: This lab is an integral part of the County's Vector Control Program. It can:

- Detect vector-borne pathogens and evaluation of their threat to public health using molecular tools and science- based methods;
- Test samples, collected in the field by Vector Control staff, for emerging and re-emerging vector-borne diseases such as dengue, hantaviruses and rickettsia pathogens;
- Develop and/or implement improved testing procedures for dengue virus, hantavirus, Rocky Mountain Spotted Fever and West Nile Virus;
- Participate in the Asian Tiger Mosquito Strategic Response Plan;
- Perform necropsies for detection of rabies, and occasionally by request from other County Departments; and
- Collaborate with other agencies, such as the United States Fish and Wild Life Service, the University of California at Davis, and the Mosquito and Vector Control Association of California.

As an example of improved testing procedures, the lab produced a serological test to detect Hantavirus exposure in wild mice reducing the need to send specimens out to another lab, while obtaining results quicker. In 2009, staff of the lab developed a faster procedure and more efficient testing for West Nile Virus. The new process was called the Bilateral Intraocular Cocktail method.

The lab is equipped for DNA sequencing, polymerase chain reaction testing and serology.

The unique significance of this laboratory is that it was constructed as a biosafety level three. There are four biosafety levels as mentioned earlier. The United States Army laboratory at Fort Detrick, Maryland is a biosafety level 4 where the most lethal agents are researched.

Biosafety level 3 is required when vertebrates are involved. Yellow fever, St. Louis Encephalitis and West Nile Virus are examples of agents requiring biosafety level 3. The pathogenicity and communicability, i.e., simple inhalation of particles or droplets may cause serious or lethal disease.

The Vector Disease and Diagnostic Laboratory has been able to perform its current functions with a staff of three people working under the County Veterinarian and within its current budget. However, as documented above, there exists a need to develop testing procedures proactively for a wide variety of vector-borne diseases that have not yet spread to California. The current lab is uniquely positioned to take on this expanded role: it has the lab space, the equipment, and the staff expertise.

The Grand Jury recommends that the Vector Disease and Diagnostic Laboratory testing capacity be expanded in one or both of the following ways:

- Add two more research staff members funded by increasing the special benefit assessment; and/or
- Issue a Request for Proposal (RFP) to the local research universities which could use the existing unused lab space and work collaboratively with the lab staff.

Role in Emergency Response: The County's Public Health Officer, within the Health and Human Services Agency, is the lead person in emergencies involving the outbreak of disease. The County Public Health Laboratory is the primary lab. The Vector Disease and Diagnostic Laboratory plays a relatively minor role unless the outbreak involves a vector-borne disease, such as the West Nile Virus.

The two laboratories have a reciprocal working relationship. Their directors meet regularly. In times of disaster or other emergency, if one lab is unable to function, the other lab serves as the backup, according to the County's Continuity of Operations Plan.

The unused space at the Vector Disease and Diagnostic Laboratory is able to accommodate the more than thirty employees of the Public Health Laboratory should that lab be taken out of service.

Funding: On July 13, 2005, the Board of Supervisors approved the levy of assessments for the Mosquito, Vector and Disease Control Benefit Assessment following 61.46% of voting property owners supporting the ballot measure. According to Article XIIID of the State Constitution (Proposition 218) approved by California voters in November 1996, property owners must approve a benefit assessment through a ballot measure and in subsequent years the governing body approves the levy on properties.

The ballot measure authorized the assessment at a rate of $8.55 per parcel in Fiscal Year 2005 with an annual increase of no more than 5%. However, no increase was necessary as the assessment for Fiscal Year 2006 was $6.36 per parcel and the current levy is $5.86. The annual amount is approved by the Board of Supervisors each year. Proposition 218 requires an annual Engineers Report to justify the benefits, separate special from general benefits, and compute the amount of the levy.

The Vector Control Program was formerly funded by a tax levy called the Mosquito Abatement and Vector Control District Service Charge. The service charge was insufficient to fund the program past Fiscal Year 2005. This service charge is still being levied but the rates are frozen at $3 per parcel for the coastal areas and $2.28 per parcel for the inland areas.

The Mosquito, Vector and Disease Control Benefit Assessment and the Mosquito Abatement and Vector Control Service Charge are placed on the tax roll, so that property owners can pay the benefit assessment and service charge through their property tax bills.

On July 30, 2014, the Board of Supervisors approved the Special Benefit Assessment at the existing rate of $5.86 per parcel for Fiscal Year 2015. The Board also approved the Service Charge at the frozen rates of $3 (coastal parcels) and $2.28 (inland parcels). The benefit assessment is expected to generate approximately $5.3 million and the service charge $2.4 million for FY 2015. These charges will amount to $7.7 million of the Vector Control Program's total budget of $8.6 million.

The Grand Jury commissioned an audit of the benefit assessment funds. The audit report was generally favorable. It indicated that the Vector Control Program complies with the requirements of Proposition 218, is adequately funded by the benefit assessment, and has access to additional funding in the event of an emergency.

One significant finding of the report was that the Ballot Guide specified an annual audit would be performed to ensure the voters that funds would be expended appropriately. To date, no audit has been authorized by the Department of Environmental Health. The Grand Jury recommends that the Department of Environmental Health's budget be amended to include funds to audit the benefit assessment revenue.

FACTS AND FINDINGS

Fact: The County Vector and Disease and Diagnostic Laboratory was envisioned to unite the ongoing need for necropsies with the ability to address future unknown pathogens with sophisticated DNA equipment.

Fact: Approximately 6000 square feet including some Biological Safety Level 3 lab space of the Vector Disease and Diagnostic Laboratory is not being utilized.

Fact: The unused lab space at the Vector Disease and Diagnostic Laboratory has been advertised for lease since April 30, 2010 and has not been rented out to date.

Fact: The Vector Disease and Diagnostic Laboratory is the back-up lab for the County's Public Health Laboratory during an emergency or natural disaster.

Fact: The Vector Control Program's largest source of funding is a benefit assessment on real property parcels in the County.

Fact: The assessment was approved by the voters in 2005.

Fact: The Ballot Guide for the 2005 election promised an annual audit.

Finding No 1: The Vector Disease and Diagnostic Laboratory has the capacity to expand its research on vector-borne diseases endemic to other countries but are capable of migrating to the San Diego region.

Finding No 2: A partnership between staff of the Vector Disease and Diagnostic Laboratory and the research staff at a local university would be beneficial to San Diego County, possibly resulting in significant advances in the ability to detect and treat vector-borne diseases.

Finding No 3: If the unused space at the Vector Disease and Diagnostic Laboratory is fully leased, an alternate site would have to be found for the County Public Health Laboratory during an emergency or natural disaster.

Finding No 4: An audit of the Vector Control special benefit assessment funding, as required by the Ballot Guide, has not been conducted since its inception in 2005.

COMMENDATIONS

The Grand Jury wishes to commend:

- **The members of the San Diego County Board of Supervisors for endorsing the construction of the County Vector Disease and Diagnostic Laboratory in view of outbreaks of vector-borne diseases, some of which were unknown in this region when the lab was conceptualized.**

- **The San Diego County Veterinarian, who had a major role in the design of the lab, for his foresight.**

- **The Veterinarian and his lab staff for developing a faster procedure for testing for West Nile Virus, and also for developing quality control procedures for vector-borne disease diagnostics.**

RECOMMENDATIONS

The 2014/2015 Grand Jury recommends that the San Diego County Board of Supervisors:

15-05: **Increase funding so that the Vector Disease and Diagnostic Laboratory may add staff allowing it to be proactive in developing testing protocols for vector-borne diseases that could potentially spread to the Southern California region**.

15-06: **Maximize the collaboration between the Vector Disease and Diagnostic Laboratory and the county's biotech industry, research universities and Public Health Laboratory.**

15-07: **Instead of leasing the unused space in the Vector Disease and Diagnostic Laboratory at market rates, issue a Request for Proposal to local universities and other research groups, who would utilize the lab space in exchange for a commitment to work collaboratively with the lab staff on diagnostic projects.**

15-08: **Instruct the Director of the Department of Environmental Health to authorize an annual audit of the special benefit assessment which is the primary funding source for the Vector Control Program.**

REQUIREMENTS AND INSTRUCTIONS

The California Penal Code §933(c) requires any public agency which the Grand Jury has reviewed, and about which it has issued a final report, to comment to the Presiding Judge of the Superior Court on the findings and recommendations pertaining to matters under the control of the agency. Such comment shall be made no later than 90 days after the Grand Jury publishes its report (filed with the Clerk of the Court); except that in the case of a report containing findings and recommendations pertaining to a department or agency headed by an elected County official (e.g. District Attorney, Sheriff, etc.), such comment shall be made within 60 days to the Presiding Judge with an information copy sent to the Board of Supervisors.

Furthermore, California Penal Code §933.05(a), (b), (c), details, as follows, the manner in which such comment(s) are to be made:

(a) As to each grand jury finding, the responding person or entity shall indicate one of the following:

(1) The respondent agrees with the finding

(2) The respondent disagrees wholly or partially with the finding, in which case the response shall specify the portion of the finding that is disputed and shall include an explanation of the reasons therefor.

(b) As to each grand jury recommendation, the responding person or entity shall report one of the following actions:

(1) The recommendation has been implemented, with a summary regarding the implemented action.

(2) The recommendation has not yet been implemented, but will be implemented in the future, with a time frame for implementation.

(3) The recommendation requires further analysis, with an explanation and the scope and parameters of an analysis or study, and a time frame for the matter to be prepared for discussion by the officer or head of the agency or department being investigated or reviewed, including the governing body of the public agency when applicable. This time frame shall not exceed six months from the date of publication of the grand jury report.

(4) The recommendation will not be implemented because it is not warranted or is not reasonable, with an explanation therefor.

(c) If a finding or recommendation of the grand jury addresses budgetary or personnel matters of a county agency or department headed by an elected officer, both the agency or department head and the Board of Supervisors shall respond if requested by the grand jury, but the response of the Board of Supervisors shall address only those budgetary or personnel matters over which it has some decision making authority. The response of the elected agency or department head shall address all aspects of the findings or recommendations affecting his or her agency or department.

Comments to the Presiding Judge of the Superior Court in compliance with Penal Code §933.05 are required from:

Responding Agency	Recommendations	Due Date
San Diego County Board of Supervisors	**15-05 through 15-08**	**08/10/15**

Appendices: The descriptions of diseases listed in the following appendices are edited from material contained in the websites and publications of the World Health Organization, the Center for Disease Control, the State Department of Public Health, the San Diego County Department of Environmental Health and the San Diego County Department of Public Health.

APPENDIX A: VECTOR BORNE DISEASES

Some Vector-Borne Diseases For which the Vector Disease and Diagnostic Laboratory Has Testing Capabilities:

West Nile Virus is most commonly spread by infected mosquitoes. West Nile virus can cause febrile illness, encephalitis (inflammation of the brain) or meningitis (inflammation of the lining of the brain and spinal cord).

West Nile virus transmission has been documented in Europe and the Middle East, Africa, India, parts of Asia, and Australia. It was first detected in North America in 1999, and has since spread across the continental United States and Canada.

Anyone living in an area where West Nile virus is present in mosquitoes can be infected. West Nile virus has been detected in all lower 48 states but not in Hawaii or Alaska.

St. Louis Encephalitis is a rare disease that is caused by a virus spread by infected mosquitoes. St. Louis Encephalitis virus (SLEV) is one of a group of mosquito-transmitted viruses that can cause inflammation of the brain (encephalitis). SLEV is transmitted by the bite of an infected mosquito. SLEV is not transmitted directly from person to person.

Cases have been reported throughout the country, but periodic outbreaks and epidemics have primarily occurred in the Mississippi Valley and along the Gulf Coast. In temperate areas of the United States, SLEV disease cases occur primarily in the late summer or early fall. In southern states, cases can occur year round. Anyone bitten by a mosquito in an area where the virus is circulating can be infected with SLEV. Elderly persons are at increased risk of severe disease if they are infected.

Chikungunya is a viral tropical disease transmitted by infected mosquitoes. In recent decades mosquito vectors of Chikungunya have spread to Europe and the Americas. It is relatively uncommon and poorly documented. The disease has primarily been found in Africa, Asia, and on islands in the Caribbean, Indian and Pacific Oceans. As of October 2014, over 776 000 suspected cases of Chikungunya have been recorded in the Caribbean islands, Latin American countries and some South American countries. 152 deaths have also been attributed to this disease during the same period. Mexico and USA have also recorded imported cases.

There is no cure or commercial vaccine for the disease. Most patients recover fully but in some cases, joint pain may persist for several months or even years.

Dengue is a disease caused by any one of four closely related dengue viruses transmitted to humans by the bite of an infected mosquito. In the Western Hemisphere, the *Aedes aegypti* mosquito is the most important transmitter (or vector) of dengue viruses, although a 2001 outbreak in Hawaii was transmitted by *Aedes Albopicus*. It is estimated that there are over 100 million cases of dengue worldwide each year.

Dengue Hemorrhagic Fever (DHF) is a more severe form of dengue infection. It can be fatal if unrecognized and not properly treated in a timely manner. DHF is caused by infection with the same viruses that cause Dengue.

Dengue is transmitted to people by the bite of an *Aedes* mosquito that is infected with a dengue virus. The mosquito becomes infected with dengue virus when it bites a person whose blood contains dengue virus. The person can have symptoms of dengue fever or DHF, or have no symptoms. After about one week, the mosquito can then transmit the virus while biting a healthy person. Dengue cannot be spread directly from person to person.

There is no vaccine for preventing dengue. The best preventive measure for residents living in areas infested with *Ae. Aegypti* is to eliminate the places where the mosquito lays her eggs; primarily artificial containers that hold water.

Hantavirus Pulmonary Syndrome (HPS) is a rare, but often fatal, disease of the lungs. HPS was first recognized in 1993 in the southwestern United States. Although many hantaviruses exist in nature, HPS in the western U.S. is caused by a specific hantavirus called Sin Nombre virus (SNV).

Hantaviruses are maintained in nature in wild rodents. In California, only deer mice carry and shed SNV.

Infected rodents shed hantavirus in their urine, droppings, and saliva. Most HPS patients become infected by breathing air contaminated with rodent urine or droppings, such as when cleaning out a rodent-infested space.

Persons first develop symptoms one to two weeks, and up to five weeks, after exposure to SNV. Early symptoms of HPS include fever, headache, and muscle aches, especially in the thighs, hips, back, and shoulders.

Other early symptoms include dizziness, chills, nausea, vomiting, diarrhea, and abdominal pain. After two to seven days of these symptoms, patients develop breathing difficulties that range from cough and shortness of breath to severe respiratory failure. Approximately 40 percent of HPS patients die from the disease.

Persons with HPS can be readily diagnosed by specific blood tests. Currently, there is no specific treatment for HPS. However, if infected individuals are recognized and hospitalized early, supportive care can improve their chances for survival.

Chances of contacting this disease can be minimized by the avoidance of contact with all wild rodents, and their droppings, and nesting materials.

Lyme disease is caused by *Borrelia* bacteria and is transmitted through the bite of infected deer ticks. The first recognized outbreak of this disease occurred in Connecticut, United States, in 1975. The current burden is estimated at 7.9 cases per one hundred thousand people in the United States, according to the US Centers for Disease Control and Prevention. It is now the most common tick-borne disease in the Northern Hemisphere. Lyme disease symptoms include fever, chills, headache, fatigue, muscle and joint pain. Most cases of Lyme disease can be treated successfully with a course of antibiotics.

Rocky Mountain spotted fever is caused by the bacteria *Rickettsia rickettsii* which is carried by ticks. The bacteria spread to humans through a tick bite. Symptoms usually develop about two to 14 days after the tick bite. They may include chills, confusion, fever, headache, muscle pain, and rash which usually starts a few days after the fever.

The complications of untreated Rocky Mountain spotted fever are often life threatening. Treatment involves carefully removing the tick from the skin. To get rid of the infection, antibiotics such as doxycycline or tetracycline need to be taken. Pregnant women are usually prescribed chloramphenicol. Treatment usually cures the infection. About 3% of people who get this disease will die.

Rickettsia 364 D, also known as *Rickettsia philipii*, is transmitted by a bite of a Pacific coast tick. Symptoms are similar but milder than those of Rocky Mountain Spotted Fever, except 364 D may also result in a small open wound or scab (called an eschar).Treatment and prevention is the same as for Rocky Mountain Spotted Fever.

Tularemia or "rabbit fever" is a potentially dangerous bacterial disease. The most common way people become exposed to tularemia is through the bite of infected ticks. However, people can also become infected by touching infected animals, being bitten by them, or by drinking or inhaling contaminated water, dust or aerosols.
Tularemia can be successfully treated with antibiotics but tularemia can be dangerous, even fatal.

Appendix B: Lesser-Known Vector Borne Diseases

Some Vector- Borne Diseases which an expanded Vector Disease and Diagnostic Lab may research:

Chagas disease is a potentially life-threatening illness caused by the protozoan parasite, *Trypanosoma cruzi* (T. cruzi). It is found mainly in endemic areas of 21 Latin American

countries, where it is mostly vector-borne transmitted to humans by contact with feces of triatomine bugs, known as 'kissing bugs', among other names, depending on the geographical area.

About seven to eight million people are estimated to be infected worldwide, mostly in Latin America where Chagas disease is endemic. However, in the past decades it has been increasingly detected in the United States, Canada, many European and some Western Pacific countries. This is due mainly to population mobility between Latin America and the rest of the world.

Infection can also be acquired through blood transfusion, congenital transmission (from infected mother to child) and organ donation, although these are less frequent means of transmission.

Up to 30% of patients suffer from cardiac disorders and up to 10% suffer from digestive (typically enlargement of the esophagus or colon), neurological or mixed alterations. In later years the infection can lead to sudden death or heart failure caused by progressive destruction of the heart muscle.

There is no vaccine for Chagas disease. Vector control is the most effective method of prevention.

Leishmaniasis is caused by a protozoa parasite from over 20 *Leishmania* species and is transmitted to humans by the bite of infected female sandflies. The primary symptom is a rash—usually on the face, upper arms, trunk and other parts of the body. An estimated 1.3 million new cases and twenty to thirty thousand deaths occur annually.

Leishmaniasis is a treatable and curable disease**.**

Effective disease surveillance is important. Early detection and treatment of cases helps reduce transmission and helps monitor the spread and burden of disease. Changes in temperature, rainfall and humidity can have strong effects on vectors and reservoir hosts by altering their distribution and influencing their survival and population sizes. Small fluctuations in temperature can have a profound effect on the developmental cycle of *Leishmania* Promastigotes in sandflies, allowing transmission of the parasite in areas not previously endemic for the disease.

Crimean-Congo hemorrhagic fever is a tick-borne viral disease that kills 30% of infected people. The virus is transmitted to people either from tick-bites or through contact with blood or tissues of infected animals such as cattle, sheep, goats and ostriches. Human-to-human transmission can occur resulting from close contact with the blood, organs or other bodily fluids of infected persons.

The virus occurs in Africa, the Balkans and Asia. CCHF is endemic in Africa, the Balkans, the Middle East and in Asian countries south of the 50th parallel north – the geographical limit of the principal tick vector.

More than one third of those infected will die within the second week of illness. There is currently no safe and effective vaccine widely available for human use.

Tests on patient samples present an extreme biohazard risk and should only be conducted under maximum biological containment conditions.

Japanese Encephalitis (JE) is a flavivirus related to dengue, yellow fever and West Nile viruses, and is spread by mosquitoes. JE is the main cause of viral encephalitis in many countries of Asia with nearly sixty-eight thousand clinical cases every year. Although symptomatic JE is rare, the case-fatality rate among those with encephalitis can be as high as 30%. Twenty-four countries in the South-East Asia and Western Pacific regions have endemic JE transmission, exposing more than 3 billion people to risks of infection.

The case-fatality rate can be as high as 30% among those with disease symptoms.

Of those who survive, 20%–30% suffer permanent intellectual, behavioral or neurological problems such as paralysis, recurrent seizures or the inability to speak.

There is no antiviral treatment for patients with JE. Treatment can relieve symptoms and stabilize the patient.

Safe and effective JE vaccines are available to prevent disease. All travelers to Japanese Encephalitis-endemic areas should take precautions to avoid mosquito bites to reduce the risk for JE. Personal preventive measures include the use of repellents, long-sleeved clothes, coils and vaporizers.

Lymphatic Filariasis, commonly known as elephantiasis, is a neglected tropical disease. Infection occurs when filarial parasites are transmitted to humans through mosquitoes. Infection is usually acquired in childhood causing hidden damage to the lymphatic system. Approximately 65% of those infected live in the South-East Asia Region, 30% in the African Region, and the rest in other tropical areas. Currently, more than 1.4 billion people in 73 countries are living in areas where lymphatic Filariasis is transmitted and are at risk of being infected.

Recommended treatment to clear the parasites from the bloodstream is a single dose of albendazole given together with either diethylcarbamazine or ivermectin. Interruption of transmission of infection can be achieved if at least 65% of the population at risk is treated over five years.

Schistosomiasis is an acute and chronic disease caused by parasitic worms. Transmission occurs when people suffering from schistosomiasis contaminate freshwater sources with

their excreta containing parasite eggs which hatch in water. People become infected when larval forms of the parasite – released by freshwater snails – penetrate the skin during contact with infested water.

Migration to urban areas and population movements are introducing the disease to new areas, including Brazil, Venezuela and Caribbean area countries. Increasing population size and the corresponding needs for power and water often result in development schemes, and environmental modifications facilitate transmission.

Appendix C: Ebola Virus Disease

Ebola Virus Disease (EVD), formerly known as Ebola hemorrhagic fever, is a severe, often fatal illness in humans. The virus is transmitted to people from wild animals and spreads in the human population through human-to-human transmission. The average EVD case fatality rate is around 50%. Case fatality rates have varied from 25% to 90% in past outbreaks.

Ebola is introduced into the human population through close contact from an unknown zoonotic reservoir. Speculation is an infected animal such as a chimpanzee, gorilla, fruit bat, monkey, forest antelope or porcupine came into contact with humans.

The incubation period, that is, the time interval from infection with the virus to onset of symptoms is 2 to 21 days. Humans are not infectious until they develop symptoms. First symptoms are the sudden onset of fever, fatigue, muscle pain, headache and sore throat. This is followed by vomiting, diarrhea, rash, symptoms of impaired kidney and liver function, and in some cases, both internal and external bleeding (e.g. oozing from the gums, blood in the stools.)

No licensed vaccines are available yet, but a few potential vaccines are undergoing human safety testing.

Samples from patients are an extreme biohazard risk; laboratory testing on non-inactivated samples should be conducted under maximum biological containment conditions, biological safety level 4.

Appendix D: Glossary of Terms

Biological safety levels are ranked from one to four based on the agents or organisms on which their research is being conducted. Each level up builds on the previous level, adding more constraints and barriers.

Chikungunya is a virus transmitted to humans by two species of mosquitos (*Aedes aegypti* and *Aedes albopictus*) which causes high fever, joint pain and swelling, headaches and a rash.

Larvicides are products used to kill immature mosquitoes before they become adults.

Necropsy is a dissection of a deceased animal's body to determine the cause of death or to collect specimens for additional testing.

Pathogen means an agent causing disease or illness for its host, such as an organism or infectious particle capable of producing a disease in another organism. Pathogens are mostly microscopic, such as bacteria, viruses or fungi.

Polymerase chain reaction is a technology in molecular biology used to amplify a single copy or a few copies of a piece of DNA across several areas of magnitude, generating thousands to millions of copies of a particular DNA sequence.

Serology is a blood test to detect the presence of antibodies against an organism.

Vector means any animal capable of transmitting the causative agent of human disease or capable of producing human discomfort or injury, including, but not limited to, mosquitoes, flies, mites, ticks, other arthropods, and rodents and other vertebrates.

Zoonotic diseases are infectious diseases that can be transferred to humans by animals.