Recovery Outline for Texas hornshell

(Photo courtesy of Brian Lang)

Texas hornshell *(Popenaias popeii)*
Current Classification: Endangered

U.S. Fish and Wildlife Service
Texas Coastal Ecological Services Field Office
Houston, Texas

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1.0 INTRODUCTION

The purpose of this recovery outline is to provide an interim strategy to guide the conservation and recovery of the Texas hornshell until a final recovery plan is completed. Meeting recovery needs will require cooperation among the U.S. Fish and Wildlife Service (Service), other Federal and State agencies, Tribes, and the public. This outline of potential recovery actions for the Texas hornshell will help interested stakeholders understand how we envision Texas hornshell conservation proceeding until a recovery plan is finalized. The current outline is based on the final Species Status Assessment (SSA) for the Texas hornshell (Service 2018), as well as the preliminary objectives and actions needed for recovery. This outline is based on the best available scientific and commercial information. The SSA can be found at the following website: *https://www.fws.gov/southwest/es/TexasCoastal/*.

1.1 **Species common and scientific name:** Texas hornshell (*Popenaias popeii*)

1.2 **Lead Regional Office/Cooperating RO(s):** Southwest Region 2

1.3 **Lead Field Office/Cooperating FO(s):**

Texas Coastal Ecological Field Offices – Lead
New Mexico Ecological Services Field Office – Cooperating
Austin Ecological Services Field Office – Cooperating
San Marcos Aquatic Resource Center – Cooperating
Inks National Fish Hatchery – Cooperating
Uvalde National Fish Hatchery – Cooperating

1.4 **Contact biologist: Charrish Stevens, (281) 212-1503**

1.5 **Listing status and date(s): Endangered, March 12, 2018**

1.6 **Recovery Priority Number: 8**

2.0 BRIEF METHODOLOGY

The Service is utilizing the Texas hornshell SSA, preliminary objectives and actions needed for recovery, and review of new scientific and commercial information available since its listing to assist with the drafting of this outline.

2.1 **Type and quality of available information:**

The Texas hornshell SSA was developed as an in-depth, all-inclusive review of this species biology and threats, evaluating their biological status based on whether they have the resources and conditions needed to maintain long-term viability. It documents biology and natural history, as well as assesses demographic risks (small population size), threats, and limiting factors in the context of determining viability and risk of extinction.

2.2 Treatment of uncertainties:

Due to the remote nature of some populations within its presumptive range and ever changing environmental pressures, data is limited. Thus, there are uncertainties associated with this assessment. Where we have substantial uncertainty, we made our assumptions, based on the best available information, explicit in the SSA.

3.0 RECOVERY STATUS ASSESSMENT

The SSA considers what the Texas hornshell needs to ensure viability as a species, defined as the ability to persist over the next 50 years and to avoid extinction. Available factors critical to the species survival were identified, as well as the repercussions when those needs are missing or diminished. The factors included historical, current, and future conditions. Using this information, we evaluated the current and future viability of the species in terms of resiliency, redundancy, and representation.

Resiliency is defined as the ability of the species to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health, such as birth versus death rates, and population size. Healthy populations are more resilient and better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities.

Redundancy is defined as the ability of a species to withstand catastrophic events (a rare destructive natural event or episode involving many populations and occurring suddenly). Redundancy is about spreading the risk and can be measured through the duplication and distribution of resilient populations across the range of the species. The greater the number of resilient populations a species has distributed over a larger landscape, the better it is able to withstand catastrophic events.

Representation is defined as the ability of a species to adapt to changing environmental conditions. Representation can be measured through the breadth of genetic diversity within and among populations and the ecological diversity (also called environmental variation or diversity) of populations across the species' range. The more representation, or diversity, a species has, the more capable it is of adapting to changes (natural or human caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of habitat characteristics within their geographical range.

3.1 Biological assessment

The Texas hornshell is a medium sized freshwater mussel with a dark brown to green, elongate, laterally compressed shell reaching lengths of over 110 millimeters (mm) (Service 2018). It is native to the Rio Grande drainage in Texas, New Mexico, and northern Mexico. Adult and juvenile Texas hornshell occur in medium to large rivers, generally in crevices, undercuts, riverbanks, travertine shelves, and under large boulders that contain suitable amounts of small-grained substrate, such as clay, silt, and/or sand. Juveniles likely inhabit interstitial spaces within trapped substrate and adults typically anchor in suitable substrate (Service 2018). Areas within

crevices, undercuts, riverbank, travertine shelves, and under boulder provide flow refugia from large flood events that occur regularly within the Rio Grande basin. However, the Devils River population is an exception; this population is typically found within gravel beds at the head of riffles and rapids (Service 2018). Texas hornshell, like most freshwater mussels, has a complex life history, which requires the use of water column and host fish for successful reproduction and metamorphosis into juvenile mussels. Their longevity is unknown; however, a mark and recapture effort conducted in 1997 and again 15 years later, indicates that the species is capable of living 15 or more years (Service 2018).

3.2 Species' Range-wide Population Status and Trends

Texas hornshell historically occurred in the Pecos River system to the confluence with the Rio Grande. Within the Rio Grande System, it occurred from Brewster County, Texas downstream to just below the current location of Falcon Dam, Starr County, Texas. This includes the Devils River, Las Moras Creek, and the Rio Salado, tributaries to the Rio Grande (Service 2018).

The Texas hornshell is currently restricted to approximately 15% of its known range in the U.S., which includes five populations in the Rio Grande basin in New Mexico and Texas: the Black River, Pecos River, Devils River, Lower Canyons of the Rio Grande, and the Lower Rio Grande near Laredo, Texas (Service 2018).

The *Black River population* is found in Eddy County, New Mexico. The species occurs in approximately 8.7 miles of the middle Black River between two low-head dams (Lang 2001). The total population size has been estimated at approximately 48,000 individuals (95%: 28,849 to 74,127), with diversity of size classes and was labeled relatively stable over a 15 year study period from 1997-2012 (Inoue *et al.* 2014). Water flows are heavily influenced by seasonal summer rains and surface water withdrawals by upstream users (Carman 2007). The watershed is surrounded by rural ranch and farm lands typically using the maximum amounts of water allotted for irrigation (Carman 2007). Hydraulic fracturing, associated with oil and gas development, also diverts additional surface and ground water. Additionally, the population is at an increased risk for industrial spills due to lack of appropriate and safe low-water crossings (Bren School of Environmental Management 2014).

The *Pecos River population* is characterized as being extremely small, with only three live individuals collected from a site on the River (Service 2018). With only three individuals, it is difficult to draw conclusions about the population's status other than it once occurred throughout the system and is now found only in a small section of the river with no recently recorded evidence of reproduction taking place. This system is threatened by high levels of salinity, which is most likely a limiting factor (Service 2018).

The *Devils River population* is found in an approximately 29 mile stretch of the river. In 2014, 2015, and 2017, surveys resulted in finding more than 150 Texas hornshell at 20 sites (Randklev *et al.* 2015 and Diaz 2017). Randklev *et al.* (2015) found that Texas hornshell in the Devils River occupy different habitats than those in the rest of its range; they occupy gravel beds at the heads of riffles or in clean-swept pools with bedrock. They found that these included several young

individuals, as well as gravid females, providing evidence of reproduction and recruitment occurring. The river system is a relatively intact watershed, with no dams, little development, and with much of the land along the river under conservation management and land protections (Service 2018; TNC 2004; TPWD 2016).

The *Rio Grande – Lower Canyons population* is located in Terrell County, Texas, occupying approximately 62 miles of river where mussels were found live. Sites vary in density, with the highest densities found near Terrell County, Texas, and decreasing in density downstream. Average densities are lower, compared to the Rio Grande – Laredo and Black River populations. Young individuals and gravid females have been found, indicating recruitment is occurring. Occupancy modeling predicts Texas hornshell are dependent on spring inflows and rocky habitats in this section of the river (Service 2018). The Lower Canyons population is surrounded by private lands along the U.S. – Mexican border; the river there is largely spring-fed, and free-flowing. This portion of the river was designated as a National Wild and Scenic River (WSR) in 1978, affording it some federal protections under the Wild and Scenic Rivers Act (1968), as amended. State, local, or private development is not limited. The Lower Canyons reach is characterized by swift rapids with pools, terminating downstream at Amistad Reservoir (Service 2018).

The *Rio Grande – Laredo population* is the largest known population, with some habitat patches estimated to contain more than 8,000 individuals (Karatayev *et al.* 2015; Randklev *et al.* 2015). In Texas, it occurs upstream from Webb County to approximately 56 river miles upstream toward Webb County. Young individuals and gravid females have been found throughout this reach, providing evidence of reproduction and recruitment. The Laredo population relies on proper water management governed by the 1944 Water Treaty and 1938 Rio Grande Compact (TCEQ 2016). Flows rely upon water releases from the Amistad Reservoir for hydropower generation and downstream irrigation needs (Texas Water Development Board 2016). Rapid growth and development along the border have stressed existing wastewater treatment facilities, leading to impaired water quality and high sedimentation loads (Texas Clean Rivers Program 2013).

3.3 Species Viability Needs

Life History Drivers: For the Texas hornshell to be considered viable, individual mussels at different life stages need specific vital resources for survival and completion of their life cycle. Both male and female mussels need to be nearby for successful spawning (March through August) and for fertilization to occur. Once fertilization has taken place, the glochidia (larvae) will mature in the female's brood pouch (modified gill) for an additional four to six weeks (Smith *et al.* 2003). Appropriate host fish (i.e., river carpsucker, gray redhorse, and red shiner) are necessary for metamorphosis from glochidia to juvenile mussels. Toward the end of glochidia's maturation, the female lures in its host fish by releasing a sticky mucous net or string that contains glochidia. The host fish swims into the nets and glochidia generally attach to the face or gills of the fish becoming encysted in its tissue (Carman 2007; Levine *et al.* 2012). The encysted glochidia remain on host fish for about one month through transformation to fully developed juveniles. Once transformed, the juveniles will excyst from the fish and drop to suitable substrate (e.g. sand, clay, and silt located in between crevices, boulders, and travertine shelves) for refugia

(Service 2018). If reproduction and metamorphosis to juvenile is successful and it drops to suitable substrate, then it will continue to develop and grow into reproducing adults.

Individual Needs: In addition to specific habitat features described in 3.1, flowing water is a requirement for all stages of life for the Texas hornshell. It aids in fertilization and flushing of habitat to prevent excess sediment buildup, as well as provides a constant food source. Also, flowing water helps to maintain ideal water quality parameters. For example, juvenile mussels have lower tolerances to salinity (~0.9ppt), ammonia (~0.7mg/L), copper and other contaminants, and dissolved oxygen (DO) (levels within substrate of > 1.3 mg/L). Where adults are able to tolerate DO levels in water column above 3 mg/L and water temperatures of less than 40° Celsius (C) (Service 2018).

Population Needs: Populations must have suitable habitat to survive long term. Flow refugia must be present with seams of clay or other fine sediments to allow for anchoring, but not so much that excess sediment smothers mussels; continuous flowing water; and good water quality are also needed (i.e. high DO, low to no salinity concentrations, low to no ammonia concentrations, and little to no pollutants). Viable populations require multiple mussel beds within an occupied reach. Each bed must be resilient enough to withstand a stochastic event, (e.g. flood), ensuring that enough members of the population survive to recolonize the reach. For this to happen, populations need to have connectivity between neighboring mussel beds. This allows infested host fish to travel to and from mussel beds, thus facilitating ebbs and flows in density and abundance over time.

Species Needs: To successfully adapt to future environmental changes, Texas hornshell must be able to maintain genetic diversity. Populations in the Rio Grande and Devils River have distinct variations in allele frequencies from those in the Black River. Thus, the species needs to retain populations throughout its range to maintain potential genetic and life history attributes that buffer response to environmental changes over time. Some genetic diversity has likely been lost given some historic populations have been extirpated. Therefore, it is critical to maintain genetic diversity in the remaining populations to maintain their capacity to adapt to future environmental change (Service 2018).

Historically, most populations were likely connected by fish migrations throughout the Rio Grande basin. However, impoundments throughout the basin and unsuitable water quality in river reaches (e.g. high salinity in Pecos, Black, and Devils Rivers), have isolated populations from each other. Repopulation of extirpated locations is unlikely to occur without human intervention. While preliminary findings show that the Black River population may have local adaptations to tolerate higher concentrations of salinity relative to the Rio Grande populations (Pers. Comm. C. Randklev 2018), the species could benefit from improved water quality by increasing freshwater inflows in reaches that are plagued with high salinity values, as well as incorporating fish passages where impediments impact host fish.

3.4 **Monitoring Needs**

To allow for successful monitoring of the species, researchers need to be familiar with the different types of habitat the species can occupy throughout its range. This is vitally important where proposed projects have direct or indirect impacts on the species and/or its habitat. Long-term monitoring and research of Texas hornshell populations throughout their range is needed. Results could establish a baseline of current population health, as well as track changes over time. More surveys are needed in remote areas to identify new mussel beds/populations. Genetic studies are needed throughout the river basin (e.g., Rio Grande and Devils River) to inform management actions, such as future propagation/relocation efforts. Additional studies on water quality and flows could yield a better understanding of how current conditions may be impacting populations and how natural resource managers can minimize and/or mitigate these limiting factors by establishing standards. Survey, relocation, propagation, and monitoring protocols will be developed by the Service, in coordination with the State and other partners, as part of the Endangered Species Act section 10 recovery permitting process. When captive propagation is implemented, monitoring and genetic management plans will be necessary to ensure success of the program and released populations.

3.5 Threats Assessment

The SSA revealed three influences that pose the largest risk to future viability of the species: accretion of fine sediments, impairment of water quality, and loss of flowing water. These risks are primarily related to habitat changes and are exacerbated by climate change. Overutilization for scientific and commercial purposes were not assessed, but will be considered for recovery purposes (Service 2018).

Increased fine sediment: While adult Texas hornshell require fine sediment to anchor on the stream bottom, too much can fill the crevices and smother the mussels. For juveniles, too much fine sediment can fill the interstitial spaces they occupy in the substrate also leading to suffocation. Under natural conditions, fine sediments collect on the streambed and in crevices during low flow events and are flushed out during high flow events, also called cleansing flows. However, the increased frequency of low flow events (from groundwater extraction, instream surface flow diversions, and drought) combined with a decrease in cleansing flows (from reservoir management and drought) has caused fine sediments to accumulate to some degree at all populations. With proper water and land management, this threat can be minimized by encouraging the use of best management practices on land and establishing a more seasonal flow for cleansing of excess sediment.

Water quality impairment: Water quality can be impaired through contamination, alteration of water chemistry (i.e. ammonia), or alteration of water quality parameters (i.e. DO, temperature, and salinity levels). Chemicals enter the environment through point and nonpoint source discharges, including spills, industrial sources, municipal effluents, and agricultural runoff. These sources contribute organic compounds, heavy metals, pesticides, herbicides, and a wide variety of newly emerging contaminants to the aquatic environment. Contaminant spills pose concern to mussel survivability, especially in the Black River population. In August 2017, a ruptured pipeline released 18,000 barrels of produced water from hydro-fracking and 11 barrels of oil into the Delaware River (a tributary to the Pecos River) upstream of the reintroduction site

(Eaton 2017). Following the contaminant/oil spill, surveys found two individuals alive, out of 80 that were reintroduced (Service 2018).

Ammonia is of particular concern below water treatment plants because freshwater mussels are particularly sensitive to increased ammonia levels (Augspurger *et al.* 2003). Karatayev *et al.* (2015) speculated that the absence of Texas hornshell downstream from two wastewater treatment plants may be attributed to their discharge into the Rio Grande River at Nuevo Laredo, Mexico, and Eagle Pass, Texas.

High salinity concentrations appear to limit Texas hornshell's presence and abundance in some river segments. The aquifer near Malaga, New Mexico, contains saline water. As the saline water emerges from the ground, it is diluted by surface flow. When surface flow in the river decrease, the salinity concentrations increase. Preliminary findings reveal that populations in parts of the Rio Grande basin are being impacted by salinization. In particular, the Pecos River population is effected by current salinity levels that regularly exceed the Texas hornshell's known tolerance limit of 2.0 parts per thousand (ppt). The Pecos River once harbored a robust population; however, after exhaustive surveys efforts only 3 live individuals and lots of long dead shell were found. This extirpation event appears to coincide with increases in salinity levels and concomitant decreases in flow (Pers. Comm. M. Hart *et al.* 2018).

Loss of Flowing Water: Texas hornshell need flowing water in order to survive. Low flow events (including stream drying) and inundation (impoundments) can eliminate appropriate habitat for the species. While they can survive these events for a short time, populations that experience these events regularly will not survive (Service 2018). Recent droughts have led or are leading to extremely low flows in rivers across the desert southwest (https://www.drought.gov/drought/states/new-mexico, accessed 4/2018). The rivers inhabited by Texas hornshell have some resiliency to drought because they are either spring fed (Black and Devils Rivers) or very large (Rio Grande). However, drought, in combination with increased groundwater pumping and regulated reservoir releases, may lead to lower river flows of longer duration than have been recorded in the past. While the species may survive short periods of low flow, as low flows persist, mussels face oxygen deprivation, increased water temperature, and, ultimately, stranding, reducing survivorship, reproduction, and recruitment in the population.

3.6 Conservation Assessment

Though only about 7% of known occupied habitat for the Texas hornshell is in New Mexico, it is an area that holds important genetic diversity for the species. The Service collaborated with water users, oil and gas developers, landowners, and other partners to develop Candidate Conservation Agreements (CCAs) and Candidate Conservation Agreements with Assurances (CCAAs) for the species on State, Federal and private lands. These agreements provide voluntary conservation that will reduce threats, while improving physical habitat and water quality. The key conservation measures in the agreements are designed to: limit oil and gas development to areas outside of the Black and Delaware River floodplains; minimize erosion; and maintain minimum water flows in the rivers.

In Texas, The Nature Conservancy and Texas Parks and Wildlife Department (TPWD)

manage lands in the Devils River watershed to maintain and enhance native communities. In the Rio Grande, we are not aware of any management actions for Texas hornshell. The Texas Comptroller of Public Accounts established an Endangered Species Task Force and has funded much of the recent research on Texas hornshell, leading to a greater understanding of the species' distribution in Texas.

The Service is currently working with Texas A&M University Institute of Natural Resource Center and TPWD to draft a Conservation Plan for Texas Freshwater Mussels, with an emphasis on State and federally listed species. Implementation will require the participation of a broad range of partners, including other Federal agencies, States, Tribes, nongovernmental organizations, businesses, and private landowners. State agencies and the Service frequently work together to review and comment on projects that propose to affect Texas hornshell and/or its habitat.

3.7 Summary Statement of Recovery Needs

Texas hornshell needs management of water quality standards, base flows, land management, habitat restoration, and reestablishment of basin connectivity, where possible. The conservation status of the Texas hornshell could improve if extant populations can be maintained at viable levels. Certain populations will benefit from population augmentation and reintroduction into streams and stream reaches via direct release of hatchery-reared juveniles, infected host fishes, or adult mussel.

4.0 PRELIMINARY RECOVERY STRATEGY

4.1 Recovery Priority Number: 8

The Texas hornshell is assigned a recovery priority number of 8, indicating that this species, while facing a moderate degree of threat, has a high recovery potential. The recovery potential for Texas hornshell is considered high because the biological and ecological limiting factors, as well as the threats to the species existence, are well known, understood, and can be alleviated to a certain degree with proper management of water flows, water quality, and land use.

The threats are moderate due to ongoing sources of habitat loss, degradation, and modification, including potential impoundment construction, water use and management, ongoing drought conditions, water quality degradation, contaminant spills, and sedimentation. The Texas hornshell has a high probability of recovery even though threats will continue into the foreseeable future. However, the Service plans to minimize the threats by: working with local stakeholders and partners to increase river flows, improving water quality through establishment of enhanced management guidelines, and utilizing current CCA and CCAA's.

4.2 Recovery Vision

The best strategy for recovery of the Texas hornshell mussel is to use existing State and Federal laws and regulations that protect, enhance, and manage aquatic habitats throughout the basins and to use non-regulatory approaches to encourage and assist the appropriate local, State, and Federal

agencies, private landowners, and local communities/businesses toward the goal of maintaining and improving ecosystem quality.

There are several actions that contribute to declines in populations and should be minimized including actions that: 1) result in mortality or injury of Texas hornshell; 2) reduce reproduction or recruitment of young into populations; 3) increase stress to remaining individuals, and; 4) alter sensitive habitat. These are critical for protecting sites where reproduction is known to still occur or which contain larger numbers of the species.

4.3 Brief Action Plan

1. Maintain suitable habitat to support viable populations by identifying river reaches that support high native aquatic biodiversity and Texas hornshell.

2. Minimize adverse effects to habitat and populations from threats by: (1) encouraging municipal and industrial compliance with current water quality discharge limits; (2) encouraging the use of effective silt and sediment runoff control from all activities within the river basins; (3) encouraging the development and implementation of adequate Streamside Management Zones along aquatic systems within identified critical habitat; (4) encouraging dam operation and water diversions to maintain base flows high enough to prevent excess sediment buildup in identified habitats; (5) working with stakeholders to implement water management strategies to aid in Texas hornshell and fish host reproduction during the spawning season; and (6) working with the Service's Fisheries and Partners for Wildlife Programs, TPWD, New Mexico Department of Game and Fish (NMDGF), and others to determine what road crossing designs best allow for water and fish passage and are stable in the arid environments.

3. Work with stakeholders and partners to: (1) establish instream flow standards that support Texas hornshell and fish host needs; and (2) build upon current best management practices (BMPs) to improve water quality from wastewater treatment plant and industrial effluents.

4. Survey and monitor status of species by: (1) conducting surveys in remote areas of the Texas hornshell's historic range to determine presence and status; and (2) establishing long-term monitoring sites of known populations.

5. Conduct research in areas that will inform conservation of the species by: (1) determining contaminant sensitivity and work with Texas Commission on Environmental Quality (TCEQ) and the Environmental Protection Agency (EPA) to ensure water quality standards and classifications address the species needs; (2) looking into detailed physical and molecular genetics analysis in new populations; (3) studying Texas hornshell life history to better understand food habits, age and growth, and mortality factors; (4) determining the minimum flow requirements; (5) determining population size and genetic make-up necessary for reintroduced populations to be self-sustaining in the Delaware River or other drainages.

6. Restore habitat and populations by: (1) working with stakeholders to remove existing fish migration barriers (including impoundments); (2) working with stakeholders to implement

groundwater and surface water conservation strategies to maximize surface water flows; (3) work with private land owners, States, local government, and Federal partners to encourage land and water stewardship.

7. Education and outreach by: (1) working with State and Federal agencies, tribes, and private organizations to promote land and water stewardship; (2) developing programs and materials to inform the public on the need and benefits of aquatic ecosystem management; (3) reviewing management, monitoring strategies, and apply adaptive management; (4) identifying captive propagation requirements and develop a protocol for large-scale captive breeding and augmentation. Include a genetics management plan and locate a suitable location to maintain a captive population; and (5) working with partners to develop a protocol for release of captive bred individuals into occupied and historically occupied reaches for research, monitoring, and to provide population redundancy.

5.0 PREPLANNING PROCESS

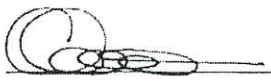
A recovery plan will be prepared pursuant to section 4(f) of the Act. The recovery plan will include objective, measurable criteria, which when met, will ensure the conservation of this species and removal from the Federal list of Endangered and Threatened Wildlife and Plants. Recovery criteria will address all threats meaningfully impacting the species. The recovery plan will estimate the time and cost required to carry out those measures needed to achieve the goal of recovery and delisting for the Texas hornshell.

Plan preparation will be under the guidance of the Texas Coastal Ecological Services Field Office. The Service anticipates either writing the recovery plan or appointing a recovery team to help draft a recovery plan for the Texas hornshell. Individuals invited to be a part of the recovery team would be experts in freshwater mussels, particularly Texas hornshell, and capable of advising the Service on recovery population thresholds and important short and long-term actions necessary to recover this species. The draft recovery plan should be finalized in 2020 and the final recovery plan should be published in 2021.

During the recovery planning process, input, comments, and review will be sought from multiple stakeholders within the states of Texas and New Mexico. These will include State and Federal agencies, tribes, industrial and agricultural groups, research universities, and conservation organizations. Primary authorship of the Recovery Plan will be the responsibility of Service staff, though State partners will be heavily involved in all phases of the planning and implementation processes.

Approval:

Approval:

 Date: 9 April 2018

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