DISEASE RESPONSE STRATEGY
JAPANESE ENCEPHALITIS

FAD PReP
Foreign Animal Disease Preparedness & Response Plan

United States Department of Agriculture

United States Department of Agriculture • Animal and Plant Health Inspection Service • Veterinary Services

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Preface

The *Disease Response Strategy: Japanese Encephalitis* provides strategic guidance for responding to an animal health emergency caused by Japanese encephalitis virus (JEV) in the United States.

This *Disease Response Strategy: Japanese Encephalitis* was last updated in **XXX 2024**. Please send questions or comments to:

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Introduction

Japanese Encephalitis (JE) is a World Organisation for Animal Health (WOAH) notifiable disease due to its potential for international spread, impact on livestock health and production, and ability to cause severe illness in humans. JE is a significant public health risk, causing approximately 68,000 cases and 13,600–20,400 deaths in humans (primarily children) annually[1]. This *Disease Response Strategy: Japanese Encephalitis* was drafted in recognition of the disease's importance to both animal and human health. This document is intended to provide strategic guidance for USDA, APHIS, and responders at all levels in the event of a JE outbreak, should it enter the United States. This guidance covers the pertinent etiology and ecology of JE as well as response strategies. Further information and in-depth reviews of JE can be found in the references and resources section at the end of this document.

This document does not cover, in detail, incident coordination or general foreign animal disease (FAD) response. For more information on these aspects, please refer to the *APHIS Foreign Animal Disease Framework: Roles and Coordination (FAD PReP Manual 1-0)* and the *APHIS Foreign Animal Disease Framework: Response Strategies (FAD PReP Manual 2-0)*. These documents cover general roles and responsibilities as well as general FAD response strategies, respectively.

Additionally, this document does not provide in detail every response policy or response procedure for an outbreak. There will be additional policy guidance provided during an outbreak on specific response operation activities, tailored to the conditions of the outbreak. Finally, this document does not address ongoing management should JE become established in the United States.

Nature of the Disease

JE is an arthropod-borne viral disease of swine, equids, birds, and humans. The disease is caused by the Japanese encephalitis virus (JEV), a positive-strand, Ribonucleic Acid (RNA) virus that belongs to the *Flavivirus* genus in the Flaviviridae family. It is a member of a serological group that includes West Nile virus (WNV), Saint Louis encephalitis virus (SLEV), and five other viruses that together occur on every continent except Antarctica.[2] Globally, this zoonotic disease is known to cause around 70,000 cases of human encephalitis each year. JE also causes significant reproductive losses in swine and encephalitis in horses.

There is only one known serotype of JEV, but at least five genotypes have been identified through sequencing of the viral pre-membrane region. Many different species are susceptible to natural JEV infection: swine (feral and domestic), equids (primarily horses), birds (wild and domestic species), cattle, sheep, goats, dogs, cats, wild mammals, reptiles, amphibians, and humans. All animals except swine and birds are considered dead-end hosts; in other words,

[1] World Health Organization (2019, May). *Japanese Encephalitis*. https://www.who.int/news-room/fact-sheets/detail/japanese-encephalitis.
[2] Khare B. & Kuhn R.J. (2022). The Japanese Encephalitis Antigenic Complex Viruses: From Structure to Immunity. *Viruses*, 14(10), 2213. https://doi.org/10.3390/v14102213.

animals experience infections with viremia levels too low to contribute to transmission to other animals or humans.[3]

JEV is endemic throughout south and southeastern Asia and portions of the Western Pacific. Its reach extends to the Indian subcontinent, as far west as Pakistan and as far south as northern Australia. In 2021-2022, JEV emerged in southeastern Australia where widespread transmission occurred and the source of introduction has yet to be determined as of the writing of this Strategy.[4] JEV has never been found in the United States.

Transmission and Reservoirs

JEV is transmitted through the bite of a mosquito, typically of the *Culex* genus. In Asia, *Culex tritaeniorhynchus*, *Cx. vishnui*, *Cx. pseudovishnui*, *Cx. gelidus*, and *Cx. fuscocephala* have been specifically implicated. In the Western Pacific, including Australia, *Culex annulirostris* is considered the primary vector of JEV.[3] In the United States, *Cx. tarsalis* and *Cx. pipiens* are the primary vectors for transmission of endemic flaviviruses. *Cx. pipiens*, *Cx. quinquefaciatus, Cx. tarsalis, Aedes albopictus, Aedes vexans,* and *Aedes japonicus*, which have been shown to be competent vectors of JEV, are the most likely species to serve as vectors if JEV were introduced into the United States.[5,6]

Vector-free transmission has been documented in pigs via oronasal shedding in an experimental setting but has yet to be demonstrated in field studies. The significance of direct transmission in natural infection remains unclear.[7] Artificial insemination practices may lead to transmission as infection may cause inflammation of the genital tract in boars and subsequent shedding of the virus in semen[8].

The virus is maintained in a transmission cycle between the mosquito vector and vertebrate hosts, predominantly swine or ardeid wading birds (such as herons and egrets). While ardeid birds have been implicated in multiple studies as the natural reservoir, birds from a variety of different species have been shown to be susceptible to infection with JEV but are considered to play a minor role in virus transmission. Young chicks and ducklings have been experimentally

[3] Van den Eynde, C., Sohier, C., Matthijs, S., & De Regge, N. (2022). Japanese Encephalitis Virus Interaction with Mosquitoes: A Review of Vector Competence, Vector Capacity and Mosquito Immunity. *Pathogens*, 11, 317. https://doi.org/10.3390/pathogens11030317.
[4] Williams, C.R., Webb C.E., Higgs, S., & van den Hurk, A.F. (2022). Japanese Encephalitis Virus Emergence in Australia: Public Health Importance and Implications for Future Surveillance. *Vector Borne Zoonotic Disease*, 22(11), 529-534. https://doi:10.1089/vbz.2022.0037.
[5] Van den Eynde, C., Sohier, C., Matthijs, S., & De Regge, N. (2022). Japanese Encephalitis Virus Interaction with Mosquitoes: A Review of Vector Competence, Vector Capacity and Mosquito Immunity. *Pathogens*, 11, 317. https://doi.org/10.3390/pathogens11030317.
[6] Riad, M.H., Scoglio, C., McVey, D.S., et al. (2017). An individual-level network model for a hypothetical outbreak of Japanese encephalitis in the USA. *Stochastic Environmental Research and Risk Assessment*, 31, 353–367. https://doi.org/10.1007/s00477-016-1353-0.
[7] Park, S.L., Huang, Y.-J.S., & Vanlandingham, D.L. (2022). Re-Examining the Importance of Pigs in the Transmission of Japanese Encephalitis Virus. *Pathogens*, 11, 575. https://doi.org/10.3390/pathogens11050575.
[8] Ogasa A, Yokoki Y, Fujisaki Y, Habu A. (1977). Reproductive disorders in boars infected experimentally with Japanese encephalitis virus. *Jap J Anim Reprod,* 23, 171–175.

shown to develop sufficient viremia to infect mosquitoes.[9] However, their role in natural transmission cycles remains unclear.

Swine and ardeid birds serve as amplifying and maintenance hosts due to their high viremia. The mechanism of maintenance through the winter in temperate regions is unknown but is suspected to be related to infected hibernating mosquitoes, transovarial passage, or maintenance in amphibians, reptiles, or bats.[10]

Horses and humans do not play an important role in the natural spread of JEV and are regarded as dead-end hosts, since the viremias they develop are insufficient to pass on the infection to mosquitoes (i.e., horses and humans do not maintain high enough viral titers to infect biting mosquitoes).[11] There has been no evidence that contact, such as two horses sharing a feed bucket, will result in JEV transmission.

Humans primarily become infected through the bite of a mosquito. Other routes such as inhalation of aerosols or direct contact with contaminated mucus membranes or infective fluids in the laboratory or field setting while collecting tissues samples, are also possible but significantly less likely.

Incubation Period[12]

The incubation period for JE in horses is between 8–10 days. For experimentally infected swine, signs of infection, fever, and viremia were observed 24 hours post inoculation with other clinical manifestations apparent within 3 days post inoculation. For the purposes of WOAH, the incubation period for JE is 21 days.

Clinical Signs, Morbidity, and Mortality

Horses[13]

Infection is most often inapparent with clinical cases occurring infrequently and varying in severity. Subclinical cases are the most common. The World Organisation for Animal Health (WOAH) Technical Disease Card for JE describes three syndromic manifestations: transitory, lethargic, and hyperexcitable.

Horses affected by the transitory type may experience fever, anorexia, lethargy, impaired

[9] Cleton, N. B., Bosco-Lauth, A., Page, M. J., & Bowen, R. A. (2014). Age-related susceptibility to Japanese encephalitis virus in domestic ducklings and chicks. *The American Journal of Tropical Medicine and Hygiene*, 90(2), 242–246. https://doi.org/10.4269/ajtmh.13-0161.
[10] World Organisation for Animal Health. (2019). *Japanese Encephalitis Technical Disease Card*. https://www.woah.org/app/uploads/2021/03/japanese-encephalitis.pdf.
[11] Mulvey, P., Duong, V., Boyer, S., *et al*. (2021). The Ecology and Evolution of Japanese Encephalitis Virus. *Pathogens*, 10, 1534. https://doi.org/10.3390/pathogens10121534.
[12] World Organisation for Animal Health. (2000). *Terrestrial Animal Health Code Article 8.10*. https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre_japanese_encephalitis.htm.
[13] World Organisation for Animal Health. (2019). *Japanese Encephalitis Technical Disease Card*. https://www.woah.org/app/uploads/2021/03/japanese-encephalitis.pdf.

locomotion, and congested or jaundiced mucosal membranes; most recover in 2–3 days.

Those affected by the lethargic-type syndrome may display neurologic signs (in addition to signs attributed to the transitory type) such as difficulty swallowing, lack of coordination (ataxia), and impaired vision; most recover in about a week.

The most severe form, the hyperexcitable type, is characterized by high fever, profuse sweating, and neurological signs such as aimless wandering, aggressive or wild behavior, blindness, and muscle tremors. The hyperexcitable type may result in collapse, coma, and death. Should the horse recover, neurological problems may persist.

In horses, morbidity rates have been reported from less than 1 percent to just over 1 percent; case fatality rates are typically 5 percent to 15 percent but can reach 30-40 percent.

Swine[13]

Although JEV typically causes subclinical infection in swine, reproductive disease is the most characteristic clinical manifestation. Reproductive failures and piglet mortality may result in production losses. Stillborn or mummified fetuses delivered at full term are most common. Abortions and piglets born with muscle tremors/convulsions followed by piglet death are also signs of JE. Among swine, reproductive losses can reach 50–70 percent and mortality in non-immune infected piglets may reach nearly 100 percent. Other signs of JE include infertility in boars that may be permanent depending on the severity of the illness.

Swine that are not pregnant do not typically show signs of infection or experience only mild transient fever. Encephalitis is occasionally observed in naïve swine under 6 months of age. Mortality rates are close to zero for adult swine.

Humans[14]

Most infections are asymptomatic. In those who develop clinical signs, illness usually begins with fever and headache which may progress to mentation changes, focal neurologic deficits, weakness, and movement disorders. Severe neurological signs such as flaccid paralysis and Parkinsonian syndrome can occur. Neurologic complications are common in survivors of severe disease.

Less than 1 percent of all infections with JEV result in clinical disease. Case fatality rates typically range from 20 to 30 percent, with neurologic sequelae in up to 50 percent of survivors.

Differential Diagnosis

When considering a potential diagnosis of JE in the United States the list of possible differential diagnoses includes but is not limited to:[15]

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[14] Centers for Disease Control and Prevention. (2022, October). *Japanese Encephalitis Virus: Clinical and Laboratory Evaluation*. U.S. Department of Health and Human Services. https://www.cdc.gov/japaneseencephalitis/healthcareproviders/healthcareproviders-clinlabeval.html.

[15] World Organisation for Animal Health. (2019). *Japanese Encephalitis Technical Disease Card*. https://www.woah.org/app/uploads/2021/03/japanese-encephalitis.pdf.

Horses

- African horse sickness
- babesiosis (equine piroplasmosis)
- bacterial encephalitis
- toxic encephalopathies
- Borna disease
- botulism
- cerebral nematodiasis or protozoodiasis
- equine herpesvirus myeloencephalopathy
- equine infectious anemia
- equine protozoal myeloencephalitis
- hepatic encephalopathy
- leucoencephalomalacia (*Fusarium moniforme*)
- other viral encephalitides, including but not limited to
    - eastern equine encephalitis
    - Murray valley encephalitis
    - western equine encephalitis
    - Venezuelan equine encephalitis
    - West Nile encephalitis
- rabies
- tetanus
- viral equine rhinopneumonitis

Swine

- blue-eye disease (porcine rubulavirus)
- brucellosis
- classical swine fever
- coronavirus
- encephalomyocarditis virus
- hemagglutinating encephalomyelitis
- Menangle virus
- other causative agent of SMEDI (stillbirth, mummification, embryonic death, and infertility)
- porcine parvovirus
- porcine reproductive and respiratory syndrome
- pseudorabies
- Teschen/Talfan
- water deprivation/excess salt
- viral/fever induced abortion

Laboratory Diagnosis

The World Organisation for Animal Health *Manual of Diagnostic Tests and Vaccines for*

Terrestrial Animals Chapter 3.1.10 outlines diagnostic laboratory methods for JE.

Vaccination and Treatment

There is not currently a USDA-licensed vaccine available for horses or swine in the United States. In endemic countries, modified live and inactivated vaccines are available for swine and inactivated vaccines are available for horses. The vaccine for horses is prepared by formalin-inactivation of a virus suspension derived from cell cultures. In swine both inactivated and live-attenuated vaccines derived from cell cultures are used.[16] The vaccines available for horses and swine are thought to be protective against all genotypes of JEV though efficacy may vary.[17] Vaccination of swine, the amplifying hosts, benefits horses and humans by decreasing the viral titers of swine, thereby reducing the transmission of JE. It also serves to prevent reproductive losses in swine. Vaccination of horses prevents clinical disease and possible sequelae.

While a study in Japan indicated that JEV-vaccinated horses can produce false-positive results in West Nile Virus (WNV) serological testing, it is unknown whether previous WNV vaccination (or infection) is protective against JEV infection in horses.[18]

Several vaccines are available for humans in endemic countries. IXIARO® (Valneva GmbH), an inactivated vaccine derived from Vero cells, is available for humans in the United States. It is approved for individuals 2 months of age and older as a 2-dose series; doses are administered 28 days apart with the last dose administered at least 1 week prior to travel.[19] For adults aged 18–65 years, the two doses can be administered in an accelerated schedule at an interval of 7–28 days

Treatment in humans and animals is supportive; there is no specific antiviral therapy available.[20] Survivors of natural infection, both animal and human, are thought to acquire long-lasting immunity.

Persistence of JEV[21]

JEV is inactivated by changes in temperature, pH, exposure to various chemicals and disinfectants as well as environmental impacts, as outlined in Table 1.

[16] World Organisation for Animal Health. (2019). *Japanese Encephalitis Technical Disease Card*. https://www.woah.org/app/uploads/2021/03/japanese-encephalitis.pdf.
[17] Spickler, A.R. (2016). *Japanese Encephalitis*. Center for Food Security and Public Health. http://www.cfsph.iastate.edu/DiseaseInfo/factsheets.php.
[18] Hirota, J., Nishi, H., Matsuda, H., et al. (2010). Cross-reactivity of Japanese Encephalitis Virus-Vaccinated Horse Sera in Serodiagnosis of West Nile Virus. *Journal of Veterinary Medical Science*, 72(3), 369-372. https://doi.org/10.1292/jvms.09-0311.
[19] Centers for Disease Control and Prevention. (2023, February). *Japanese Encephalitis Virus: Japanese Encephalitis Vaccine*. U.S. Department of Health and Human Services. https://www.cdc.gov/japaneseencephalitis/vaccine/index.html.
[20] Spickler, A.R. (2016). *Japanese Encephalitis*. Center for Food Security and Public Health. http://www.cfsph.iastate.edu/DiseaseInfo/factsheets.php.
[21] World Organisation for Animal Health. (2019). *Japanese Encephalitis Technical Disease Card*. https://www.woah.org/app/uploads/2021/03/japanese-encephalitis.pdf.

Table 1. Resistance to Physical and Chemical Action of Japanese Encephalitis Virus.

Action	Resistance
Temperature	Destroyed by heating for 30 minutes above 56 °C (132.8 °F); thermal inactivation point is 40 °C (104 °F).
pH	Inactivated in acid environment of pH 1–3 (stable in alkaline environment of pH 7–9).
Chemicals/disinfectants	Inactivated by organic and lipid solvents, common detergents, iodine, phenol iodophors, 70% ethanol, 2% glutaraldehyde, 3–8% formaldehyde, 1% sodium hypochlorite.
Environment	Virus very labile and does not survive well in environment; sensitive to ultraviolet light and gamma irradiation.

Criteria for Disease Freedom/Trade Implications

WOAH does not grant official recognition for JE-freedom, but as a member of WOAH, the United States can self-declare the entire country, zone, or compartment free of JE. Criteria for self-declaration of disease freedom are outlined in the WOAH Terrestrial Animal Health Code, Chapter 1.6. Surveillance of susceptible animals, reservoir hosts, and mosquito vectors will likely be required to demonstrate disease freedom. In the case of JE, eradication is unlikely making a disease freedom declaration also unlikely.

WOAH recommends importation restrictions on live horses from countries or zones affected with JE but does not address trade restrictions for swine.[22] Trading partners determine whether to implement, lift, or modify trade restrictions based on negotiations and information that is provided by the United States.

One Health Approach

One Health is a collaborative, multisectoral, and transdisciplinary approach – working at the local, regional, national, and global levels – with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment.

Responding to a potential introduction of JEV to the United States will require a One Health approach, with collaboration across the animal, human, and environmental health sectors. APHIS will coordinate response activities closely with the Department of Health and Human Services (HHS) Centers for Disease Control and Prevention (CDC), the Department of Homeland Security (DHS), the Environmental Protection Agency (EPA), as well as state, local, tribal, and territorial (SLTT) partners from animal health (domestic and wild), public health, and environmental agencies. APHIS supports timely and open communication and information sharing among sectors and with non-governmental partners from academia, industry, and non-governmental organizations. Elements of this response strategy, including surveillance, vector control, and wildlife management will only be possible using this One Health approach.

[22] World Organisation for Animal Health. (2000). Terrestrial Animal Health Code Article 8.10. https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre_japanese_encephalitis.htm.

Response Strategy

If JEV was introduced to the United States, detection likely would be delayed due to the low index of suspicion for JE among veterinarians (due to endemic diseases with similar clinical signs in swine and horses) and healthcare providers, and the potential cross-reactivity between JEV and other flaviviruses in serologic tests. This detection delay would increase the likelihood that an enzootic transmission cycle would be established prior to detection. Transmission in wild birds along with a large number and wide range of potential hosts and mosquito vectors present in the United Statesmake achieving eradication of JE difficult.

In the United States, JE is an Foreign Animal Disease (FAD) and a notifiable disease. Suspect cases should be reported to a State Animal Health Official or Area Veterinarian-in-Charge. For more information on conducting FAD investigations please refer to the *APHIS Foreign Animal Disease Framework: Investigation Manual (FAD PReP Manual 4- 0)*.

Response options will be determined based upon the circumstances of JEV introduction in the United States. Should it become apparent that elimination of JE is not achievable, APHIS response efforts will focus on control of JE in domestic animal populations as needed to protect public health and to support the swine and equine industries.

Case Definitions

Case definitions for JE are available on the APHIS National List of Reportable Animal Diseases webpage. <Insert link to NLRAD case definition when available>

Surveillance

Currently there is no active surveillance for JE being conducted in the United States in mosquitoes, swine, equids, or birds. JE surveillance among humans focuses on cases among international travelers and about one JE case per year is reported to the National Notifiable Disease Surveillance System[23].

In the event of a JE detection in the United States, a surveillance plan will be developed according to the *National Animal Health Management System (NAHEMS) Guidelines: Surveillance, Epidemiology, and Tracing*. Existing passive and active surveillance mechanisms for endemic arboviral diseases could be leveraged for JE surveillance, such as CDC's ArboNET. Passive surveillance for endemic arboviral diseases, including West Nile, St Louis encephalitis, and eastern equine encephalomyelitis, could potentially identify JEV infection in a horse, human, or bird. Active arboviral surveillance in mosquitoes could be expanded to potentially identify JEV infection. Mosquito surveillance in the United States is generally conducted at the county or local level by public health and environmental health officials. APHIS will coordinate closely with CDC, state, and local jurisdictions on surveillance efforts.

[23] Janatpour ZC, Boatwright MA, Yousif SM, Bonilla MF, Fitzpatrick KA, Hills SL, Decker CF. (2023). Japanese encephalitis in a U.S. traveler returning from Vietnam, 2022. Travel Med Infect Dis, 52, 102536. https://doi.org/10.1016/j.tmaid.2022.102536..

Diagnostics

The National Veterinary Services Laboratories, Foreign Animal Disease Diagnostic Laboratory (NVSL-FADDL), has assessed an RT-qPCR assay capable of detecting JEV genotypes I-IV, including genotype IV from the 2022 Australian outbreak. Diagnostic testing for animals displaying clinical signs suggestive of JEV would be provided at no cost to animal owners and producers at the NVSL in Ames, Iowa during the initial response. Veterinarians and producers must first notify their State or Federal Animal health officials if JEV is on a differential list, and these officials will assist in the submission and sampling as needed. NVSL uses both PCR and sequencing to identify and confirm the presence of the virus.

Acceptable sample types for pigs include fresh brain, tonsils, spleen, EDTA blood, or serum, as well as aborted fetal brain. For horses, acceptable sample types include fresh brain, cerebrospinal fluid, EDTA blood, or serum. Collect and submit as many of the suggested sample types as available on suspect cases. Due to the brief viremia associated with JEV infection (4-5 days), there is a limited diagnostic window for virus detection by PCR in blood and serum samples. Further validation may lead to the expansion of the approved sample types in the future.

Laboratory diagnosis of human JEV infections can be performed using serology. However, the usefulness of serology in animals is limited due to known cross-reactivity to endemic viruses. Initially, serology would not be offered as an on-demand diagnostic test at NVSL.

Epidemiological Investigation and Tracing

Epidemiological investigation and movement tracing during an outbreak are critical in controlling and eradicating FAD outbreaks. While JEV is transmitted through the bite of a mosquito, tracing animal movements may help identify the source of infection and the location of potentially infected animals. This will contribute to defining the extent of the outbreak. Tracing should include consideration of vector exposure and contact of animals with water birds and feral pigs. Tracing efforts for potentially exposed humans will be coordinated with the appropriate public health authority.

Trace-back and trace-forward information should ideally be collected for at least 42 days[24] before the appearance of clinical signs in animals infected with JEV. Additional tracing information will be collected for movements up to the time quarantine was imposed.

[24] 42 days is two times the incubation period listed in the WOAH Terrestrial Code chapter for Japanese Encephalitis.

Tracing

Trace Back: Identifying the origin of all swine and equines that have been brought onto an Infected Premises (IP) in order to establish the original location of their infection.

Trace Forward: The tracing of all swine, equines, and people* that have left an IP and could have possibly transmitted infection to, or developed illness on, a new premises. The premises that received the animals should be investigated and kept under surveillance or quarantine.

Forward tracing of dead-end hosts (e.g., equines) would enable monitoring of their health, but is unlikely to contribute to understanding of the epidemiology of the outbreak. Therefore, tracing forward of equids will not be prioritized.

Quarantine and Movement Control

Preventing contact between JEV and susceptible animals can be partly accomplished through quarantine and movement control. Quarantines and movement controls of swine, due to their ability to serve as amplifying hosts, are critical to contain JE, particularly if eradication is deemed feasible. Additionally, there is growing evidence that transmission may occur through direct contact between pigs, which may contribute to spread if infectious pigs are moved. IPs should be rapidly quarantined and movement controls should be implemented for swine in the Control Area (CA) until initial risk assessments can be completed. The results of the risk assessments will guide continued need for quarantine and movement controls.

Quarantine is a type of biosecurity protocol that refers to imposing restrictions on entering or leaving a premises, area, or region where disease exists or is suspected. Quarantine stops the movement of infected animals from Infected, Contact, and Suspect Premises.

Movement control refers to activities regulating the movement of animals in an area subject to certain criteria. Movement control is accomplished through a permit system that allows entities to make necessary movements without creating an unacceptable risk of disease spread.

Each State's animal health emergency response plan should describe the implementation of quarantine and movement controls, including a permit system. USDA may impose a Federal quarantine and restrict interstate commerce from the infected States, asking the States (or adjoining counties) to provide resources to maintain and enforce the quarantine.

All decisions regarding quarantine and movement control will be determined using science-based assessments and will weigh the risk of disease transmission against the need for critical movements and business continuity. Movement controls will be focused on minimizing the spread of infection.

Zone, Area, and Premises Designations

Appropriate premises designations will be required for implementation of any quarantine and movement control measures established based on the results of the risk assessments. These designations will be determined in accordance with the *APHIS Foreign Animal Disease Framework: Response Strategies (FAD PReP Manual 2-0)* and *NAEHMS Guidelines: Quarantine and Movement Control*. See Attachment A for further information on zone, area, and premises designations and minimum sizes of zones and areas for JE. Because JEV is spread by a vector, the CA is likely to be at least 30 km (18.6 miles) beyond a known IP. The CA size will be adjusted during the response to consider the range of the endemic mosquito species serving as the vector(s), if such information is available.

Control and Eradication

There are five strategies for control and eradication of an FAD, as outlined in the *APHIS Foreign Animal Disease Framework: Response Strategies (FAD PReP Manual 2-0)*:

- *Emergency eradication effort.* Twelve months or less. Regulatory intervention at time of outbreak by State-Federal-Tribal authorities.
- *Extended emergency eradication effort.* Greater than 12 months. Regulatory intervention at time of outbreak by State-Federal-Tribal authorities.
- *National animal disease control program.* Long-term program. Regulatory control program conducted by State-Federal-Tribal authorities.
- *Individual State or Tribal Nation animal disease control program.* Short-term or long-term. State requirements or Tribal Nation requirements.
- *Animal disease monitored with limited or no regulatory intervention.* Short-term or long-term. Little or no regulatory intervention by State-Federal-Tribal authorities.

Eradication strategies are unlikely to eliminate JE because the virus is maintained in mosquito-water bird transmission cycles. Temporary elimination might be possible, but reintroduction would be likely if JEV was already established in an enzootic mosquito-wildlife transmission cycle. Therefore, eradication (i.e., depopulation) is not likely to be an appropriate or necessary part of the control program in most circumstances. Eradication may be considered if the outbreak is confined to a limited geographic area and ecological conditions for establishment are determined to be unfavorable. If eradication is not deemed to be feasible, the decision may be made to manage the outbreak to the extent possible through biosecurity and other control measures or to monitor the disease with limited regulatory intervention.

Horses

Horses, unlike swine, do not maintain sufficient viremia to be epidemiologically important in JEV transmission and would not be included in an eradication strategy. If infected horses experience severe illness, including varying degrees of encephalitis and neurological signs, it is possible that they may need to be euthanized for welfare reasons. This decision will be made by

the owner and attending veterinarian.

Swine

Swine are amplifying hosts of JEV, posing a risk to humans, horses, and other swine. However, as stated above, stamping out swine is unlikely to be effective in controlling JE due to virus maintenance in the sylvatic cycle.

Vaccination

Emergency vaccination of swine may be considered to help limit the spread of JEV in the United States according to the "emergency vaccination to live without stamping-out" response strategy outlined in the *APHIS Foreign Animal Disease Framework: Response Strategies (FAD PReP Manual 2-0)*. It may also be used in certain circumstances to limit viral amplification in support of public health (i.e., to reduce human infection).

Vaccination may also be used to limit reproductive losses in swine and to protect horses from developing disease outside of the response activities.

However, there is not currently a JE vaccine for swine or horses licensed in the United States. If JE was identified in the United States, APHIS would investigate availability of acceptable vaccines, potentially involving emergency approval of vaccines being used in other countries.

Vector Control

In the absence of vaccination, the most effective control measures rely on stopping the transmission of JEV by vectors. Vector control will be a critical issue during a JE outbreak and may be immediately instituted upon detection of JE in the United States. The general concept of mosquito control during a JE outbreak is to reduce the mosquito population below transmission thresholds as quickly as possible until the opportunity for JEV transmission is eliminated.

The recommended approach is Integrated Pest Management (IPM) that targets all stages of the mosquito life cycle. This includes adult treatments targeting infected mosquitoes which aims to limit immediate vector transmission and larval treatments to stop future transmission by mosquito vectors. IPM includes field surveys and systematic collections of mosquitoes to optimize resource allocation towards the vector species spreading JEV in a given area. Knowing when the vectors are present during the day or night and their larval habitats allows for targeted use of mitigation strategies.

Space spraying involves treating an open area with an ultralow volume (ULV) or thermal fogging pesticide by hand, truck, or aircraft (including drones). This treatment targets flying or active mosquito vectors that contact the suspended pesticide treatment. Therefore, treatment timing should be when mosquitoes are most likely to be in flight. If sufficient adult mosquitoes are killed this will help stop JEV transmission in the area. However, resting insects will be unaffected by the treatment. A separate larval treatment is needed to kill the aquatic or immature stages that will later emerge as adults and repopulate the area with mosquito vectors.

Various measures to reduce contact with mosquitoes, such as behavioral management include stabling animals in screened barns during peak mosquito biting activity, can be protective,

particularly during outbreaks. Environmental management includes reducing mosquito larval habitats by eliminating sources of standing water. Chemical management must be used with caution and in accordance with EPA labels. The EPA maintains resources on integrated mosquito control that can be used during a JE outbreak.

State and local laws and regulations for vector control and insecticide use, including any relevant environmental regulations, must also be considered in any vector control efforts. In addition, personal protection measures should be adhered to when using insecticides of any type.

In the United States, government-level control of insect vectors is primarily left to the discretion of county or municipal governments. APHIS will work closely with CDC, EPA, and local jurisdictions during a JE response in accordance with the *NAHEMS Guidelines: Wildlife Management and Vector Control*.

Depopulation, Disposal, and Decontamination

Mass Depopulation and Euthanasia

As stated above, depopulation of swine is unlikely to be used as a control strategy. Equids would not be included in any response involving depopulation.

Disposal

There are no special requirements for disposal of carcasses of animals infected with JEV. The goal is to conduct operations in a timely, safe, bio-secure, aesthetically acceptable, and environmentally responsible manner. Disposal will involve more Federal authorities due to its wider reaching impact on health and the environment. USDA will coordinate with HHS, DHS, and EPA to provide technical assistance and guidance, in alignment with State and local regulations. More information can be found in the *NAHEMS Guidelines: Disposal*.

Cleaning and Disinfection

The goal of cleaning and disinfection (C&D) is to inactivate pathogens at IPs and prevent the off-site spread of pathogens. When performing C&D procedures it is vitally important to do so in the safest and most humane manner as possible. C&D protocols, procedures, and methods, along with safety issues and precautions are more thoroughly discussed in the *NAHEMS Guidelines: Cleaning and Disinfection*.

As noted in Table 1, JEV is susceptible to organic and lipid solvents, common detergents, iodine, phenol iodophors, 70 percent ethanol, 2 percent glutaraldehyde, 3–8 percent formaldehyde, and 1 percent sodium hypochlorite. Per the National Pesticide Information Retrieval System, there are no EPA registered products for use against JEV (as of the writing of this strategy).

For JE response, it will also be necessary to consider vector control during the C&D process (e.g., limiting standing water). JEV is unstable in the environment, and most fomites are not implicated in natural transmission of the virus. Non-disposable equipment that is contaminated with blood from potentially viremic animals should be decontaminated to prevent any risk of transmission to people (e.g., through needlestick injury).

Decontamination of equipment and housing on affected pig premises is recommended to prevent transmission via oronasal secretions. On other premises, no decontamination precautions, other than normal hygienic measures, are necessary.

Health, Safety, and Personal Protective Equipment

Because JE is zoonotic and a threat to public health, it is important that appropriate precautions are taken to prevent responders from contracting JE during a response effort. JEV is most commonly transmitted to humans through the bite of an infected mosquito, however, appropriate biosafety precautions should be observed when handling blood/articles contaminated with blood from potentially viremic animals, oronasal secretions from infected swine, and when working with JEV in the laboratory.

Upon confirmation of JE, public health agencies have the authority and discretion to implement appropriate public health measures, including but not limited to surveillance, prevention, and case management (as required). They will also make recommendations as to whether vaccination is appropriate for response personnel. APHIS will work closely with CDC and SLTT public health authorities in a response to ensure the safety and health of all personnel.

Personal protective equipment (PPE) is fundamental to ensure personnel are protected from JEV as well as other hazards during a response. This PPE must be appropriately disposed of and/or cleaned and disinfected when leaving an IP. One measure to prevent responder exposure to JEV is preventing mosquito bites using repellents and clothing (e.g., long-sleeved shirts and pants). Additionally, APHIS will work closely with CDC and SLTT public health authorities to determine whether vaccination is appropriate for responders and in what circumstances.

Responders may also be exposed to other health hazards; prevention of adverse human health events related to emergency response efforts is important. For further information, please see the *NAHEMS Guidelines: Health and Safety* and *NAHEMS Guidelines: Personal Protective Equipment*.

Biosecurity

JEV is not generally transmitted by fomites, but equipment contaminated with blood from viremic animals (e.g., needles, postmortem equipment) may pose a risk to the health of response personnel (e.g., through needlestick injuries). Disposable equipment contaminated with blood should be securely disposed of following existing biosecurity protocols. Reusable equipment contaminated with blood should be decontaminated (see Cleaning and Disinfection). Although there are no additional JE-specific recommendations, general biosecurity measures should be followed according to the *NAHEMS Guidelines: Biosecurity*.

Wildlife Management

Wild birds, such as herons and egrets which are native to North America, serve as reservoirs for the virus in JEV endemic regions and would likely serve as reservoirs if JEV were introduced into the United States. Additionally, JEV can infect various wild animals, such as mammals, reptiles, and amphibians. It can also infect feral animal populations, such as feral swine and wild horses in the United States.

In the event of a JE outbreak in domestic swine and/or equids, APHIS will work in close collaboration and coordination with other agencies, entities, and units that have primary jurisdiction over wildlife and feral animal populations. Close coordination with wildlife officials will be extremely important as the sylvatic cycle will drive impacts to domestic swine and equids. More details can be found in the *NAHEMS Guidelines: Wildlife Management and Vector Control*.

Communication

A clear and consistent communication strategy is essential for a successful One Health response. APHIS will work with other agencies, including but not limited to CDC, DHS, EPA, and USDA Food Safety Inspection Service (FSIS), to develop synchronized messaging throughout the response. Our communication must be early, accurate, and transparent to build public trust. We will develop communication materials for the media, public, swine and horse owners/producers, and veterinarians.

APHIS has developed key initial messages for the response. Further messaging and communication products will be developed in coordination with our partners and tailored to the specifics of the outbreak. Appendix B includes example fact sheets intended for swine producers and equine stakeholders.

Key Initial Messages

- Japanese Encephalitis virus (JEV) is a mosquito-borne virus
  - The virus does not spread from person to person
  - Animals like pigs and horses cannot directly pass the virus to people
- JEV can make horses, donkeys, and pigs sick
  - Pig producers should look for signs of illness and report any unexplained abortions or stillbirths to their veterinarian
  - People working with pigs and horses, even if they're only a backyard pet or a small herd, should take steps to control mosquitoes and continue to practice good biosecurity
- Japanese encephalitis (JE) is not a food safety concern
  - Pork meat and pork products are safe to eat
- USDA and CDC are working closely with our state, local, tribal, and territorial public health partners to ensure a coordinated response

Because the mosquitoes that transmit WNV are likely the same mosquitoes that would transmit JEV in the United States, many of the public education strategies outlined in the CDC's "West

Nile Virus in the United States: Guidelines for Surveillance, Prevention, and Control" could be adapted to communicate with the public and livestock producers during a JE outbreak. APHIS will work with the CDC to coordinate this messaging.

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Note: All FAD PReP documents are also references to this APHIS *Disease Response Strategy: Japanese Encephalitis*.

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Attachment A: Zone, Area, and Premises Designations for Japanese Encephalitis

Tables A-1 and A-2 contain a summary of the zone, area, and premises designations; Figures A-1 and A-2 illustrate these designations.

Table A-1. Summary of Premises Designations

Premises	Definition	Zone
Infected Premises (IP)	Premises where a presumptive positive case or confirmed positive case in swine exists based on laboratory results, compatible clinical signs, case definition, and international standards.	Infected Zone
Contact Premises (CP)	Premises with susceptible swine that may have been exposed to JE, either directly or indirectly, including but not limited to swine, arthropod vectors, or potential reservoir hosts from Infected Premises.	Infected Zone, Buffer Zone
Suspect Premises (SP)	Premises under investigation due to the presence of swine reported to have clinical signs compatible with JE. This is intended to be a short-term premises designation.	Infected Zone, Buffer Zone, Surveillance Zone, Vaccination Zone
At-Risk Premises (ARP)	Premises with susceptible animals, but none of those susceptible animals have clinical signs compatible with JE. Premises objectively demonstrates that it is not an Infected Premises, Contact Premises, or Suspect Premises. At-Risk Premises seek to move susceptible animals within the Control Area by permit. Only At-Risk Premises are eligible to become Monitored Premises.	Infected Zone, Buffer Zone
Monitored Premises (MP)	Premises objectively demonstrates that it is not an Infected Premises, Contact Premises, or Suspect Premises. Only At-Risk Premises are eligible to become Monitored Premises. Monitored Premises meet a set of defined criteria in seeking to move susceptible animals or products out of the Control Area by permit.	Infected Zone, Buffer Zone
Free Premises (FP)	Premises outside of a Control Area and not a Contact or Suspect Premises.	Surveillance Zone, Free Area
Vaccinated Premises (VP)	Premises where emergency vaccination has been performed. This may be a secondary premises designation.	Containment Vaccination Zone, Protection Vaccination Zone

Table A-2. Summary of Zone and Area Designations

Zone/Area	Definition
Infected Zone (IZ)	Zone that immediately surrounds an Infected Premises.
Buffer Zone (BZ)	Zone that immediately surrounds an Infected Zone or a Contact Premises.
Control Area (CA)	Consists of an Infected Zone and a Buffer Zone.
Surveillance Zone (SZ)	Zone outside and along the border of a Control Area.
Free Area (FA)	Area not included in any Control Area.
Vaccination Zone (VZ)	Emergency Vaccination Zone classified as either a Containment Vaccination Zone (typically inside a Control Area) or a Protection Vaccination Zone (typically outside a Control Area). This may be a secondary zone designation.

Figure A-1: Example Premises

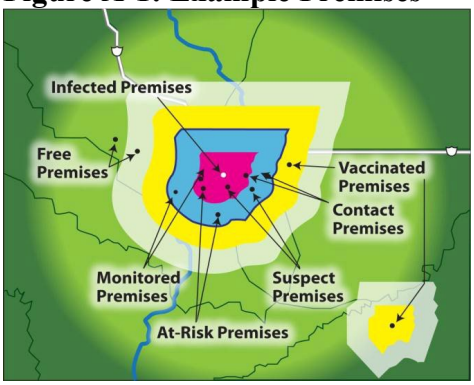

Figure A-2: Example Zones and Areas

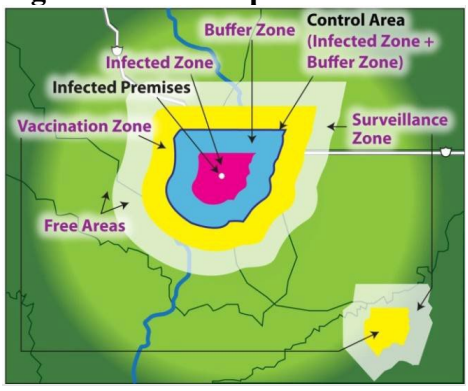

Table A-3 lists the minimum sizes of zones and areas during vector-borne outbreaks (spread by mosquitoes or culicoides).

Table A-3. Sample Minimum Sizes of Zones and Areas for Mosquito or Culicoides Vector-Borne Diseases

Note: This table is a baseline as outlined in the NAEHMS Guidelines: Quarantine and Movement Control. During the response, many factors which affect mosquito flight activities (such as wind and nearby land use) and the mosquito species in an area will be used to establish these zones. Perimeters may be larger or smaller than those listed below.

Zone or area	Minimum size and details
Infected Zone (IZ)	Perimeter should be at least 10 km (~6.2 miles) beyond perimeters of presumptive or confirmed Infected Premises. Will depend on disease agent and epidemiological circumstances. This zone may be redefined as the outbreak continues.
Buffer Zone (BZ)	Perimeter should be at least 20 km (~12.4 miles) beyond the perimeter of the Infected Zone. Width is generally not less than the minimum radius of the associated Infected Zone but may be much larger. This zone may be redefined as the outbreak continues.
Control Area (CA)	Perimeter should be at least 30 km (~18.6 miles) beyond the perimeter of the closest Infected Premises. Please see Table 3-1 in FAD PReP Manual 2-0 for factors to consider in determining the size of a Control Area. This area may be redefined as the outbreak continues.
Surveillance Zone (SZ)	Width should be at least 20 km (~12.4 miles) but may be larger depending on the known geographic range of vector.

Appendix B: Fact Sheets

Japanese Encephalitis Virus (JEV) Fact Sheet for Swine Producers

What is it?

Japanese encephalitis virus (JEV) is a virus that mainly affects pigs, horses, waterbirds (e.g., herons and egrets) and people. JEV can produce disease in people, neurological disease in pigs and horses and reproductive failure in breeding swine. There is no specific treatment for Japanese encephalitis (JE) in pigs. JEV is not a food safety concern.

How does JEV spread?

JEV is an *arbovirus* which means that it is transmitted via bites from infected mosquitoes. The natural lifecycle of JEV is between waterbirds and mosquitoes. On occasion spillover to other animals may occur. Waterbirds and pigs act as amplifying hosts, which means that they develop a level of virus in their blood that is high enough to infect more mosquitoes after feeding on infected animals.

What are the signs in pigs?

Many pigs infected with the virus do not show any signs of illness. Swine that are not pregnant do not typically show signs of infection or experience only mild transient fever. However reproductive losses can reach up to 50-70%.

Piglets

- Increase in stillborn, mummified or weak piglets (most common)
- Convulsions
- Shaky, wobbly or shivering
- Increase in pre-weaning deaths

Sows

- Increased return rates after mating
- Delayed farrowing—more than 118 days
- Increase in abortions

Boars

- Inflamed or swollen testicles
- Semen abnormalities
- Infertility

How can I minimize the risk of JEV to my pigs?

Is there a vaccine?

There is currently not a vaccine available in the United States.

Control mosquitoes on your property

Monitoring for mosquitoes at the various stages of their lifecycle helps to determine the most effective control methods. Key measures that will help reduce mosquito numbers on your property include:

- Inspecting bodies of water and containers for larvae, as well as areas where adult mosquitoes rest, like ceilings and walls
- Removing anything in the open that is filled with water or has the potential to hold water
- Filling in potholes or other areas that collect water
- Clearing debris from gutters, downspouts, and drains around buildings so that water doesn't pool
- Trimming overhanging tree branches where mosquitoes may rest
- Ensuring effluent drainage is free flowing, flushed regularly and does not pool
- Sealing tanks, wells or other large water containers, or screening with 1mm mesh
- Install insect screens
- Use fans inside buildings where pigs are housed to disrupt mosquito activity

What do I do if I suspect my pigs have JE?

JE is a notifiable disease in the United States.

If you suspect JE (or any other notifiable disease) in your pigs, please call your private veterinarian or State Animal Health Official.

How does JEV affect people?

Humans can also be infected with JEV. Most infections in people cause no symptoms. Some people experience a fever and headache, but severe cases may result in convulsions, disorientation, and coma. If you experience any worrisome symptoms, you should seek medical advice from a healthcare provider immediately.

You can protect yourself by preventing mosquito bites.

- Use an insect repellent
- Wear loose-fitting long-sleeved shirts and pants when outdoors, especially between dawn and dusk

Additional resources

Reach out to your local University extension services, local environmental/mosquito control agency, and/or your veterinarian for additional assistance.
Swine Health Information Center JEV Fact Sheet
Centers for Disease Control and Prevention JEV Website
Environmental Protection Agency Mosquito Control Website

Japanese Encephalitis Virus Fact Sheet for Horse Owners

What is it?

Japanese encephalitis virus (JEV) is a virus that mainly affects pigs, horses, waterbirds (e.g., herons and egrets) and people. JEV can produce disease in people, neurological disease in pigs and horses and reproductive failure in breeding swine. There is no specific treatment for Japanese encephalitis (JE) in pigs. JEV is not a food safety concern.

How does JEV spread?

JEV is an *arbovirus* which means that it is transmitted via bites from infected mosquitoes. The natural lifecycle of JEV is between waterbirds and mosquitoes. On occasion spillover to other animals may occur. Waterbirds and pigs act as amplifying hosts, which means that they develop a level of virus in their blood that is high enough to infect more mosquitoes after feeding on infected animals. Horses are known to be a 'dead end host' meaning that the level of virus circulating in infected horses' blood is too low to reinfect mosquitoes. Horses do not contribute to continued spread.

What are the signs in horses?

Many horses infected with the virus do not show any signs of illness. Most cases that do have clinical signs are mild and will recover within a short period of time, however some horses may develop severe encephalitis that can cause death.

Common clinical signs in horses include:

- Elevated temperature (> 101°F)
- Dullness or lethargy
- Reduced appetite
- Neurological signs such as incoordination, difficulty swallowing, impaired vision, wobbliness or hyperexcitability

Horses infected with other arboviruses may also show similar clinical signs to infection with JEV. These include West Nile virus and Eastern Equine Encephalitis.

How can I minimize the risk of JEV to my horses?

Is there a vaccine?

There is currently not a vaccine available in the United States.

Control mosquitoes on your property

Monitoring for mosquitoes at the various stages of their lifecycle helps to determine the most effective control methods. Key measures that will help reduce mosquito numbers on your property include:

- Inspecting bodies of water and containers for larvae, as well as areas where adult mosquitoes rest, like ceilings and walls
- Removing anything in the open that is filled with water or has the potential to hold water
- Filling in potholes or other areas that collect water
- Clearing debris from gutters, downspouts, and drains around buildings so that water doesn't pool
- Trimming overhanging tree branches where mosquitoes may rest
- Ensuring effluent drainage is free flowing, flushed regularly and does not pool
- Sealing tanks, wells or other large water containers, or screening with 1mm mesh

Minimize horse exposure to mosquitoes

- Put a light summer or cotton sheet on horses, a fly mask, and if the horse allows, apply a safe insect repellent according to label instructions
- House horses during peak periods of mosquito activity (between dusk and dawn)

What do I do if I suspect my horse has JE?

JE is a notifiable disease in the United States.

If you suspect JE (or any other notifiable disease) in your horses, please call your private veterinarian or State Animal Health Official.

How does JEV affect people?

Humans can also be infected with JEV. Most infections in people cause no symptoms. Some people experience a fever and headache, but severe cases may result in convulsions, disorientation, and coma. If you experience any worrisome symptoms, you should seek medical advice from a healthcare provider immediately.

You can protect yourself by preventing mosquito bites.

- Use an insect repellent
- Wear loose-fitting long-sleeved shirts and pants when outdoors, especially between dawn and dusk

Additional Resources

Reach out to your local University extension services, local environmental/mosquito control agency, and/or your veterinarian for additional assistance.

Centers for Disease Control and Prevention JEV Website

Environmental Protection Agency Mosquito Control Website

Attachment C: Abbreviations

APHIS	Animal and Plant Health Inspection Service
ARP	At-Risk Premises
BZ	Buffer Zone
C&D	cleaning and disinfection
CA	Control Area
CDC	Centers for Disease Control and Prevention
CP	Contact Premises
EDTA	ethylenediamine tetraacetic acid
EPA	Environmental Protection Agency
FA	Free Area
FAD	Foreign Animal Disease
FADDL	Foreign Animal Disease Diagnostic Laboratory
FAD PReP	Foreign Animal Disease Preparedness and Response Plan
IP	Infected Premises
IPM	Integrated Pest Management
IZ	Infected Zone
JE	Japanese encephalitis
JEV	Japanese encephalitis virus
MP	Monitored Premises
NAHEMS	National Animal Health Emergency Management System
NVSL	National Veterinary Services Laboratories
PCR	polymerase chain reaction
PPE	personal protective equipment
RT-qPCR	reverse transcription-quantitative polymerase chain reaction
SLEV	Saint Louis encephalitis virus

SLTT	state, local, tribal, territorial
SMEDI	stillbirth, mummification, embryonic death, and infertility
SP	Suspect Premises
SZ	Surveillance Zone
USDA	United States Department of Agriculture
VP	Vaccinated Premises
VS	Veterinary Services
VZ	Vaccination Zone
WNV	West Nile virus
WOAH	World Organisation for Animal Health