



Wood Turtle Survey Results Report - Final
NJARNG Facilities
2021



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Acronym List

AASF – Army Aviation Support Facility
BMP – Best Management Practice
BT – Box turtle
CLTF – Combined Logistics and Training Facility
CWL – Conserve Wildlife Foundation of New Jersey
DGIF – Department of Game and Inland Fisheries
DoD – Department of Defense
DoD PARC – Department of Defense Partners in Amphibian and Reptile Conservation
EMB – Environmental Management Bureau
FWS – Fish and Wildlife Service
GLIN - *Glyptemys insculpta*. Common name “Wood turtle”
GPS – Global Positioning System
HK – Hackettstown Armory
HQ – Headquarters
IACUC – Institutional Animal Care and Use Committee
LRMP – Legacy Resource Management Program
LVLS – Lawrenceville Little Shabakunk Creek
LVS – Lawrenceville Shabakunk Creek
NEPA – National Environmental Policy Act
NJ – New Jersey
NJARNG – New Jersey Army National Guard
NJDEP – New Jersey Department of Environmental Protection
NJDFW – New Jersey Division of Fish and Wildlife
NJDMAVA – New Jersey Department of Military and Veteran Affairs
NOAA – National Oceanic and Atmospheric Administration
PARC – Partners in Amphibian and Reptile Conservation
PLS – Planning Level Survey
PN – Princeton Warehouse
SAPWTP - Standardized Assessment Protocol for Wood Turtle Populations
TPWD – Texas Parks and Wildlife Department
TR – Toms River Armory
US – United States
USDA – United States Department of Agriculture
USFWS – United States Fish and Wildlife Services
USGS – United States Geological Survey
UV – Ultraviolet
VA – Virginia
WO – West Orange Armory

Definitions

Best management practices (BMPs) – Proactive conservation efforts that are not tied to statutory/regulatory requirements.

Brackish water – Water that naturally contains a significant concentration of dissolved solids (USGS, 2017).

Calipers – A tool for measuring dimensions of an object.

Carapace – The top side of the turtle shell (SeaWorld Parks and Entertainment, n.d.).

Chytrid fungus – The *Batrachochytrium dendrobatidis* (aka Bd) fungus that affects amphibians resulting in a disease called chytridiomycosis.

Habitat fragmentation – The process during which a large expanse of habitat is transformed into a number of smaller patches of smaller total area isolated from each other by a matrix of habitats unlike the original (Academic Press, 2017).

Intermittent stream – Streams that flow during certain times of the year when smaller upstream waters are flowing and when groundwater provides enough water for stream flow. Runoff from rainfall or other precipitation supplements the flow of seasonal stream. During dry periods, seasonal streams may not have flowing surface water.

Oxbows – A U-shaped bend in the course of a river.

Pesolas – A tool that uses a spring scale to measure weight.

Plastron – The bottom side of the turtle shell (SeaWorld Parks and Entertainment, n.d.).

Potentially suitable GLIN habitat – Land area that contains a freshwater stream with surrounding

Ranaviruses – Members of the Iridovirus family that infect insects, fish, amphibians, and turtles. forested or field habitat.

Riparian habitat - Lands that occur along watercourses and water bodies that are distinctively different from surrounding lands because of the unique soil and vegetation characteristics that are strongly influenced by the presence of water (USDA, 1996).

Scutes – Flexible keratinized plates made from epidermal tissue that are on the shell of a turtle.

1.0 Introduction

The wood turtle (GLIN, *Glyptemys insculpta*) is a state threatened turtle species native to New Jersey (NJ). This species inhabited most of central and northern NJ, however habitat loss and fragmentation has resulted in steady habitat declines documented as early as the 1970s (NJDEP Wood Turtle, 2020). Consequently, GLIN were listed as threatened in the state of NJ in 1979 and are currently listed as “under review” for potential federal listing by the United States Fish and Wildlife Service (USFWS) (DoD, 2019). The primary objectives of this project were to review installation habitat data to identify New Jersey Department of Military and Veteran Affairs (NJDMAVA) properties with potentially suitable GLIN habitat, conduct presence/absence surveys at all NJDMAVA properties with potentially suitable GLIN habitat using the survey/guidelines and procedures recommended in the Department of Defense (DoD) Legacy Resource Management Program (LRMP) Recommended Wood Turtle Best Management Practice (BMP), and provide land use and land management recommendations to ensure state and National Environmental Policy Act (NEPA) compliance based on site-specific survey results. The secondary project objectives were to collect morphological data for both GLIN and non-target species, mark all turtles using shell notch codes provided by the NJDEP, report all turtle sighting locations to the NJDEP, the American Turtle Observatory, and HerpMapper.org, and report any observed shell lesions or shell disease to Brian Zarate of the Department of Environmental Protection (DEP) at brain.zarate@dep.nj.gov.

As discussed in Section 3.0, surveyors reviewed previous natural resource planning level survey (PLS) documents to assess the on-site habitat characteristics for 47 New Jersey Army National Guard (NJARNG) properties. Site-specific habitat characteristics were compared to species-specific habitat needs to identify properties that may support GLIN populations. In total, 6 streams and tributaries at 5 different NJARNG properties were selected for this survey, including the Hackettstown Armory, Lawrenceville NJDMAVA Headquarters (HQ), Princeton Warehouse, Toms River Armory, and West Orange Armory. Site-specific results are discussed in Section 5.0 of this report.

2.0 GLIN Characteristics

Physical Characteristics

GLIN typically have a distinctive yellow, red-orange, or pinkish-red coloration to the neck and under-surfaces of the legs (Virginia Herpetological Society, 2020). The carapace is brown with rigid pyramid-shaped scutes. The plastron is hinge-less, with yellow scutes containing brown or black blotches on the outer edges (CWF NJ, 2020). Adult males typically have concave plastrons, while the plastrons of adult females are generally flat (DoD, 2019).

Behavior

GLIN have an active period that typically occurs in April through October. During this active period, GLIN can be found in streams and on the surrounding upland landscape. During this time, GLIN have 5 distinct behavioral periods which are emergence and pre-nesting, nesting, post-nesting, pre-hibernation, and overwintering (US FWS, 2018). In the spring, GLIN emerge from hibernation to bask along stream banks, with breeding activity beginning once water temperatures reach 59° F (CWF NJ, 2020). During emergence and pre-nesting, GLIN can typically be found within 10 meters of streams. Mating occurs within streams in April and is usually concluded by mid-May when the turtles’ transition to a terrestrial environment for foraging and egg laying (NJDEP, 2020). The post-nesting period spans from approximately July to late September. During this time, GLIN can typically be found within 90 meters of the stream. Pre-hibernation occurs in either October or November which leads to the overwintering period. The overwintering period is when GLIN are primarily immobile but can make occasional small underwater movements. This period ends around March or April when emergence begins (US FWS,2018).

Habitat

GLIN reside in both aquatic and terrestrial environments, unlike most turtle species that are generally limited to one type of environment. Typical GLIN habitat includes freshwater streams, brooks, and rivers located within undisturbed uplands such as fields or forests. GLIN are commonly associated with the presence of native brook trout, as both species require clean streams free of pollutants and disturbances (NJDEP Wood Turtle, 2020). This species range includes counties in northern and central NJ, excluding urbanized regions, with the largest currently known populations existing in Hunterdon, Morris, Sussex, Passaic, and Warren counties (CWF NJ, 2020). Figure 1 displays the range map for this species.

3.0 Site Priority Determinations

3.1 Preliminary Habitat Investigation

Habitat data was reviewed for a total of 47 NJDMAVA properties. These 47 properties were assigned priority rankings based on the suitability of the habitat present and surveyor knowledge of site features. These rankings are also summarized in Table 6 and displayed in Figure 1. Site-specific maps displaying site habitat features for all high and medium priority sites are included in the Figures section of this report.

3.1.1 Habitat Suitability Determinations

Habitat suitability determinations were made by performing the following steps:

1. Review landscape data, previous rare species PLS, and wetland reports to identify sites with potentially suitable GLIN habitat. For the purposes of this survey, a site is considered to contain “potentially suitable GLIN habitat” if it contains a freshwater stream with surrounding forested or field habitat.
2. Review HerpMapper.org and iNaturalist.org observational data to identify which sites are within close proximity to documented GLIN sightings. HerpMapper.org and iNaturalist.org observations are shown in Figure 2.

3.1.2 HerpMapper.org Results

A data request was submitted to HerpMapper on 1/8/2020 and was accepted on 2/1/2020. A review of the provided spatial data identified 14 documented GLIN observations between 1956 and 2014. No GLIN observations have been documented in the HerpMapper database since 2014. Of the 14 documented observations, 8 were in Warren County along the Delaware River, 2 were in Sussex County, 2 were in Passaic County, 1 was in Mercer County, and 1 was in Somerset County. None were located within 5 miles of any NJDMAVA facilities. The closest HerpMapper observation to a high or medium priority site was in 1956 near the Neepaulakating Creek, 8.3 miles from the Franklin Armory. A documented GLIN observation was also made 8.6 and 10.1 miles from the Lawrenceville HQ and Princeton Warehouse facilities, respectively, in 2003 along the Assunpink creek. All HerpMapper observations are shown in Figure 2.

3.1.3 iNaturalist.org Results

A review of the iNaturalist spatial data identified 22 documented wood turtle observations in NJ between 2003 and 2019. The most recent documented wood turtle observation in the iNaturalist database was on October 1, 2019, in Burlington County. This is unusual because Burlington County is outside of the wood turtle species range. Of the 22 documented observations, 1 was in Bergen County, 2 were in Burlington County, 1 was in Mercer County, 7 were in Morris County, 2 were in Somerset County, 6 were in Sussex County, 1 was in Union County, and 2 were in Warren County. All iNaturalist observations are shown in Figure 2, however it should be noted

that iNaturalist intentionally obscures all locational data for species with conservation status to protect the geoprivacy of the actual observation locations. Therefore, the points on Figure 2 do not represent the actual observation locations.

3.1.4 Site Priority Rankings

The 47 NJARNG properties were categorized into high, medium, low, and lowest priority. These categories can be seen below:

High Priority (5)

These sites contain potentially suitable stream habitat with potentially suitable riparian habitat and are within the GLIN species range.

- Franklin Armory - **Property Transfer Pending – This site was not surveyed.**

Note: One wood turtle was identified at this site during surveys conducted by Andrea M. Teti, Inc in 2004, as stated in the Parsons 2006 Rare Species Surveys Report (NJ Army National Guard).

- Hackettstown Armory
- Lawrenceville NJDMAVA HQ
- Princeton Warehouse
- West Orange Armory

Medium Priority (2)

These sites contain potentially suitable stream habitat with potentially suitable riparian habitat but are not within the GLIN species range.

- Bridgeton Armory - **Property Transfer Pending – This site was not surveyed.**
- Toms River Armory

Low Priority (12)

These sites contain streams, wetlands, and/or forested habitat, however:

A. GLIN were not found during previous survey efforts

OR

B. The on-site habitat features are not considered suitable for GLIN based on surveyor knowledge of the site. Site-specific rationale for this ranking is included below.

- B.G. Doyle Veteran’s Cemetery – Stream is largely surrounded by maintained grass habitat. A 0.2-mile segment of stream is bordered on one side by forested area. However, this forested area is surrounded by maintained grass. Although this site is within the species range, the surrounding disturbed habitat is likely not suitable for this species.
- Cape May Armory – Stream is brackish, not freshwater. The site is not within the range of this species.
- Cherry Hill Armory – No undeveloped riparian zone surrounding the Cooper River. The site is not within the range of this species.
- Dover Armory – No streams on-site. The shallow wetland area is known to be frequently dry. Habitat surveys conducted by Andrea M. Teti, Inc. in 2004 concluded that potential wood turtle habitat is not present at this site.
- Fort Dix 3600 Area – Short isolated stream segments offer no potential for species movement up or downstream. The surrounding habitat is partially developed. Site is within the range of this species.

- Hammonton Armory – No streams on-site, however a forested wetland is present along the train tracks. Wood turtles have been documented basking along train tracks at other sites. The surrounding habitat is partially developed. The site is not within the range of this species.
- Morristown Armory – A narrow stream is located on this site but is known to dry up regularly. The surrounding habitat is mostly undeveloped. Site is within the range of this species. Habitat assessments conducted by Andrea M. Teti, Inc. in 2004 determined that marginal basking and nesting habitat exists on-site, however no wood turtles or wood turtle evidence was observed during a 4-day survey effort conducted in May and June of 2004. Results from these surveys are described in Appendix B of the Parsons 2006 Rare Species Surveys report. Additionally, no wood turtles were found during an informal presence/absence survey conducted by EMB staff in August 2014, however this survey was conducted outside of the recommended optimal survey window for this species.
- Paramus Veteran’s Home – A manmade ditch is located on the eastern side of this property, however it is surrounded by developed lands, such as parking lots, maintained grass, and roads. This site is not within the range of this species.
- Picatinny – A manmade ditch runs along the northeast side of the vehicle yard. The ditch is shallow and frequently dry. The surrounding habitat is partially undeveloped. Fencing surrounding the property should inhibit species movement onto the site, however, according to the iNaturalist observational data, 1 wood turtle was documented approximately 0.7 miles southwest of the FMS along Lake Denmark road. Although, as stated in Section 3.1.3 above, iNaturalist intentionally obscures rare species positional data for geoprivacy reasons. This site is within the range of this species.
- Sea Girt NGTC – A short on-site tributary discharges into Stockton Lake. Lake is brackish water, not freshwater. The lake and tributaries are surrounded by developed land. The site is not within the range of this species.
- Trenton-Mercer – Short, secluded ~500 ft stretch of stream, leading to a deeper pooled area. No upstream or downstream species movement possible. Surrounding habitat is developed, with fencing and roads isolating this short stream segment. Site is within the range of this species.
- Woodstown Armory – No streams on site. One stream exists immediately adjacent to the site. The surrounding habitat is agricultural fields. The site is not within the range of this species.

Lowest Priority (28)

These sites do not contain streams or any other habitat features that may support GLIN populations.

- Atlantic City Armory
- Bordentown Warrior Transition Center
- Burlington Armory
- Flemington Armory
- Freehold Armory
- Jersey City Armory
- Korean War Memorial
- Lakehurst Combined Logistics and Training Facility (CLTF)
- Lakehurst Army Aviation Support Facility (AASF)
- Lodi Armory
- Menlo Park Veteran’s Home
- Mount Holly Armory
- Newark Armory
- New Egypt Armory
- Newton Armory
- Pitman Armory

- Riverdale Armory
- Somerset Armory
- Teaneck Armory
- Veterans Haven North
- Veterans Haven South
- Vietnam War Memorial
- Vineland Readiness Center
- Vineland Veteran's Home
- Washington Armory
- Westfield Armory
- Woodbridge Armory
- Woodbury Armory

4.0 Survey Methods

The survey methods listed below are outlined in the 2021 Wood Turtle Survey Plan and are consistent with the "Standardized Assessment Protocol for Wood Turtle Populations" developed by the Northeast Wood Turtle Working Group. This protocol was recommended in the DoD LRMP "Recommended Best Management Practices for the Wood Turtle on Department of Defense Installations, 2019." Additional survey protocol recommendations and insight were provided by Brian Zarate of the NJDEP, and Virginia (VA) state herpetologist J.D. Kleopfer, who has been conducting GLIN surveys in Virginia for over 20 years.

4.1 Survey Period and Conditions

Surveys should be conducted in the spring on days when air temperatures are greater than 40°F (4.44°C), skies are clear, and the water is calm. According to the VA DGIF (Virginia Department of Game and Inland Fisheries) Instream Wood Turtle Survey Guidance document, surveys are most successful when performed during a warming trend, but not on the first day of such a trend. Several sources, including correspondences with VA state herpetologist J.D. Kleopfer, have stated that detection success declines as GLIN leave the streams in late spring and summer. To maximize detection probability, every effort was made to conduct all surveys in this optimal short early springtime window.

4.2 Field Survey Methodology

All field surveys were conducted following the DoD LRMP. All surveying and processing methods were approved by the Stockton University Institutional Animal Care and Use Committee (IACUC) (Protocol #2020-006) and were conducted in accordance with the awarded Scientific Collecting Permit issued by the NJDEP (Permit NO: SC 2021064).

1. Each surveyor was assigned an observer ID number. Observer #1 was always the lead surveyor. All observers were recorded on the Wood Turtle Population Assessment / Survey Form.
2. The observers navigated to the lower bounds of the site-specific stream segments.
3. The beginning air and water temperature was collected at the lower bounds before surveying using an electronic thermometer. Positional data of the lower bound starting point was collected using a handheld Trimble GeoExplorer 2008 GPS unit.
4. Stream segment coordinates, survey number, survey date, start time, weather conditions, and stream conditions were recorded on the Wood Turtle Population Assessment / Survey Form.
5. Observers were positioned on both sides of the stream and remained within 10 meters of the stream bank. Observer #1 (the lead observer) had the right of way and all other observers remained perpendicular or behind this individual to prevent inadvertently alerting upstream turtles causing them to change position or hide before being detected. The observers worked

upstream at a maximum pace of one-kilometer per hour as they conducted a visual search by inspecting in-stream structures, stream banks, and surrounding riparian habitat within 10 meters of the stream corridor, with care to avoid clouding the water with sediment and hindering the view of other surveyors. Observers also searched riparian features such as oxbows, side streams, flood channels, and pools. Although every effort was made to survey each stream segment in its entirety, dense vegetation or obstructions occasionally limited or dictated the approach for surveying an area. These site-specific limitations are addressed in Section 5.0.

6. For turtle processing:
 - a. Surveyors completed a “Wood Turtle Individual Form” for each turtle found. A blank “Wood Turtle Individual Form” can be found in Appendix D. All turtle handling was completed with single-use surgical gloves. Gloves were changed between individuals to prevent the spread of pathogens such as Ranavirus or Chytrid fungus. The entire processing procedure, including handling, rotating, measuring, shell notching, inspecting, and photographing, took approximately 10 minutes per turtle. These procedures had the potential to invoke a degree of stress, discomfort, or brief pain to the animal. Surveyors attempted to limit the handling time to minimize the distress caused to the animal. Following processing, the individual was released in the location where it was found.
7. Inspection for deformities:
 - a. Surveyors analyzed the carapace and plastron for indication of shell lesions or disease. The NJ Division of Fish & Wildlife (DFW) received reports of severe shell lesions on northern, red-bellied turtles (*Pseudemys rubriventris*) in Salem County in 2019, the cause of which is currently unknown. Any observed shell lesions or decay were photographed, documented, and reported to Brian Zarate of the NJDEP at Brian.Zarate@dep.nj.gov. Specific information on turtle location, time, date, number of individuals, and any other relevant observations such as abnormal behavior, water conditions, other sickly or deceased nearby animals, etc. were included. Appendix K includes an informational flyer and photograph regarding this announcement.
8. Inspection for pre-existing shell notch code:
 - a. Surveyors inspected the peripheral scutes for pre-existing shell notch codes. Instructions for how to read notch codes are included in Appendix H. Any new or old shell notch codes were reported to the NJDEP for mark-recapture purposes.
9. Measurements:
 - a. Surveyors used calipers to collect standard morphological measurements including carapace length, plastron length, carapace width, plastron width, and shell height. A pesola was used to measure mass. All measurements were recorded on the “Wood Turtle Individual Form”.
10. Shell notching:
 - a. If shell notches were not present, surveyors assigned a unique shell notch identification code using the notch code list provided by the NJDEP. This list is included in Appendix H. Notches were made using a V-shaped file to create V-shaped notches in the peripheral scutes to a depth of 1/8”.
11. Positional data:
 - a. Surveyors used a Trimble Global Positioning System (GPS) unit to collect positional data for each individual found.
12. Photographs:
 - a. Surveyors collected photographs of every individual from different perspectives. Any pre-existing or new shell notch codes were visible in the photographs taken. Surveyors

took additional photographs of any injuries, deformities, lesions, or abnormalities of any kind to report to the NJDEP.

13. Release:

- a. Surveyors released the individual where it was found after processing.

14. Decontamination protocol:

- a. Surveyors disinfected all field equipment in accordance with the Northeast PARC field equipment disinfection protocol found in Appendix J. All boots, waders, and any other gear used were disinfected between each site, and all processing equipment, such as calipers, pesolas, nets, etc. were disinfected between each individual to prevent the spread of Chytridiomycosis and Ranavirus between individuals and between sites.

15. Reporting rare wildlife sightings:

- a. Surveyors reported all rare wildlife sightings to the NJDFW by electronically submitting a rare wildlife sighting report form to bioticsnj@dep.nj.gov. A blank rare wildlife sighting form is included in Appendix C.

16. Submitting turtle observations

- a. Surveyors submitted all turtle observations to HerpMapper.org using their online observation submission form. Note: The primary threat to this species is habitat loss. However, wildlife collection by poachers is a concern, especially for a state and federally protected species. It is important not to disclose positional data of any herpetofauna publicly, as these species are less mobile and more easily exploited. Point-location data entered on HerpMapper are not shared publicly. Public view is restricted to the county-level for all species. Positional data is only made available for research, conservation, preservation, and educational groups following a thorough data request review process. To gain access to these positional data, users must submit a HerpMapper data request for each individual subject property. If the data request is approved, the user is sent observational data for the subject property as an Excel .csv file. For these reasons, it is unlikely that poachers would be able to access this information for misuse.

5.0 Site Specific Analysis

5.1 Lawrenceville NJDMAVA HQ

Lawrenceville NJDMAVA Shabakunk Creek Tributary

The Shabakunk Creek Tributary is a small tributary that flows west to east near the southern property boundary of the Lawrenceville NJDMAVA HQ site. The surveyed portions of the Shabakunk Creek Tributary, shown in Figure 3 - LV, was approximately 705 feet in length. The upper and lower bounds of this tributary are cement culverts. The tributary is approximately 1 meter wide consisting of a silt and rock substrate with decomposing organic matter. The dominant land use along the tributary is forested area. The characteristics of this stream are shown in Photographs LVS 1-4. Site characteristics can be found in Table LVS4. This location was in the range of GLIN and contained streams and partially forested riparian habitat, meeting the criteria for potential GLIN habitat. Although this tributary met the criteria for potentially suitable habitat, it was narrower and more fragmented than the ideal GLIN habitat. GLIN are more commonly found in larger streams.

The three surveys conducted at this site on April 13, April 19, and May 11, 2021, were done following the guidelines from the DoD LRMP titled "Recommended Best Management Practices for the Wood Turtle on DoD Installations." The weather conditions on April 13, 2021, were partly cloudy and warm. The weather on April 19, 2021, were sunny with clear skies. On May 11, 2021, the weather conditions were cloudy and warm. Weather condition data from these three surveys can be found in Table LVS1. The weather conditions met the criteria for GLIN surveys since both the air temperature and water temperature were

above 40°F (4.44°C) and there was no precipitation during the survey period. These site conditions met the DoD recommended Best Management Practices Survey guidelines.

Surveyors began at the downstream extent of the Shabakunk Creek, where the creek flows into a cement culvert beneath the adjacent properties. Initial water temperature, air temperature, weather conditions, and starting location were documented. Water temperature at the lower and upper bounds was not recorded on April 13, 2021. Surveyors conducted on-foot surveying heading upstream at a slow pace of less than one kilometer per hour in accordance with the DoD Recommended Best Management Practices guidelines. At the end of the creek survey segment, the surveyors collected the water temperature, air temperature, weather conditions, and ending GPS data point. GLIN field survey methodology data can be found in Table LVS2.

No GLIN were located during the three surveys conducted in this section of the property. Given that the weather conditions were suitable for GLIN surveying, and all three surveys were conducted in accordance with DFW protocols and DoD guidelines, surveyors concluded that GLIN are not present in this location. GLIN survey results can be found in Table LVS3.

A single Eastern box turtle (*Terrapene carolina carolina*) was found during the May 11, 2021, survey in the forested area north of the upstream extent of the Shabakunk Creek. The location of this turtle is shown in Figure 3 - LV. The surveyors examined the turtle for existing notch codes and determined that it was not a recaptured individual. Surveyors used a file to notch the R11, L9, and L11 scutes. This notch code represents the identification number 2900. The collected capture data from this individual can be found in Appendix I. Photographs of the box turtle can be seen in Photographs BT 1-7.

Lawrenceville NJDMAVA Little Shabakunk Creek Tributary

The Little Shabakunk Creek Tributary is a small tributary that flows west to east near the Northeastern property boundary of the Lawrenceville NJDMAVA HQ site. The surveyed portion of this tributary, shown in Figure 3 - LV, was approximately 283 feet in length. The upper and lower bounds of this tributary are cement culverts. The tributary is approximately 1 meter wide consisting of a silt and rock substrate. Decomposing organic matter is present in the stream substrate. The dominant land use along the tributary is forested riparian habitat surrounded by a maintained grass field. The characteristics of this stream are shown in Photographs LVLS 1-5. Site characteristics can be found in Table LVLS4. This location was in the range of GLIN and contained streams and partially forested riparian habitat, meeting the criteria for potential GLIN habitat.

The three surveys conducted at this site on April 13, April 19, and May 11, 2021, were done following the guidelines from the DoD LRMP titled “Recommended Best Management Practices for the Wood Turtle on DoD Installations.” The weather conditions on April 13, 2021, were partly cloudy and warm. The weather conditions on April 19, 2021, and May 11, 2021, were cloudy. Weather condition data from these three surveys can be found in Table LVLS1. The weather conditions met the criteria for GLIN surveys since both the air temperature and water temperature were above 40°F (4.44°C) and there was no precipitation during the survey period. These criteria met the DoD recommended Best Management Practices Survey guidelines. In addition to the stream segments selected for GLIN surveying, two unnamed small springs/seepage areas were also surveyed. These springs were in the southwest corner of the property and approximately 200 meters northwest of the chosen stream segment for GLIN surveying. On the first day of surveying this site, April 13, 2021, water temperature was not recorded.

Surveyors began at the downstream extent of the Shabakunk Creek, where the creek flows into a cement culvert beneath the adjacent properties, where the initial water temperature, air temperature, weather conditions, and starting GPS data points were documented. Water temperature at the lower and upper bounds was not recorded on April 13, 2021. Surveyors conducted on-foot surveying heading upstream at a slow pace of less than one kilometer per hour in accordance with the DoD Recommended Best Management Practices guidelines. At the end of the creek survey segment, the surveyors collected the water temperature, air temperature, weather conditions, and ending GPS data point. GLIN field surveying methodology data can be found in Table LVLS 2.

No GLIN were located during the three surveys conducted in this section of the property. Given that the weather conditions were suitable for GLIN surveying, and all three surveys were conducted in accordance with DFW protocols and DoD guidelines, surveyors concluded that GLIN are not present in this location. The GLIN survey results can be found in Table LVLS 3.

5.2 Toms River Armory Tributary

The Toms River Armory is located next to an unnamed stream that flows west to east near the northeastern property boundary. There was standing water at the downstream segment while the upstream segment is dry. The surveyed portion of this tributary, shown in Figure 3 - TR, was approximately 791 feet long. The upper and lower bounds of this tributary are cement culverts that go under Whitesville Road and the unnamed road entrance to Winding River Park respectively. The unnamed stream at this site is an intermittent stream. The tributary is approximately one meter wide consisting of a sand and silt stream substrate. The dominant land use along the tributary is forested area. The characteristics of this stream are shown in Photographs TR 1-4. Site characteristics can be found in Table TR4. This location once contained streams and partially forested riparian habitat, which partially met the criteria for potential GLIN habitat. A large wetland area is also present on-site. However, this site is not within the accepted GLIN species range.

The three surveys conducted at this site on April 14, April 16, and April 28, 2021, were done in accordance with the DoD Recommended Best Management Practices guidelines. The weather conditions on April 14, 2021, were partly cloudy and warm. The weather on April 26, 2021, was sunny and windy. On April 28, 2021, the weather conditions were sunny and clear. Weather condition data from these three surveys can be found in Table TR1. The weather conditions met the criteria for GLIN surveys since both the air and water temperature were above 40°F (4.44°C) and there was no precipitation during the survey period. These criteria met the DoD recommended Best Management Practices Survey guidelines. When conducting the first of the three GLIN surveys, it was noted that the stream was mostly dried, which supported the site Armorer's statement that the stream had been stagnant for more than a year. This stream segment is no longer considered suitable GLIN habitat since it no longer contains water. The Armorer speculated that upstream changes to the stream supply likely permanently eliminated this tributary. Surveyors also walked the wetland area and power line corridor to look for box or snapping turtles. No turtles were found.

Surveyors began at the downstream extent of the unnamed stream, where the creek flows into a cement culvert beneath the main access road to Winding River Park, where the initial water temperature, air temperature, weather conditions, and starting GPS data points were documented. Water temperature at the lower and upper bounds was not recorded on April 14, 2021. Surveyors conducted on-foot surveying heading upstream at a slow pace of less than one kilometer per hour in accordance with the DoD Recommended Best Management Practices guidelines. At the end of the creek survey segment, the

surveyors collected the water temperature, air temperature, weather conditions, and ending GPS data point. GLIN field survey methodology data can be found in Table TR2.

No GLIN were located during any of the three surveys conducted in this section of the property. Given that the weather conditions were suitable for GLIN surveying, and all three surveys were conducted in accordance with DFW protocols and DoD guidelines, surveyors concluded that GLIN are not present in this location. The GLIN survey results can be found in Table TR3. One box turtle shell was found near the downstream starting point. The right side of the shell had been damaged and no scute notches were identified. Box turtles have been previously documented in the forested sections of the Toms River Armory in 2018, 2019, and 2020. Snapping turtles were observed in 2020 at this site, and a spotted turtle was observed in 2019.

5.3 Princeton Warehouse Tributary

The Princeton Warehouse Tributary is a small tributary that flows west to east near the Northern property boundary of the Princeton Warehouse site. The surveyed portion of this tributary, shown in Figure 3 - PN, was approximately 507 feet long. The upper bound of this tributary is a culvert leading from the Princeton Municipal Sewage Landfill property. The lower bound of this tributary is a cement culvert that goes under River Road. The tributary is approximately one meter wide consisting of a mixture of silt, rock, and decomposing organic matter stream substrate. The dominant land use along the tributary is forested area. The characteristics of this stream are shown in Photographs PN 1-5. Site characteristics can be found in Table PN4. This location was in the range of GLIN and contained streams and partially forested riparian habitat, meeting the criteria for potential GLIN habitat.

The three surveys conducted at this site on April 14, May 11, and May 13, 2021, were done in accordance with the DoD Recommended Best Management Practices guidelines. The weather on April 14, 2021, was cloudy. The weather on May 11, 2021, was sunny and warm. On May 13, 2021, the weather conditions were warm and partly cloudy or sunny. Weather condition data from these three surveys can be found in Table PN1. The weather conditions met the criteria for GLIN surveys since both the air and water temperature were above 40°F (4.44°C) and there was no precipitation during the survey period. These criteria met the DoD recommended Best Management Practices Survey guidelines. The stream corridor and surrounding forested area were very densely vegetated at this site. The dense understory vegetation made surveying difficult. This limited visibility and dictated survey-movements and direction of surveyors. Surveyors occasionally had to leave the immediate stream corridor to navigate around obstructions, leaving small portions of the area un-surveyed. Surveyors made every effort to survey the area to the best of their abilities but acknowledge that limitations exist. Surveyors estimate that approximately 90% of the stream corridor was surveyed in its entirety.

Surveyors began at the downstream extent of the unnamed stream, where the creek flows into a cement culvert leading from the Princeton Municipal Sewage Landfill Property, where the initial water temperature, air temperature, weather conditions, and starting GPS data points were documented. Surveyors conducted on-foot surveying heading upstream at a slow pace of less than one kilometer per hour in accordance with the DoD Recommended Best Management Practices guidelines. At the end of the creek survey segment, the surveyors collected and documented the water temperature, air temperature, weather conditions, and ending location. GLIN field survey methodology data can be found in Table PN2.

No GLIN were located during any of the three surveys conducted in this section of the property. Given that the weather conditions were suitable for GLIN surveying, and all three surveys were conducted in

accordance with DFW protocols and DoD guidelines, surveyors concluded that GLIN are not present in this location. GLIN survey results can be found in Table PN3. Although no GLIN were found on this property, it is possible that GLIN populations exist in the portions of the unnamed stream adjacent to the property. The Princeton Warehouse is also adjacent to multiple parks such as the Autumn Hill Reserve, Gulick Preserve, and Barbara Smoyer Park which could be habitats for GLIN. The Millstone River adjacent to the site may also provide a potentially suitable GLIN habitat. If present, it is possible that GLINs may move on and off site. It is also a possibility that GLIN are present on-site in low densities and were not detected during these surveying efforts due to the dense vegetation conditions.

5.4 West Orange Armory Bear Brook Tributary

The Bear Brook Tributary is a small tributary that flows in a south to north direction across the western portion of the West Orange Armory site. The surveyed portions of this tributary, shown in Figure 3 - WO, were two segments approximately 259 feet long (right fork) and 700 feet long (left fork). An additional 340-foot-long reach of the Bear Brook Tributary was incidentally not included as part of this survey effort. This portion of the tributary is labelled in Figure WO1. The upper bound of this tributary is a seepage area. The lower bound of this tributary was the property boundary, although the stream continued onto the adjacent property. The tributary is approximately one meter wide consisting of a mixture of silt, rock, and decomposing organic matter stream substrate. The dominant land use along the tributary is forested area. The Bear Brook Tributary is bordered to the east by single-family housing developments. The characteristics of this stream are shown in Photographs WO 1-7. Site characteristics can be found in Table WO4. This location was in the range of GLIN and contained streams and partially forested riparian habitat, meeting the criteria for potential GLIN habitat.

The three surveys conducted at this site on April 20, April 28, and May 4, 2021, were done in accordance with the DoD Recommended Best Management Practices guidelines. The weather conditions on April 20, 2021, were initially partly cloudy and warm, then transitioned to be clear and sunny. The weather on April 28, 2021, was partly cloudy and warm. On May 4, 2021, the weather conditions were warm and partly cloudy. Weather condition data from these three surveys can be found in Table WO1. The weather conditions met the criteria for GLIN surveys since both the air temperature and water temperature were above 40°F (4.44°C) and there was no precipitation during the survey period. These site conditions met the surveying criteria of the DoD Recommended Best Management Practices guidelines.

Surveyors began at the downstream extent of the Bear Brook Tributary, which was the site's property boundary, where the initial water temperature, air temperature, weather conditions, and starting GPS data points were documented. Surveyors conducted on-foot surveying heading upstream at a slow pace of less than one kilometer per hour in accordance with the DoD Recommended Best Management Practices guidelines. At the end of the creek survey segment, the surveyors documented the water temperature, air temperature, weather conditions, and ending location. GLIN field survey method data can be found in Table WO2.

No GLIN were located during any of the three surveys conducted in this section of the property. GLIN survey results can be found in Table WO3. There was an additional stream segment of approximately 340 feet that was not surveyed. The presence of GLIN at this site cannot be determined without the surveying of this un-surveyed stream.

5.5 Hackettstown Armory Musconetcong River Tributary

The Musconetcong Tributary is a small tributary that flows East to West in the Northern portion of the property. The surveyed portion of this tributary, shown in Figure 3 - HK, was approximately 1,590 feet long. The upper bound of this tributary is a cement culvert that goes under the NJ Transit Morris and Essex Rail Line. The lower bound of this tributary is a cement culvert that goes under Willow Grove Street. The tributary is approximately one meter wide consisting of a silt stream substrate. The dominant land use along the tributary is dense forested area. The characteristics of this stream are shown in Photographs HK 1-6 and summarized in Table HK4. This location was in the range of GLIN and contained streams and partially forested riparian habitat, meeting the criteria for potential GLIN habitat.

The three surveys conducted at this site on May 6, May 11, and May 13, 2021, were done in accordance with the DoD Recommended Best Management Practices guidelines. The weather conditions on May 6, 2021, were sunny and clear. The weather on May 11, 2021, was partly cloudy and warm. On May 13, 2021, the weather conditions were warm and sunny. Weather condition data from these three surveys can be found in Table HK1. The weather conditions met the criteria for GLIN surveys since both the air temperature and water temperature were above 40°F (4.44°C) and there was no precipitation during the survey period. These criteria met the DoD Recommended Best Management Practices guidelines. The stream corridor and surrounding forested area were very densely vegetated at this site. The dense understory vegetation made surveying difficult. This limited visibility and dictated survey-movements and direction of surveyors. Surveyors occasionally had to leave the immediate stream corridor to navigate around obstructions, leaving small portions of the area un-surveyed. Surveyors made every effort to survey the area to the best of their abilities but acknowledge that limitations exist. Surveyors remained within 10 meters of the stream segment when they were unable to survey in the immediate stream corridor. On the third day of surveying, the first 300 feet of the stream segment were dry, and multiple smaller segments (less than 10 feet) along the stream segment were also dry. Surveyors estimate that approximately 90% of the stream corridor was surveyed in its entirety.

Surveyors began at the downstream extent of the Musconetcong River, where the stream flows into a cement culvert beneath the adjacent properties, where the initial water temperature, air temperature, weather conditions, and starting GPS data points were documented. Surveyors conducted on-foot surveying heading upstream at a slow pace of less than one kilometer per hour in accordance with the DoD Recommended Best Management Practices guidelines. At the end of the creek survey segment, the surveyors documented water temperature, air temperature, weather conditions, and ending location. GLIN survey methodology data can be found in Table HK2.

No GLIN were located during any of the three surveys conducted in this section of the property. Given that the weather conditions were suitable for GLIN surveying, and all three surveys were conducted in accordance with DFW protocols and DoD guidelines, it has been concluded that GLIN are not present in this location. The GLIN survey results can be found in Table HK3. Although no GLIN were found on this property, it is possible that GLIN populations exist in the portions of the Musconetcong River adjacent to the property. The Hackettstown Armory is also adjacent to Stephens State Park Campground and Hackettstown Park which may contain potentially suitable GLIN habitat. If present, it is possible that GLINs may move on and off site.

6.0 Conclusion

As discussed in Section 5.0, after considering site-specific habitat characteristics and species-specific habitat requirements, potentially suitable habitat was identified at 7 NJARNG properties, including the Franklin Armory, Bridgeton Armory, West Orange Armory, Hackettstown Armory, Toms River Armory,

Lawrenceville NJDMAVA HQ, and Princeton Warehouse. Due to pending property transfers, surveys were not conducted at the Franklin or Bridgeton properties. After conducting thorough surveys of the 5 properties in accordance with NJDEP and DoD recommended GLIN survey methods, it has been concluded that GLIN are not likely present at the Hackettstown Armory, Lawrenceville NJDMAVA HQ, Princeton Warehouse, or Toms River Armory. Additional surveys are required to make presence/absence determinations at the West Orange Armory.

After conducting thorough surveys of the 5 properties in accordance with NJDEP and DoD recommended GLIN survey methods, it has been concluded that GLIN are not likely present at any of the 5 surveyed properties. Surveyors acknowledge that visibility limitations existed at the Hackettstown Armory and Princeton Warehouse due to the densely forested stream corridor. GLIN are also unlikely to be present at any of the 40 non-surveyed NJARNG properties as suitable habitat is not present and/or these sites are not within the GLIN species range. However, as discussed in Sections 5.3 and 5.5, GLIN may be present at adjacent properties near the Hackettstown and Princeton properties where habitat is more characteristic for this species. For that reason, it is important to acknowledge that GLIN may move on-site in summer or fall as they migrate to upland habitats from off-site aquatic environments following the spring breeding season. It is also possible that GLIN may naturally move between the smaller on-site tributaries and the larger off-site streams.

A Rare Wildlife Sighting Report Form, including photographs and maps, was submitted to the NJDEP on June 14, 2021, for the Eastern Box Turtle found on May 11, 2021, at the Lawrenceville NJDMAVA HQ. This sighting was also submitted to HerpMapper.org with photographs of the individual on June 11, 2021. Photographs and observation information were also sent to iNaturalist.org on June 15, 2021. A Rare Wildlife Sighting Report Form was not submitted for the box turtle found at the Toms River Armory because it was deceased prior to surveying.

7.0 Recommended Conservation Implementation Strategies and Best Management Practices

7.1 Site-Specific BMPs

7.1.1 Lawrenceville NJDMAVA HQ

No GLIN were found at the Little Shabakunk Creek or the Shabakunk Creek at this property. One Eastern box turtle (*Terrapene carolina carolina*) was found in a forested area in the Southern portion of the property as shown in Figure 3 - LV. The Eastern box turtle is listed as special concern by the NJDEP DFW Endangered and Nongame Species Program Special Concern Species Status List published in 2012. It is recommended by the DoD PARC's article "Eastern Box Turtle and the Department of Defense, 2017" that military natural resource managers maintain both forested and field habitats while considering how land management activities (i.e., mowing, tree clearing, prescribed burning) may impact the box turtle. Mowing in grasslands, shrublands, pastures, and hayfields are of particular concern for the box turtle during the spring and summer months. There are several recommendations in the PARC article, "Habitat Management Resources for Eastern Box Turtle Habitat." Of these recommendations, reduction of turtle mortality is pertinent accompanied with preservation of potential nesting habitats. Reduction of turtle mortality during such maintenance can be achieved by considering mowing rotation, percent of area mowed, timing, mower style, blade height, directionality, and mower speed. It is also suggested to avoid using heavy machinery from May 1 through September 15 when box turtles are more active. Nesting areas for these box turtles typically occur in open-canopy areas with well-drained soil. According to "Conservation Plan for the Eastern Box Turtle in Massachusetts," published by the Natural Heritage & Endangered Species Program Massachusetts Division of Fisheries & Wildlife, it is pertinent that garbage, bird seed, and pet food be

properly contained. These food sources can attract predators such as racoons and skunks. It is also recommended that individuals be cautious of the potential presence of box turtles on roadways and anywhere vehicles may be used. If a box turtle is found injured, it is recommended to transport the individual to a state rehabilitator. It is also important to report sightings of the box turtles to the NJDMAVA EMB. The NJDMAVA EMB will then report all findings to the NJDEP and DFW using the Rare Wildlife Sighting Report Form found in Appendix C. Signage should also be posted at this site to inform site personnel of the presence of box turtles and inform them not to move them from their habitat. Suggested signage can be found in Appendix L.

7.1.2 Hackettstown Armory and Princeton Warehouse

No GLIN were found at the Hackettstown Armory or the Princeton Warehouse. The Hackettstown Armory is adjacent to Stephens State Park and the Musconetcong River which likely supports GLIN populations. The Princeton warehouse is adjacent to the Millstone River and Delaware and Raritan Canal which likely supports GLIN populations. Since these adjacent properties likely support GLIN populations, GLIN may move onto the NJARNG property in the summer or fall while migrating upland. For this reason, it is important to adopt precautionary BMPs which can be found in Section 7.1.4. Signage should be posted at this site to inform site personnel of the possible GLIN presence since the adjacent sites are suitable habitats for GLIN.

7.1.3 Toms River Armory and West Orange Armory

Although no turtles were found during the GLIN survey efforts at the Toms River Armory, box turtles have been previously documented in the forested sections of this site in 2018, 2019, and 2020. Snapping turtles were observed in 2020 at this site, and a spotted turtle was observed in 2019. For this reason, it is important to be mindful of how mowing, tree clearing, prescribed burning, and the use of heavy machinery may impact these turtle species. It is also important for site personnel to be cautious of potential nesting areas (open-canopy areas that have well-drained soil) during the spring and summer. Site personnel should also make sure that garbage, bird seed, and pet food are properly contained to deter skunk and racoon presence and be cautious of potential turtle presence on roadways or areas where automobiles may be used. If any turtle species are discovered at these two sites, site personnel should report sightings to the NJDMAVA EMB. The NJDMAVA EMB will then report all findings to the NJDEP and DFW using the Rare Wildlife Sighting Report Form found in Appendix C. It is also important not to remove any turtles from their habitat. For the spotted turtle species, it is suggested that predator populations (raccoons, foxes, coyotes, and crows) on the sites are monitored and properly controlled. Site personnel should also maintain upland forested buffer habitat between wetland areas and along stream riparian zones. Vehicles should also not be used in any wetland area where spotted turtles may be present. Signage should also be posted at this site to inform site personnel of the potential presence of GLIN and box turtles.

Although no turtles were found during the West Orange surveys, there may have been turtles in the un-surveyed stream segment. Snapping turtles and box turtles were previously observed at this site in 2020 according to a neighboring homeowner along the southwest border of the property. For the West Orange Armory, a GLIN survey should be conducted in spring or early summer in 2022 for the un-surveyed stream segment shown in Figure WO1. This would provide more accuracy in determining if GLIN or other species are present at this site. Since snapping and box turtles have been observed in the past, it is important to be mindful of how mowing, tree clearing, prescribed burning, and the use of heavy machinery may impact these turtle species. It is also important for site personnel to be cautious of potential nesting areas (open-canopy areas that have well-drained soil) during the spring and summer. Site personnel should also make

sure that garbage, bird seed, and pet food are properly contained to deter skunk and racoon presence and be cautious of potential turtle presence on roadways or areas where automobiles may be used. If any turtle species are discovered at these two sites, site personnel should report sightings to the NJDMAVA EMB. The NJDMAVA EMB will then report all findings to the NJDEP and DFW using the Rare Wildlife Sighting Report Form found in Appendix C. It is also important not to remove any turtles from their habitat. For the spotted turtle species, it is suggested that predator populations (raccoons, foxes, coyotes, and crows) on the sites are monitored and properly controlled. Site personnel should also maintain upland forested buffer habitat between wetland areas and along stream riparian zones. Vehicles should also not be used in any wetland area where spotted turtles may be present. Signage should also be posted at this site to inform site personnel of the potential presence of these turtle species.

7.1.4 All Locations

When mowing or operating a heavy piece of machinery, it is important for operators to be cautious of potential GLIN presence. Operators should conduct an on-foot survey of the mowing or land area prior to operating the heavy machinery to reduce potential GLIN mortality. If possible, mowing should be done only in the off-season (October through the end of March) when GLIN are likely to be confined to streams and immediate riparian corridors. If mowing cannot be avoided, it is recommended that the mowing head be raised approximately 100 millimeters (about 3.94 inches). A 300 meter unfragmented riparian buffer should be established (Massachusetts Division of Fisheries and Wildlife, 2018). This area should not be mowed or mechanically cleared. Signage should also be posted at this site to inform site personnel of the potential presence of various turtle species.

All sightings of any turtle species should be reported to the NJDMAVA EMB Natural Resource Manager.

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The NJDMAVA EMB will then report all findings to the NJDEP and DFW using the Rare Wildlife Sighting Report Form found in Appendix C.

7.2 Species-Specific BMPs

7.2.1 GLIN BMPs

No GLIN were found at any of the five NJARNG sites, but there are two sites that have adjacent properties that may support GLIN populations. For the Princeton Warehouse and the Hackettstown Armory, surveyors recommend the following BMP:

1. Limiting mowing to the off-season (October through the end of March). If mowing cannot be avoided, mower heads should be raised to 100 millimeters.
2. Conduct on-foot surveys of areas to look for GLIN or other turtle species prior to mowing or operating heavy machinery.
3. Establishing an unfragmented riparian buffer of at least 300 meters where no mowing or clearing is done.
4. Display signage about GLIN on site message boards to inform site personnel about what to do if they find a GLIN.
5. All sightings of any GLIN should be reported to the NJDMAVA EMB Natural Resource Manager.