THOMPSON-NICOLA
REGIONAL DISTRICT

MOSQUITO SURVEILLANCE & REDUCTION PEST MANAGEMENT PLAN

CONFIRMATION NO: 116-0032-21-26
April 2021

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EXECUTIVE SUMMARY

This Pest Management Plan (PMP) will serve as a strategic management tool that will allow for the effective reduction of larval mosquitoes within specified mosquito surveillance and reduction areas of the Thompson-Nicola Regional District (TNRD) including all public, private and First Nations Reserve lands by permission of the applicable owner, agent or authority.

The TNRD carries out mosquito reduction activities within the following Electoral Area boundaries:

1. **a 10km radius surrounding and including the community of Blue River in Electoral Area 'B';**
2. **Electoral Areas 'J', 'L', 'M', 'O', 'P';**
3. **Electoral Area 'N' (except area around Coquihalla Summit Recreation Area); and**
4. **a portion of Electoral Area 'A' (excluding Wells Gray Provincial Park)**

The municipalities included in the program boundaries are:

1. **the City of Kamloops;**
2. **the District of Clearwater;**
3. **the District of Barriere;**
4. **the Village of Chase;**
5. **the Resort Municipality of Sun Peaks; and**
6. **the District of Logan Lake.**

Mosquito reduction activities will conducted using Integrated Pest Management Principles including careful monitoring to determine pest incidence and abundance. All treatments will target mosquitoes in their larval stages.

No treatments of adults will be conducted under this PMP unless ordered by a Medical Health Officer from the Interior Health Authority or the Government of British Columbia.

All mosquito surveillance and reduction activities will be undertaken in a manner that minimizes risk to the environment and human health. This PMP addresses all required elements of a PMP as outlined in Section 58 of the BC *Integrated Pest Management Regulation*.

1.0 INTRODUCTION

The goal of the Thompson-Nicola Regional District (TNRD) Mosquito Surveillance and Reduction Program is to reduce mosquito populations to a tolerable level. In areas adjacent to extensive larval development habitat, mosquito populations can become extremely high. When this happens, quality of life for residents in the area can decrease because of severely limited outdoor activity. Further, high numbers of mosquitoes can cause allergic reactions in some individuals and can negatively impact outdoor based economic activity.

In some instances, human and animal health can also be impacted as some mosquito species are capable of transmitting illnesses such as Western Equine Encephalitis, Canine Heartworm and West Nile virus and therefore, the TNRD may, under direction of a Medical Health Officer, undertake vector mosquito control aimed at the reduction of mosquito species known to transmit disease.

The TNRD has conducted a mosquito reduction program since 1972. The program is based on the principles of Integrated Pest Management (IPM) meaning that the most effective, economical and environmentally sound methods of mosquito reduction are considered first. Prevention and reduction of mosquito larval development sites is the primary objective of the TNRD program, as preventing a problem is always better than trying to reduce the problem once it occurs.

The TNRD mosquito reduction campaign is focused on treating mosquitoes while they are in their larval stages, (as opposed to their adult stage) for two primary reasons. Firstly, larval treatment is efficient – it is possible to treat larval mosquitoes in extremely high numbers in larval development habitats, while adult mosquitoes tend to disperse soon after emerging over a much wider area. Secondly, unlike adult mosquito pesticides, larvicides such as Aquabac, Vectobac, Altosid and VectoLex are species-specific, affecting only aquatic members of the Order Diptera, which includes mosquitoes, black flies and midges.

Adult mosquito treatment **will only be considered under an Order from a Medical Health Officer and the application would be completed following the parameters directed by the Medical Health Officer.**

It is a provincial requirement that a Pest Management Plan (PMP) (this document) be developed when more than 1 ha/year of habitat will be treated. This PMP will outline how the TNRD will use pesticides in accordance with the terms and conditions of the *Integrated Pest Management*

Regulation. The content of PMP's prepared in the province of British Columbia is also legislated under the *Integrated Pest Management Regulation* (Section 58) and a checklist of required components is included in Appendix A.

1.1. IDENTIFYING INFORMATION [IPMR SECTION 58(1)]

1.1.1. Responsibility for the TNRD Integrated Mosquito Surveillance and Reduction Program [IPMR Section 58(1)(b)(c)]

The primary contact for information relating to the mosquito surveillance and reduction program is:

Coleen Hougen
Integrated Pest Management Supervisor

300-465 Victoria Street
Kamloops, B.C. V2C 2A9.
Phone: (250) 377-6306 or at 1-877-377-8673.

1.1.2. Geographic Boundaries of the Area to Which This Plan Applies [IPMR Section 58(1)(a)]

The TNRD Mosquito Surveillance and Reduction Program is conducted within in the following areas:

1. a 10km radius surrounding, and including, the community of Blue River in Electoral Area 'B';
2. Electoral Areas 'J', 'L', 'M', 'O', 'P';
3. Electoral Area 'N' (except area around Coquihalla Summit Recreation Area); and
4. a portion of Area 'A' (excluding Wells Gray Provincial Park).

The municipalities included in the program boundaries are:

1. the City of Kamloops;
2. the District of Clearwater;
3. the District of Barriere;
4. the Village of Chase;
5. the Resort Municipality of Sun Peaks; and
6. the District of Logan Lake.

Appendix B includes maps of the geographic boundaries of the TNRD Mosquito Surveillance and Reduction Program. Maps displaying the locations of larval development sites can be provided upon request. Please contact Martin Dickson, Environmental Services Coordinator (Section 1.1.1) at the TNRD for specific larval development site information.

1.1.3. Term of this PMP

This PMP shall be in force for a five-year period from April 13, 2021 to April 12, 2026.

2.0 INTEGRATED PEST MANAGEMENT

A requirement of all PMP's in British Columbia is an explanation of how the applicant (in this case, the TNRD) will utilize the elements of Integrated Pest Management (IPM). The six elements of an IPM strategy that will be discussed in detail in the following sections are:

1) **a strategy to *prevent* organisms from becoming pests (planning);**
2) **a method to *identify* pests;**
3) **a *monitoring* (surveillance) program;**
4) **a description of the *injury thresholds* used to make treatment decisions;**
5) **a description of *treatment options* and selection criteria; and**
6) **a method for *evaluating effectiveness* of pesticide use.**

2.1. PREVENTION (PLANNING) [IPMR SECTION 58 (2) (A)]

Prevention is one of the most important options for successful mosquito reduction. The TNRD actively pursues the following preventative measures in its mosquito reduction program:

- Reduction and/or modification of mosquito larval development sites; and,
- Public outreach

2.1.1. Source Reduction & Habitat Modification

The TNRD encourages the reduction of mosquito larval development sites and water management as effective methods of mosquito reduction. Mosquitoes are unable to complete their life cycle without stagnant water.

Source reduction is simply the use of physical methods to eliminate standing water by draining or filling in mosquito larval development sites or allowing water to flow through the site. If draining or filling is not an option, many mosquito larval development sites such as storm water retention ponds, sewage treatment ponds, farm dugouts, and ornamental ponds, can be made unsuitable for mosquito larval development through a combination of good design (*e.g.*, steeply sloped and gravelled shore lines), water level manipulation, and control of emergent vegetation. Bodies of water with sloped, gravelled, rocky or sandy shorelines will usually support fewer mosquitoes because larvae will be exposed to wave action and will have difficulty obtaining food.

Scraping of sediment from the bottom of roadside ditches every few years can make the ditches unattractive for mosquito larvae. Ditches that are slow to drain may form a series of pocket pools and support lush grasses and weeds, thereby becoming prime larval development sites. It is important to note that some ditches can be habitat for other organisms including amphibians

and fish, and so prior to working in ditches potential impacts to other species should be considered on a case-by-case basin.

Landowners and local governments will be encouraged to use the above described methods within their lands.

In some agricultural areas, over-irrigation or flood-irrigation can produce significant larval development habitat. Proper watering of fields at ranching and hay farming operations will be encouraged by the TNRD through education. Efforts will be made to contact farmers when over-irrigation, flood-irrigation or broken irrigation pipes are noticed. Farmers will be encouraged to alter their practice and/or repair broken irrigation pipes.

Homeowners/residents will be encouraged to participate in habitat management. Since some species of mosquitoes (e.g. *Culex* and *Culiseta*) can readily develop in containers, the TNRD encourages residents to reduce standing water around their homes. Some examples of measures that can be undertaken by residents to help reduce mosquito larval habitat on their property include:

- Eliminate standing water outdoors by emptying artificial containers (e.g., flower pots, wheel barrows, old tires, barrels, storage drums, abandoned equipment and tins cans) at least once a week, or by storing them in an inverted position, drilling holes in them, disposing of them or covering them.
- Cover the top of water collecting containers (e.g. rain barrels) with a screen to prevent mosquitoes from laying floating eggs.
- Drain water from swimming and wading pools when not in use or cover them so that mosquitoes cannot lay eggs.
- Keep water off swimming pool covers and ensure that the pump is circulating water.
- Change water in bird baths weekly.
- Install fountains or aerators in artificial waterbodies or ornamental ponds.
- Clear leaves and twigs from tarps, awnings, eaves troughs, storm gutters and roof gutters throughout the summer and early fall so water does not pool or collect.
- Avoid over-irrigating lawns and fields.
- Ensure proper drainage of septic tank fields.
- Drain or fill-in low areas, tire ruts or hole left during excavation.
- Encourage ranchers/agricultural producers to change water weekly in livestock watering troughs.

2.1.2. Public Outreach

The TNRD includes public outreach as a vital component of their mosquito surveillance and reduction program. Public outreach includes advising the public of measures that they can take to reduce the incidence of mosquito bites.

NOTE: COVID-19 has impacted outreach activities. The TNRD may not attend meetings or events while COVID-19 remains a threat.

Some examples of public outreach initiatives conducted by the TNRD include:

- maintenance of a 24-hour Mosquito Advisory Line whereby residents can leave a message and have a TNRD representative return their call within 24 hours to report potential mosquito larval development habitats and to answer any questions residents may have concerning mosquito treatments, mosquito biology, or current mosquito reduction activities;
- attendance (as funding allows) at events such as trade shows, club meetings, outdoor festivals and fairs, workshops, farmers' markets, public events, public meetings, parades and rodeos, community garage sales, home and garden shows, family fun days, arts festivals;
- presentations/workshops for aboriginal groups, local governments, schools, and the public (as funding allows);
- social media updates (e.g. Facebook and Twitter) that notify the public of operational activities, treatments, nuisance reduction;
- advertising on radio and television (as funding allows) on topics related to mosquitoes and WNV, including promoting the use of mosquito repellents; and
- a website for information related to the mosquito surveillance and reduction program. This website can be accessed at: https://www.tnrd.ca/services/nuisance-mosquito-control/ .

As part of its public outreach initiatives, the TNRD promotes the following:

- avoiding, where possible, being out at dusk and dawn, as mosquitoes tend to be more active during these times;
- wearing protective clothing including long-sleeve shirts or jackets and long pants that mosquitoes cannot bite through;
- avoiding dark coloured clothing as it can attract mosquitoes;
- using mosquito netting for babies and toddlers in cribs and strollers;
- applying Health Canada approved insect repellents, such as those containing DEET (N,N-dithyl-m-toluamide), Icaridin or Lemon Eucalyptus Oil (30%); and
- reducing habitat development sites and vegetation that provide harbourage on and around residences.

The TNRD does not promote the use of bug zappers, devices that give off sound waves and Citrosa plants for protection against mosquito bites as these are not shown to be effective.

2.2. A Description of the Program That Will Be Employed to Identify the Pest [IPMR Sections 58(2)(b)]

One of the most important steps in mosquito reduction is to correctly identify the pest species and its habitat. This is particularly important because only certain mosquito species are known to be a significant nuisance, while other species are known to be competent vectors of WNV (and

related arboviruses). Species identification allows mosquito reduction staff to tailor their program to meet specific objectives (i.e., nuisance mosquito reduction and/or vector mosquito reduction).

Mosquito surveillance allows applicators to identify when and where mosquito pests occur. The TNRD has engaged in both ongoing larval surveillance and adult surveillance. At least 38 different species of mosquitoes representing all of BC's five genera of mosquitoes have been captured in adult light traps and/or as larvae in the Regional District (Table 1). Each of the species present in the TNRD except *Culex territans* (which feeds on amphibians) and *Culex pipiens* (which feeds on birds) can be a nuisance species to some degree. *Culex pipiens* is an excellent vector of mosquito-borne illness among birds and therefore is an important species to target when undertaking vector mosquito treatments:

Table 1. List of the Mosquito Species Identified within the TNRD

Aedes campestris	*Aedes increpitus*	*Anopheles earlei*
Aedes canadensis	*Aedes intrudens*	*Anopheles freeborni*
Aedes cataphylla	*Aedes melanimon*	*Anopheles punctipennis*
Aedes cinereus	*Aedes mercurator*	*Coquillettidia perturbans*
Aedes communis	*Aedes pionips*	*Culex pipiens*
Aedes dorsalis	*Aedes provocans*	*Culex tarsalis*
Aedes euedes	*Aedes pullatus*	*Culex territans*
Aedes excrucians	*Aedes punctor*	*Culiseta alaskaensis*
Aedes fitchii	*Aedes sierrensis*	*Culiseta impatiens*
Aedes flavescens	*Aedes spencerii* var *idahoensis*	*Culiseta incidens*
Aedes hendersoni	*Aedes spencerii* var *spencerii*	*Culiseta inornata*
Aedes hexodontus	*Aedes sticticus*	*Culiseta morsitans*
Aedes implicatus	*Aedes vexans*	

In the field, mosquito larvae and adults are difficult to identify to the species level. For positive identification, most mosquitoes need to be examined under a microscope. Therefore, in the TNRD, the determination as to whether a larva is likely to be a pest species or not will be based on the habitat where the larvae are found and the time of year. Mosquitoes are selective with their habitats. Different species of mosquitoes tend to choose different types of habitats. The time of year can also give clues to the identity of the mosquito species.

Most mosquitoes in the TNRD are from the *Aedes* genus. Most *Aedes* species lay their eggs in moist soil near recently flooded area. Snowmelt species rely on warm temperatures and/or low oxygen levels in water to induce their eggs to hatch. Larvae of the floodwater species usually appear as soon as their eggs are wetted. Large areas of habitat often become active with rising floodwaters along creeks, rivers, and lakes and in permanent marshes as the snow melts and raises the water level in the marshes. Eggs laid by most species remain viable for several years, and therefore egg concentrations in the soil can become very dense. All the *Aedes* species can be considered human nuisance mosquitoes (although some are more aggressive than others.) *Whenever larva are found in flooded habitats or in permanent ponds (especially in the spring), applicators will assume that these are pest species and treatment of the larvae will be considered*.

As the summer progresses, the occurrence of floodwater larvae tends to decrease (unless a large storm event causes flooding, or in the case of agriculture, a farmer over-irrigates, flood-irrigates, or fails to repair broken pipes). Water left standing after the spring floods can begin to colonize with species of mosquitoes from the *Anopheles*, *Culiseta* and *Culex* genera. *Anopheles* mosquitoes are easily recognized as the larvae are much different in appearance from all other larvae in British Columbia. They lay flat on the surface of the water and lack a siphon. *All Anopheles species in British Columbia can be considered human pests and therefore whenever these species are found, treatment will be considered.*

Culiseta and *Culex* mosquitoes lay their eggs on the surface of standing water and will produce multiple generations over the summer. Most species from each of these genera can be nuisance mosquitoes and/or vectors of mosquito-bourne illness and therefore whenever these species are found, treatment will be considered.

The determination as to whether adult mosquitoes are posing a health risk, and therefore warranting adulticiding control, is a duty of the local Medical Health Officer.

2.3. MONITORING (SURVEILLANCE) PROGRAM [IPMR SECTIONS 58(2)(C)(I)(II)(III)]

The TNRD conducts three kinds of surveillance as part of the mosquito surveillance and reduction program: 1) environmental conditions; 2) larval development sites and larval populations; and 3) adult mosquito populations.

2.3.1. Environmental Monitoring

The TNRD monitors river levels, snow pack levels, temperature forecasts, dam release plans (for Nicola River) and precipitation forecasts. Water Survey Canada maintains real-time continuous

flow data for many rivers in the province including the North and South Thompson Rivers. This data is monitored daily during peak flows at http://wateroffice.ec.gc.ca/index_e.html . Snow pack levels are viewed on the Ministry of Forest, Lands and Natural Resource Operation website: http://bcrfc.env.gov.bc.ca/data/asp/realtime/index.htm. Monitoring of each of these variables before and during the season, allows technicians to estimate the size and number of larval development sites that will appear throughout the season.

Environmental monitoring is of critical importance when attempting to predict river levels and peaks. It is a goal of the program to postpone aerial larviciding in the North Thompson valley until after a major river peak to reduce the amount of larvicide needed to conduct the aerial campaign; however, this is balanced with larval development as the larvae cannot be allowed to pupate while waiting for the river to peak.

Current weather conditions are monitored through Environment Canada weather forecasts as these can affect whether treatments are carried out on any given day. Ground based treatments of granular larvicides are occasionally deferred during high precipitation events or during high winds. When helicopter applications are planned, wind and precipitation monitoring is especially important as helicopter treatments are halted when wind conditions make it difficult for the pilot to aim granular larvicides at the larval development sites (*i.e.* the pilot is unable to compensate for drift of the granular product due to wind). Also, helicopter campaigns are often postponed during precipitation events because the granular larvicides can become wet and clog the application equipment. This can result in improper application rates and possible damage to the application equipment.

Current weather conditions are exceptionally relevant during adulticiding campaigns. Wind speed, ambient temperature and precipitation all influence the application of adulticides and suitable parameters are included on most of the adulticide labels. Winds must be negligible to prevent excessive drift of Ultra Low Volume (ULV) droplets, however some labels state that a slight breeze is desirable. Adulticides such as malathion can only be applied when the ground and vegetation is dry and is expected to remain dry for at least 8 hours. Also, ambient temperature can be important with some chemical pesticides, and their effectiveness is impeded if they are not applied when the ambient temperature is optimal (*e.g.* malathion should be applied when ambient temperatures are between 15°C and 30°C). Adulticiding will only be conducted under this PMP when ordered by a Medical Health Officer, **and** environmental conditions are appropriate.

2.3.2. Surveillance of Larval Mosquitoes

The TNRD will conduct larval surveillance in areas identified as known or potential larval development sites. Sampling will be undertaken as required, based on meteorological factors such as rainfall, temperature, river levels or flooding events. The results of sampling will be used to make treatment decisions.

Monitoring Methods, Frequency of Monitoring and Data Collected

Regular surveillance of larval mosquito populations will be undertaken throughout the mosquito season to determine when and if treatment is required (based on threshold levels- See Section 2.4.1). Larvicides have been shown to be most effective when the mosquito larvae are actively feeding and when the larvae are at the right stage (instar) of development. The results of larval surveillance will be used to:

- Define the nature and extent of the mosquito problem based on larval surveys;
- Generate the data needed to determine if larviciding should be considered (i.e. the treatment threshold has been reached or surpassed);
- Give direction to daily mosquito treatment activities (priorities will be set based on the instar of the larvae);
- Determine which larval development sites can be eliminated from future surveillance; and,
- Identify the genus of mosquito present at a larval site (if possible), to evaluate whether the species are significant human pests.

"Mosquito larval dippers" are commonly used to sample mosquito larvae. With this device, a 300 ml sample of water from a suspected larval development site is checked for the presence of mosquito larvae. The number of larvae present, and their development stage (instar) is recorded, and the process repeated at several locations to determine the average density. The results of this sampling are used to make a treatment decision. Following treatment sampling is done again (on a subsample of sites) to assess effectiveness of the treatment.

An electronic database that enables management staff and technicians to access larval development site data quickly and accurately.

The database(s) include the following information:

- the location and size of the larval development habitat (size estimate as this fluctuates with flood level);
- description of the habitat (floodwater, snowmelt, manmade, etc);
- maps and/or photographs associated with each development site;
- the status of the land (public or private);
- status regarding "no treatment areas" if any;
- landowners'

- contact information;
- larval development site data (mosquito species present, if known, and surveillance history) and;
- monitoring and treatment data including the following:
  - ✓ date and time of monitoring or treatment event
  - ✓ number of larvae present per dip
  - ✓ name of larvicide (if used)
  - ✓ active ingredient of larvicide
  - ✓ PCP number of larvicide
  - ✓ kilograms or litres of larvicide applied
  - ✓ number of hectares treated
  - ✓ applicators also keep a record of precipitation (if any), wind speed and temperature in a notebook

2.3.3. Surveillance of Adult Mosquitoes

Adult surveillance will be conducted in the TNRD using CDC black light traps, and/or New Jersey light traps. CDC black light traps and New Jersey traps use black light to attract adult mosquitoes which are sucked into a collection jar. To increase these traps effectiveness, dry ice can be placed near the trap as it releases carbon dioxide, a powerful mosquito attractant. Mosquitoes captured in traps will be counted and then examined under microscope and identified to the species level.

Trap counts will be used to assess the annual effectiveness of the larval reduction program. Since adult mosquitoes are trapped in similar locations on an annual basis, year to year comparisons of adult mosquito counts will be made. This allows the TNRD to determine whether the program delivered the expected level of mosquito reduction, given the environmental conditions (e.g. we would expect a higher trap count in a higher flood year, but should be concerned if trap counts were higher than average in a dry year).

Adult trapping may also be conducted in response to specific concerns from landowners. When adult mosquito populations increase unexpectedly, mosquito collections can give a clue as to the proximity and type of larval development site in the area. Different species of mosquitoes rear in different types of development sites, and therefore, once the species of mosquito causing the nuisance is determined, crews can search for possible development sites in the area.

2.3.4. Assessing Environmental Conditions and Damage Caused by Mosquitoes Before Insecticide Use

Damage Caused by Mosquito Larvae

Unlike other types of pests, mosquito larvae do not cause direct environmental damage or affect environmental conditions. Potential damage caused by mosquito larvae is related to the potential

of some species (as adults) to cause a nuisance and/or to transmit disease to humans and/or other animals.

Damage Caused by Mosquito Adults

Adult mosquito outbreaks can have negative economic effects. Adult mosquitoes can, and do, interfere with a variety of recreational activities by limiting the use of outdoor areas. This can have economic consequences where tourism is a significant industry. Studies have also shown that numerous outdoor work activities (e.g., agriculture, forestry, construction) are negatively impacted by the presence of large numbers of biting mosquitoes. In the farming industry, dairy and beef cattle have been shown to have smaller weight gains when exposed to both constant annoyance and being bitten while grazing or feeding.

There can also be health concerns related to mosquito bites. There are several species of mosquitoes within the TNRD that are potential vectors of disease. Also, mosquito bites can cause severe reactions in some individuals and skin infections can occur when individuals scratch their bites.

2.4. INJURY THRESHOLDS [IPMR SECTIONS 58(2)(D)(I)&(II)]

With respect to mosquitoes, injury thresholds are generally referred to as *treatment thresholds*. The TNRD has established treatment thresholds for larval mosquito populations. The TNRD will not propose a threshold for treatment of adults, because **no nuisance mosquito adulticiding will be performed in the TNRD**. If a Medical Health Officer **orders** adult control, it will be up to the Medical Health Officer to determine treatment thresholds, if any.

2.4.1. Treatment Thresholds for Mosquito Larvae

The treatment threshold for mosquito larvae is determined by the certified applicator and considers several variables. The applicator decides whether the numbers of larvae present are likely to cause a nuisance if allowed to develop to adults.

As a general guideline, the treatment threshold for mosquito larvae is an average of **three larvae per 300ml dip**. This threshold was selected because it is a standard that has been used in British Columbia and other areas of Canada and the United States. However, the TNRD will consider exceptions to this standard (e.g. one larva per 300ml dip). In some cases, an applicator may decide that an average of three larvae per dip may not be enough to require treatment. For example, if the larval development site is very small and a significant distance from the public, the applicator may decide that allowing the larvae to develop will not pose a nuisance problem and therefore no

treatment would be necessary. Conversely, a technician may encounter a site that is large and deep with larvae distributed throughout the water column. In this case, it may be difficult to capture three larvae in a dip, however the cumulative number of larvae in the site can be significant and treatment could be warranted. Certified Mosquito and Biting Fly Pesticide Applicators, in consultation with the TNRD manager, will make the final decision as to whether to carry out larval treatment. No larviciding will be conducted on private property without the consent of the landowner.

2.4.2. Treatment Thresholds for Mosquito Adults

It is expected that the Medical Health Officer will have determined the threshold for protection of human health and would issue an Order based on this threshold. It is also expected that the Medical Health Officer will outline the geographical area to be sprayed, the pesticide to be used and any special considerations.

When responding to an Order, unless otherwise directed by the Medical Health Officer, adulticiding will only be undertaking when meteorological conditions are appropriate as outlined on the product label and when adequate buffer zones can be maintained around the following:

- Bodies of water including dry streams and wetlands (a 10m, pesticide-free zone is required around these habitats);
- Water supply intakes or wells used for domestic or agricultural purposes, including water used for livestock or irrigation of crops (a 30m no-treatment zone must be maintained around a water supply intake or well unless the Confirmation holder is "reasonably satisfied" that a smaller no-treatment zone is sufficient to ensure that pesticide from the use will not enter the intake or well- a record must be kept of the information on which the decision was based for a smaller no-treatment zone); and
- Apiaries.

2.5. Treatment Options for Reducing Mosquito Larvae [IPMR Sections 58(2)(e)(i)(ii)(iii)(iv)]

IPM involves the use of different techniques to reduce mosquito populations. The treatment options that the TNRD will employ include:

- Source reduction and habitat modification (prevention);
- Treatment of larvae with a biological larvicide;
- Treatment of larvae with a chemical larvicide;
- Chemical treatment of adult mosquitoes (only under an Order by a Medical Health Officer).

2.5.1. Source Reduction and Habitat Modification

Section 2.1.1(Source Reduction) describes the physical and mechanical methods that are promoted and utilized by the TNRD for reducing mosquito larva.

Rationale/Selection Criteria for Source Reduction and Habitat Modification

Mosquitoes require water to develop. Removal of standing water sources or modification of habitats, as described in Section 2.1.1, will effectively reduce mosquito larval numbers. This is always the preferred treatment option since elimination of the larval habitat is the most effective immediate and long-term reduction strategy.

Benefits of Source Reduction and Habitat Modification

The use of source reduction and habitat modification provides an effective, long-term solution to reducing mosquito larvae, and may reduce the need for using pesticides.

Limitations of Source Reduction and Habitat Modification

Typically, source reduction or habitat modification is conducted on small man-made habitats. Activities such as draining water collecting containers around a property and ditching can only go so far to reduce overall mosquito numbers. The most important habitats (natural ponds and floodwaters) cannot be modified as these are protected under provincial legislation.

2.5.2. Biological Treatment of Mosquito Larvae

Biological treatment involves the release or introduction of bacterial agents to reduce larval mosquito populations. The biological agents proposed for use under this PMP are *Bacillus thuringiensis* var *israelensis* (*Bti*) and *Bacillus sphaericus* (Table 2). The biological products, and their formulations, manner of application and the type of equipment required for each manner of application is detailed in Section 5.0 .

Rationale/Selection Criteria for Using Biological Agents

Mosquitoes are most efficiently and economically reduced when they are concentrated as larvae in a larval development site and therefore larvicides are an excellent choice for reducing mosquito populations. The relatively low risk nature of biological larvicides makes them an optimal choice for use in an IPM program.

Benefits of Using Biological Agents

The benefits of using these products are that they pose little risk to the applicator and they have little or no toxic impact on non-target species when applied at the label rates.

Limitations of Using Biological Agents

When biological larvicides are being used, frequent larval monitoring is required to ensure that applications are made within the treatment window. Treatments must be completed before the larvae stop feeding in the late 4th instar phase of development. It is most beneficial from an economic and environmental standpoint to wait until the larvae are in their 3rd or early 4th instar. Waiting for later instars allows the greatest amount of time for the highest number of mosquito larvae to hatch and be available to the larvicide. Also, it keeps the larvae in the environment longer and available to predators that benefit from the larvae as a food source.

Bti (Vectobac and Aquabac) rapidly breakdown in water through exposure to sunlight and aquatic microorganisms (generally 48 to 72 hours), therefore treatments must be repeated when monitoring confirms the presence of newly hatched mosquito larvae. *Bacillus sphaericus* formulated as VectoLex does not have this limitation as it has a prolonged action of up to 30 or more days.

According to the *Integrated Pest Management Regulation* Section 78(2), a pesticide-free zone is not required around standing water when applying the mosquito larvicides included in this PMP. However, in accordance with Section 78 (1) of the *Integrated Pest Management Regulation*, mosquito larvicides are limited in that they may not be applied in permanent, fish-bearing bodies of water or waters that have permanent, direct, surface-water connections with fish-bearing bodies of water. An exception to this rule is if a Medical Health Officer declares that an arbovirus is in the area. In that case, fish bearing waters may also be considered for treatment of larvae.

2.5.3. Chemical Treatment of Larvae

In the context of this PMP, the only chemical larvicide proposed to treat mosquito larvae is Altosid which has the active ingredient methoprene. Table 2 includes the formulations of methoprene that may be used under this PMP. The larval chemical treatment products, and their formulations, manner of application and the type of equipment required for each manner of application is detailed in Section 5.0 .

Rationale/Selection Criteria for Using Chemical Larvicides Containing Methoprene

As was noted earlier, mosquitoes are most effectively and economically reduced when they are in the larval stage and are concentrated in a larval development site (such as a storm water catch basin or a human-made, self-contained, water body).

Methoprene is generally selected as the preferred larvicide in man-made, self-contained habitats (such as over-irrigated fields and ditches, golf course ponds, and disturbed seepage sites) because of its low toxicity to non-target organisms and its extended action of up to 30 days depending on the formulation.

Benefits of Using Chemical Larvicides Containing Methoprene

Methoprene products have a benefit over the biological products in that they are active for up to 30 days in water AND the pellets can be applied to sites that may periodically dry-up and then become wetted again. Methoprene is considered safe for applicators to use without significant protective gear and is environmentally friendly, meaning that it has very low toxicity to non-target organisms when applied at the labelled rates. When methoprene is used, larvae develop to their pupal stage, and are therefore present in the water for a longer time than with the bacterial products. This is a benefit to the environment since the larvae are available to larval predators in the habitat.

Limitations of Using Chemical Larvicides Containing Methoprene

There are some disadvantages associated with the application of chemical larvicides containing methoprene. At present, methoprene is much more expensive than *Bti*. In the laboratory, high doses of methoprene have been shown to be slightly toxic to non-target organisms such as some crustaceans and fish. In the field, when applied according to the label, toxic concentrations are not reached, and the product is undetectable in the environment within a few days. However, following current legislation, **methoprene will only be considered for use in man-made water bodies that would never become contiguous with running water or for treatment of storm water catch basins**. Ideal locations include sewage lagoons, disturbed seepages, golf course ponds, and agricultural fields that are repeatedly flooded by over-irrigation and thus produce repeated generations of mosquitoes. The greatest disadvantage is that applicators are unable to assess the efficacy of a treatment until after the larvae pupate and therefore if the treatment failed, adult mosquitoes are inevitable.

Table 2. List of larvicides that are included in this PMP for use within the TNRD. Selection of the larvicide will be made by the applicator following assessment of the larva development habitat and consideration of available resources.

Trade Name	Formulation	Active Ingredient	PCP No.	Application Rate	Manner of Application	Application Methods
Mosquito Dunks	13g dunk	*Bacillus thuringiensis* var *israelensis* Strain H-14 (BMP-144)	28888	1 dunk per 6 m^2 of water surface	Ground	Manual placement
Vectobac 200G	Granules	*Bacillus thuringiensis* var *israelensis* Strain H-14 (AM65-52)	18158	3-10kg/ha	Ground & Aerial	Manual placement, backpack applicator, granular spreader, helicopter or fixed-wing aircraft. The TNRD may also use Drones for application if this method becomes listed as an option on the label.
Vectobac 1200L	Liquid	*Bacillus thuringiensis* var *israelensis* Strain H-14 (AM65-52)	21062	0.25-1.0L/ha	Ground & Aerial	Backpack sprayer, truck/ATV-mounted sprayer, helicopter or fixed-wing aircraft. The TNRD may also use Drones for application if this method becomes listed as an option on the label.
Aquabac 200G	Granules	*Bacillus thuringiensis* var *israelensis* Strain H-14 (BMP-144)	26863	2.5-20kg/ha	Ground & Aerial	Manual placement, backpack applicator, granular spreader, helicopter or fixed-wing aircraft. The TNRD may also use Drones for application if this method becomes listed as an option on the label.
Aquabac XT	Liquid	*Bacillus thuringiensis* var *israelensis* Strain H-14 (BMP-144)	26860	300-2400mL/ha	Ground & Aerial	Backpack sprayer, truck/ATV-mounted sprayer, helicopter or fixed-wing aircraft. The TNRD may also use Drones for application if this method becomes listed as an option on the label.
Altosid Pellets	pellets	methoprene	21809	2.8-11.2kg/ha	Ground	Manual placement or Backpack Applicator
Altosid XR Briquets*	36.4g Briquet	methoprene	27694	1 briquette per basin	Ground	Manual placement
VectoLex WSP*	10g water soluble pouch	*Bacillus sphaericus*	28009	1 pouch per catch basin	Ground	Manual placement
VectoLex CG	Granules	*Bacillus sphaericus*	28008	5.6-16.8 kg/ha in water bodies & 0.56-1.68 g/m^2 of water surface area in tires	Ground & Aerial	Manual placement, backpack applicator, granular spreader, helicopter or fixed-wing aircraft. The TNRD may also use Drones for application if this method becomes listed as an option on the label.
VectoLex WDG	powder to be mixed with water	*Bacillus sphaericus*	28007	0.56-1.68kg/ha	Ground & Aerial	Backpack sprayer, truck/ATV-mounted sprayer, helicopter or fixed-wing aircraft. The TNRD may also use Drones for application if this method becomes listed as an option on the label.

*for use in storm water catch basins only

2.5.4. Chemical Treatment of Adult Mosquitoes

If a Medical Health Officer issues a Pesticide Application Order, the TNRD would apply pesticides following the parameters of the Order. It is expected that if an Order is issued, the Medical Health Officer will consider the need for the protection of fish bearing waters and sensitive habitats. Further, it is expected that the BCCDC would acquire updated information from the Beekeepers Registry and would provide this info to spray personnel so that Beekeepers could be notified of any planned sprays in the areas near their hives.

Table 3 includes a list of currently registered pesticides for adult mosquito treatment. The adult chemical pesticides, and their formulations, manner of application and the type of equipment required for each manner of application is detailed in Section 5.0 .

Rationale/Selection Criteria for Using Adulticides to Treat Adult Mosquitoes

A Medical Health Officer may issue an Order to adulticide when provincial surveillance results have provided evidence that the risk of disease outbreak is significant.

Benefits of Using Adulticides to Reduce Adult Mosquitoes

The use of adulticides to reduce adult mosquitoes can be beneficial as (1) it can help to break the zoonotic cycle that is amplifies a disease and (2) it can reduce the chances of humans being bitten by a disease-infected mosquito.

Limitations of Using Adulticides to Reduce Adult Mosquitoes

The primary limitations to the use of the adulticides proposed for use are:

- They have a rapid rate of degradation (especially at high air temperatures) and therefore may necessitate additional treatments if surveillance results still show high levels of adult mosquitoes;
- They are highly toxic to most insects, including beneficial species;
- They are highly toxic to honeybees;
- Adulticiding should only be conducted between dusk and dawn to protect honey bees, which is difficult for applicators and requires extensive preparation and understanding of spray routes which are driven in the dark;
- If using the Gardex Commercial Industrial micro spray concentrate, mixing is required which puts the applicator at increased risk;
- Adulticide applications cannot be made in areas within 10 metres of water bodies due to the high toxicity of the active ingredients proposed for use to both fish and aquatic insects. An additional buffer zone is also required based on spray width of equipment.

Table 3. List of adulticides that are included in this PMP for use within the TNRD under the Order of Medical Health Officer. Selection of the adulticide will be made by the Medical Health Officer.

Trade Name	Formulation	Active Ingredient	PCP No.	Application Rate	Manner of Application	Application Method
Fyfanon ULV Concentrate	Liquid for ULV spray	malathion	9337	Residential areas: <260ml/ha Other Areas: 425-550ml/ha	Ground	Non-thermal, ULV aerosol generator
Malathion 95 ULV Insecticide	Liquid for ULV spray	malathion	25638	Residential areas: <274 ml/ha Other areas: 425-500ml/ha	Ground	Non-thermal, ULV aerosol generator
Gardex Commercial Industrial micro spray concentrate	Liquid for ULV spray (requires mixing prior to application)	pyrethrins 3.0%; Piperonyl butoxide 6.0%; N-Octyl bicycloheptene dicarboximide 10.0%	11855	2.5-3g pyrethrin/ha	Ground	Non-thermal, ULV aerosol generator
Pyrocide Fogging formula 7067 for ULV Mosquito Adulticiding	Liquid for ULV spray	pyrethrin 5%; piperonyl butoxide 25%	13378	2.8g-3.4g pyrethrin/ha; 25-30g piperonyl butoxide/ha	Ground	Non-thermal, ULV aerosol generator

*Ultra Low Volume (ULV) adulticiding applications may be done truck or ATV-mounted sprayers or backpack sprayers.

2.5.5. Selection of a Treatment Method

Once a decision has been made to conduct a treatment, the applicator must decide which product they will use, the application rate and how it will be applied. The decision will be based on a combination of the following considerations:

FOR LARVAL TREATMENTS

1) the advantages and disadvantages of each pesticide as discussed in Sections 2.5.2 to 2.5.3 and the properties of the pesticide and its method of application as will be discussed in Section 5.0 ;
2) the life stage (instar) and species of the larvae (single generation mosquito, or multi-generational mosquito);
3) the number (density) of larvae present;
4) the characteristics of the larval habitat (high organics, intermittently dry, type of habitat, and size and location of site(s));
5) the availability of the larvicide;
6) the cost of the larvicide; and
7) the proximity to fish bearing water and the likelihood of intermittent connection to fish bearing water.

FOR ADULT TREATMENTS

1) The selection of a treatment product and method will be made by the Medical Health Officer.

2.6. DESCRIPTION OF THE MONITORING PROGRAM FOR EVALUATING THE EFFECTIVENESS OF THE PESTICIDE [IPMR SECTIONS 58(2)(F)(I)(II)(III)]

The final component of an Integrated Pest Management approach is that of post-treatment evaluation. Post-treatment evaluation can help to improve a program over time as applicators learn which pesticides, application rates, methods and timing worked best at each application site. Constant evaluation of a program and its results will improve and refine the mosquito reduction program.

2.6.1. Evaluating the Effectiveness of Pesticide Use on Pest Populations

The *Integrated Pest Management Regulation* Section 78(4b) specifies that the efficacy of a mosquito larvicide be assessed by conducting pre-treatment and post-treatment larval samples of the water being treated. Within 10 days following treatment, certified applicators will return to a number of the larval development sites to conduct post-treatment monitoring using the same methods of assessing and recording larvae counts as described in Section 2.3.2 for pre-treatment monitoring. This information will be used to determine if the rate and type of pesticide application chosen for the location was suitable, and if the application failed, it would allow the applicator to plan for alternate methods of treatment.

Adult mosquito populations will be monitored post-treatment under direction of a Medical Health Officer. It is likely that mosquito trapping as described in Section 2.3.3 would be used to assess population numbers.

2.6.2. Post-Treatment Monitoring of the Environment and Non-Target Organisms Following Larval Treatment

As was discussed earlier, larvicides containing methoprene or biological bacterial agents have been shown to have no adverse environmental impacts when applied according to label directions, and no lasting adverse effects on populations of invertebrates or other non-target aquatic organisms. Consequently, post-treatment monitoring of non-target organisms and environmental effects will not be undertaken.

2.6.3. Post-Treatment Evaluation of Environmental Impacts and Non-Target Effects Following Adult Treatments

When applicators return to the treatment area to conduct post-treatment monitoring of the pest they will also take time to look for any evidence of non-target effects. Technicians will review:

- Whether environmentally sensitive areas were adequately protected;

- Whether the application rate or droplet size needs to be adjusted based on the results of mosquito surveillance or any signs of non-target affects;
- Whether there was any observable off-site insecticide movement or impact on surrounding areas; and
- Whether the established PFZs and NTZs were appropriate for the treatment method that was employed.

If an applicator believes that possible unintended environmental impacts have resulted from an adulticiding campaign, the technician must immediately inform the Manager responsible for the control work, and a review of the treatment must be conducted with the Medical Health Officer.

3.0 Description of Operational Information That Will Be Followed Under the PMP [IPMR Section 58(3)(a)]

The transportation, storage, handling, mixing, loading, application, and disposal of pesticides are governed by federal and provincial legislation. All persons working with pesticides will follow safe handling practices including workplace requirements for Workplace Hazardous Materials Information System (WHMIS) labelling and worker education. The required practices for pesticide applicators are detailed in:

- B.C Ministry of Environment (2005 or current edition) *Handbook for Pesticide Applicators and Dispensers; and*,
- Worker's Compensation Board of British Columbia (2009) *Standard Practices for Pesticide Applicators.* https://www.worksafebc.com/en/resources/health-safety/books-guides/standard-practices-for-pesticide-applicators?lang=en

3.1. Description of Procedures for Safely Transporting Insecticides [IPMR Section 58(3)(a)(i)]

The following procedures for safely transporting pesticides will be practiced by all TNRD representatives working under this PMP. The *Integrated Pest Management Regulation* (section 65(1)) legislates that pesticides must be kept, handled, stored and transported in the container in which it was originally packaged and with the label originally affixed by the manufacturer, or in a container designed for containing the pesticide and labeled accordingly. Also section 33 (2) of the *Regulation* states that a "person who transports or causes or allows the transport of a pesticide must ensure that the pesticide is secured and transported … in a manner that prevents the escape, discharge or unauthorized removal of the pesticide from the transport vehicle, and prevents the contamination of food or drink intended for animal or human consumption, household furnishings, toiletries, clothing, bedding or similar items that are transported with the pesticide."

Further, the Handbook for Pesticide Applicators and Dispensers, 5th Ed. (Ministry of Environment, 2005) outlines several general precautions to be taken during transport of pesticides, and all TNRD representatives will adhere to the following practices:

1) all pesticide containers will be inspected for defects prior to transporting and pesticides will be in original containers with original labels;
2) chemical pesticides will not be transported in the passenger compartment of any vehicle, nor will anyone ride in the back of a truck together with these pesticides
3) pesticides will never be transported along with food, feed or consumer goods;
4) liquid pesticides will not be transported on wooden truck beds as it is difficult to clean wood in the case of a spill, and future items carried in the truck could become contaminated;
5) all pesticide containers will be secured to prevent spillage;
6) the driver of any vehicle transporting pesticides will be trained in spill clean-up and will carry, along with the pesticides, necessary equipment to contain and/or neutralize a spill;
7) the drivers of vehicles containing pesticides will ensure that all documents and placards are carried in, or placed on, transport vehicles if required under the *Transport of Dangerous Goods Act*, R.S.B.C 1996, c. 458, and regulations, the IPMA or the IPMR;
8) limited amounts of pesticides shall be carried in any one vehicle (the quantity shall be no more than what is necessary for each project, except where transportation occurs between storage facilities);
9) pesticides shall be carried in a secure lockable compartment such as a locked storage box, box trailer, or canopy; and
10) pesticides shall be transported separately from food, drinking water and people.

3.2. Description of Procedures for Safely Storing Insecticides [IPMR Section 58(3)(a)(ii)]

Most of the insecticides proposed for use in this PMP will be stored at the TNRD owned site, located at 660 Mission Flats Road, Kamloops, B.C. Any instances where pesticide is stored somewhere other than the TNRD sites, the TNRD will ensure that the same storage standards are in place. The following standards of the *Integrated Pest Management Regulation* with respect to the safe storage of pesticides will be adhered to:

1) a person who stores a pesticide will store it in a manner that minimizes hazards to human health and the environment (IPMR Section 33 (1));
2) all pesticides will be stored in the container in which it was originally packaged and with the label originally affixed by the manufacturer, or in a container designed for containing the pesticide and labelled with the trade name, chemical name, concentration of active ingredient and Pest Control Product number (IPMR Section 65 (1));

3) all pesticides will be stored separately from food intended for human or animal consumption (IPMR Section 66 (1a));
4) according to IPMR Section 66 (1b) all pesticides will be stored in a facility that is:
   (i) ventilated so that pesticide vapors are vented to the outside,
   (ii) not used for the storage of food intended for human or animal consumption,
   (iii) locked when unattended, and
   (iv) accessible only to persons authorized by the person storing the pesticide.
5) according to IPMR Section 66 (3) of the IPMR, fumigants and other pesticides that release vapors, and bear a "poison" symbol on the label (e.g. malathion) must be stored in a storage facility that is not attached to or within a building used for living accommodation;
6) according to IPMR Section 66 (2), each door providing access to a storage facility will clearly bear the words "WARNING: CHEMICAL STORAGE — AUTHORIZED PERSONS ONLY" written in block letters;
7) vehicle canopies are considered mobile storage units and must adhere to the items listed above; and
8) according to IPMR Section 31, TNRD representatives will inform the local fire department of the pesticide storage location within 60 days after starting to store pesticides.

3.3. Description of Procedures for Safely Mixing, Loading and Applying Insecticides [IPMR Section 58(3)(a)(iii)]

Only one adulticide included in this PMP would require mixing prior to use (Gardex Commercial Industrial micro spray concentrate). As this is the most dangerous activity with respect to pesticide application, special care will be taken and mixing will only be done by certified applicators. At the time of mixing, a spill kit and all first aid supplies will be nearby, including eye wash facilities and a copy of this PMP. Emergency phone numbers and a telephone will be present. The person mixing the pesticide will wear protective clothing, gloves, boots, face shield, hat and respirator. When mixing the product, the applicator will take care to keep the pesticide container well below eye level to reduce the chances of pesticide splash on face and eyes. Before pesticides are applied, applicators will inspect all application equipment to ensure there are no leaks or needed repairs. No mixing or loading of adulticides will occur within 15 meters of fish or wildlife habitat or riparian areas.

During adulticiding applications, spare clothing for the applicators, spill kits, emergency first aid kits and phone numbers will be readily available in the vehicle and stored separately from the pesticide. The applicators will wear all necessary protective gear during the entire spray

campaign including coveralls, rubber boots, rubber gloves, respirators and eye protection. The applicators will always work in pairs.

Vectobac 1200L and Aquabac XT are the only larvicides listed in this PMP that require mixing. These pesticides are mixed with water to obtain a better distribution on the surface of the larval development habitat. The labels specify that the level of dilution is up to the applicator and is based on weather, the size of the larval development habitat and the method of application. The person mixing the pesticide will wear protective clothing as listed on the product labels, which may include gloves, boots, face shield, and hat.

3.4. .Description of Procedures for Safe Disposal of Empty Insecticide Containers and Unused Insecticides [IPMR Section 58(3)(a)(iv)]

The safe disposal of empty insecticide containers and unused insecticides shall comply with all current federal and provincial legislation governing their disposal. In addition, personnel shall follow these procedures for safely disposing of empty insecticide containers and unused insecticides proposed for use under this PMP:

- Ensure that all insecticide waste is disposed of in a manner consistent with the requirements of the *Environmental Management Act*, S.B.C. 2003, Chapter. 53 and the *Hazardous Waste Regulation* B.C. Reg. 63/88, as appropriate;
- Ensure that empty insecticide containers are returned to the insecticide distributor as part of their recycling program (if applicable); or triple rinsed or pressure rinsed, altered so that they cannot be reused, and disposed of in a permitted sanitary landfill or other approved disposal site; and
- Ensure that all leftover insecticide mix is stored for future use in a manner consistent with the requirements specified in Section 3.2.

3.5. Description of Procedures for Responding to Pesticide Spills [IPMR Section 58(3)(a)(v)]

Appropriate spill containment equipment will be ready and available at the storage site (including mobile storage), mixing and loading sites, and during all pesticide applications. All persons authorized and trained to work with the pesticides will be familiar with the protocol for containing and responding to spills. The spill equipment may include:

1) personal protective equipment;
2) absorbent material such as sawdust, sand, activated charcoal, vermiculite, dry coarse clay, kitty litter or commercial absorbent (not applicable to larvicides);
3) neutralizing material such as lime, chlorine bleach or washing soda (not applicable to larvicides);
4) a long handled broom;
5) a shovel; and
6) water-proof waste-receiving container with lid and a pen to label the contents.

If a spill occurs, TNRD representatives will follow the recommendations as described in the Handbook for Pesticide Applicators and Dispensers, 6th Ed. (Ministry of Environment, 2005):

1) the source of the spill will be contained;
2) people and animals will be kept away from the spill site and people will be prevented from walking through, driving through, or breathing in fumes from the spill;
3) the product label or knowledgeable agencies will be consulted to determine the best course of action for clean-up of the spill;
4) if the spill is small enough to be handled without assistance, clean-up will begin immediately;
5) personal protective gear will be worn during clean up and if the spill is indoors, adequate ventilation will be ensured;
6) the spilled material should be stopped from spreading by creating a barrier with soil, sawdust, newspaper or spill kit dam (not applicable to granular larvicides);
7) absorbent material shall be spread over the spill, if applicable, to absorb any liquid;
8) the absorbent material shall be collected in water proof containers with the contents clearly labelled with the pesticide name, P.C.P. number and quantity of pesticide;
9) the area should be decontaminated with a neutralizing solution (*e.g.* for malathion, a mixture of washing soda (sodium bicarbonate) and caustic soda (sodium hydroxide) will decontaminate the site) (not applicable to larvicides);
10) when more than five (5) litres or five (5) kg of insecticide are spilled, the person responsible for the project shall immediately report to the BC Provincial Emergency Program by telephoning 1-800-663-3456 or, where that is not practical, to the local police or nearest detachment of the RCMP, and to the appropriate regional office of the BC Ministry of Environment & Climate Change Strategy, Integrated Pest Management Program; and
11) A TNRD manager shall be notified of the details related to the spill as soon as practical by the project supervisor.

4.0 Description of Environmental Protection Strategies and Procedures That Will Be Followed Under the PMP [IPMR Sections 58(3)(b)]

The following sections describe the TNRD's strategies for protection of the environment. Much of the information included in the following sections is drawn directly from the *Integrated Pest Management Regulation* and the Handbook for Pesticide Applicators and Dispensers, 6th Ed. (Ministry of Environment, 2005).

4.1. STRATEGIES TO PROTECT COMMUNITY WATERSHEDS [IPMR SECTION 58(3)(B)(I)]

The TNRD will follow the guidelines contained in the *Forest Practices Code of British Columbia Act* and the *IPMR* to protect community watersheds, and will ensure that each of the steps listed below are conducted:

1) the location of community watersheds will be determined by accessing the Ministry of Environment Community Watershed website: http://www.env.gov.bc.ca/wsd/data_searches/comm_watersheds/index.html
2) when adulticiding, a 10m pesticide-free zone (PFZ) will be maintained around all streams, lakes and other water bodies (see Section 73(1) of *IPMR*) and the 10m will be measured in horizontal distance from the high water mark of the waterbody;
3) when larviciding no PFZ is required (see Section 78(2) of the *IPMR*);
4) a 100 meter no-treatment zone shall be maintained upslope of a community water supply water intake (except in the case of larvicides);
5) an adequate buffer zone will be maintained around the PFZ and the buffer zone will be clearly marked prior to adulticiding;
6) no mixing of pesticides will occur within a community watershed;
7) insecticides will not be stored within a community watershed for more than 24 hours prior to their use, and removed from the community watershed within seven days of their use, unless they are stored in a permanent structure; and
8) insecticide applications will be stopped if insecticide residues or insecticide breakdown products are detected at a community watershed water intake, and there will be no further insecticide applications until the local Medical Health Officer has been satisfied that all required measures have been implemented to preserve water quality.

In order to protect domestic drinking water and water for agricultural use, applicators will follow all standards for pesticide-free zones (PFZs) and no-treatment zones (NTZs) as specified in the *Integrated Pest Management Act and Regulations*. Table 4 lists the PFZ's and NTZ's for mosquito pesticide applications.

Table 4. Standards as described in the *Integrated Pest Management Regulation* (IPMR) for Pesticide Free Zones (PFZ) and No Treatment Zones (NTZ) to protect water during pesticide applications to reduce mosquitoes.

Insecticide	Water Source	Regulation	Applicable Section from IPMR
Adulticides	Water supply intake or well used for domestic or agricultural purposes, including water for livestock or for irrigation of crops.	30m NTZ	71(3)
	Bodies of water* and streams	10m PFZ	73(1)
Bacterial Larvicides	Water supply intake or well used for domestic or agricultural purposes, including water for livestock or for irrigation of crops.	Exempted from PFZ	71(12)
	Bodies of water* and streams	Exempted from PFZ however no treatment allowed in permanent, fish bearing bodies of water or waters that have permanent, direct, surface-water connections with fish bearing bodies of water	78(2); 78(1)
Non-Bacterial Larvicides (methoprene)	Water supply intake or well used for domestic or agricultural purposes, including water for livestock or for irrigation of crops.	30m NTZ unless applicator is reasonably satisfied that the smaller zone will ensure that pesticide from the use will not enter the water supply intake or well.	71(3); 71(4)
	Bodies of water* and streams	Exempted from PFZ however no treatment allowed in permanent, fish bearing bodies of water or waters that have permanent, direct, surface-water connections with fish bearing bodies of water	78(2); 78(1)

*"Body of water" does not include a human-made, self-contained body or structure for water

4.2. STRATEGIES TO PROTECT FISH AND WILDLIFE, RIPARIAN AREAS AND WILDLIFE HABITAT [IPMR SECTION 58(3)(B)(II)]

Riparian areas are defined as the areas around bodies of water. These areas usually contain lush vegetation, including trees and shrubs, and high biodiversity (birds, insects, reptiles, amphibians, plants, and mammals). They are often critical habitats, home ranges and travel corridors for wildlife. Riparian areas are essential for stream, lake, and marsh health as they support vegetation that maintains bank stability and provide cover for water bodies to help maintain cooler water temperatures.

Endangered wildlife species are protected under the federal *Species at Risk Act (SARA).* All pesticide use under this PMP shall be undertaken in a manner to ensure that endangered wildlife species are not impacted.

Due to the low toxicity of the bacterial larvicides, applications may be conducted within riparian areas, and sensitive wildlife habitat, however the following will be undertaken to keep impacts to riparian, wildlife habitat and fish bearing waters to a minimum:

(1) Care will be taken to ensure minimal impacts on vegetation and soil (*e.g.* attempt will be made to stay on paths and avoid trampling vegetation).
(2) There will be no fuelling of machinery/application equipment or mosquito larvicide mixing within 15 meters of riparian areas, or sensitive wildlife habitat.
(3) There will be no cleaning up or disposal of larvicides or their containers within 15 meters of riparian areas, sensitive wildlife habitat, or permanent, fish bearing bodies of water or waters that have permanent, direct, surface-water connections with fish bearing bodies of water.

Also, as per the Integrated Pest Management Regulation, fish habitat will be further protected as no larviciding will take place in permanent, fish-bearing bodies of water or waters that have permanent, direct, surface-water connections with fish-bearing bodies of water unless the BCCDC, under Section 78(1.1) of IPMR, has advised that West Nile virus has been identified in mosquitoes in the region and the mosquito species targeted for treatment are vectors of West Nile virus.

If a Medical Health Officer orders adulticiding treatments, the standard PFZs and NTZs will be maintained (Table 4), and crews will ensure that no disposal, rinsing, mixing or storing of pesticides, or fuelling or maintenance of equipment will occur within 40 m of riparian areas, fish-bearing waters, waters with a permanent, direct, surface water connection to fish-bearing waters or in sensitive wildlife management areas. Prior to adulticiding treatments, riparian areas, fish bearing waters and waters with a permanent, direct surface water connection to fish bearing waters, and sensitive wildlife areas will be identified and clearly understood by all applicators.

4.3. CHANCE FIND PROCEDURE FOR PROTECTION OF ARCHAEOLOGICAL SITES

The Heritage Conservation Act (HCA) protects all archaeological sites whether on Provincial Crown or private land. Archaeological sites are an important resource that is protected for their historical, cultural, scientific and educational value. They are non-renewable, susceptible to disturbance and are finite in number. The HCA automatically protects all archaeological sites that predate AD 1846 with the exception of burial sites and rock art sites which are protected regardless of age.

Any individuals working on the TNRD Mosquito Control Program that believe that they may have encountered any archaeological materials, they will stop work in the area and follow the procedure below:

- **All work in the vicinity of the remains is to cease immediately & any archaeological and/or human remains must NOT be disturbed**.
- The find location will be recorded, and all remains will be left in place.
- The provincial Archaeology Branch will be contacted.
- If the significance of the remains is judged to be sufficient to warrant further action and they cannot be avoided, then the project archaeologist in consultation with the Archaeology Branch and representatives of local First Nation communities will determine the appropriate course of action.
- If human remains are encountered and they are not archaeological, then the RCMP will be contacted immediately.

(This Section was adapted from the Province of BC Archaeological Chance Find Procedure document http://www.frontcounterbc.ca/pdf/ArchaeologicalChanceFindProcedure.pdf)

4.4. STRATEGIES TO PREVENT CONTAMINATION OF FOOD INTENDED FOR HUMAN CONSUMPTION [IPMR SECTION 58(3)(B)(III)]

The larvicides proposed for use in this PMP will not cause contamination of food intended for human consumption. This is due to their physical properties and their use only in aquatic areas. However, general guidelines for safety will be followed by applicators (*e.g*. applicator will wash hands before eating and food will be stored separately from pesticides and equipment used for larviciding).

Greater care will be taken if adulticiding is required (under direction of a Medical Health Officer). Applicators will exercise caution and ensure that no food comes in contact with adulticides, personal protective equipment for adulticiding (gloves, coveralls, etc.) or adulticiding equipment. No applicator will be allowed to eat while conducting an adulticiding campaign (all sprayers must be turned off and the applicator must wash before eating).

Mosquito adulticides also have the potential to cause a temporary contamination of food if adulticiding is conducted near gardens or orchards. Prior to any treatment, it is expected that the Medical Health Officer will advise farmers and home owners of the potential risk of pesticide residues and of the importance of washing all fruits and vegetables before eating them.

4.5. PRE-TREATMENT INSPECTION PROCEDURES FOR IDENTIFYING TREATMENT AREA BOUNDARIES [IPMR SECTIONS 58(3)(B)(IV)]

Section 58(3)(b)(iv) of the IPMR requires that a PMP include a description of the pre-treatment inspection procedures for identifying treatment area boundaries. Section 71(1)(a)(c) of the IPMR requires that a confirmation holder to do all the following before the pesticide use:

- ensure that each individual who will be using the pesticide is informed of the boundaries of the proposed treatment area, the requirements for personal protection, and the pesticide use procedures required to protect human health and the environment;
- carry out an inspection of the treatment area to ensure that the applicable regulatory requirements and standards can be met in carrying out the use, and
- if the pesticide is to be applied aerially, ensure that the pilot conducts an inspection of the proposed treatment area to ensure that he or she is familiar with the boundaries and other critical features of the treatment area.

To ensure that the above regulatory requirements are met, the TNRD will establish and implement the following strategies and procedures prior to the application of mosquito larvicides and adulticides, as applicable.

Prior to any *adulticiding* work (under order of a Medical Health Officer), an assessment of the treatment area will be completed. This will be conducted during the day, not on the night of treatment so that all areas of the treatment site can be seen. The staff, in consultation with the Medical Health Officer who ordered the spray, will plan a driving route, and clearly mark the route so that it can be easily followed in the dark. When sensitive areas like organic gardens, bee hives, riparian areas, fish-bearing waters, waters with permanent surface water connections to fish-bearing waters, sensitive wildlife habitat, standing or running water, domestic and agricultural water sources, and community watersheds are found, they will be clearly marked so that buffer zones and pesticide-free zones are maintained. If the applicators feel that they cannot safely conduct the application without affecting any of the sensitive areas described above, the spray plan will be postponed and discussed with the Medical Health Officer.

Prior to *ground* based *larviciding*, the applicator will ensure that he or she has permission to treat the site, and the applicator will ensure that he or she is not treating in a permanent, fish bearing body of water or waters that have permanent, direct, surface-water connections with fish bearing bodies of water unless the BCCDC has advised that West Nile virus has been identified in mosquitoes in the region and the mosquito species targeted for treatment are vectors of West Nile virus (*IPMR* Section 78(1.1)).

When the *larviciding* application is to be done by *air*, the pilot will be guided on a reconnaissance flight prior to the treatment and will be shown the habitats to be treated. Ground crews will have completed pre-treatment monitoring and will have determined the boundaries of the habitat to be treated. During the application, the pilot will remain in direct radio contact with the ground crew in case of any questions or concerns related to the location of, or permission for, treatment.

4.6. PROCEDURES FOR MAINTAINING AND CALIBRATING PESTICIDE APPLICATION EQUIPMENT [IPMR SECTION 58(3)(B)(V)]

All pesticide application equipment used shall be safe, clean, in good repair, compatible and calibrated appropriately for the larvicide or adulticide being applied (See Section 7(1)(b) of the *IPMR*).

Equipment used for adulticiding will be calibrated prior to use when an Order to adulticide has been issued by a Medical Health Officer, and after every 14 days of application. Re-calibration will be conducted if the type of pesticide to be applied changes and a new application rate is required. For each piece of application equipment that requires calibration, records of the date of calibration and the data collected during the calibration will be maintained for three years from the date of calibration.

In order to calibrate the ULV sprayers, they will be filled with water and then tested for flow rate by measuring the volume of liquid pumped through the system during a one minute interval. The appropriate flow rate, droplet size and application procedure (*e.g.* swath width, truck speed, etc.) will be determined by reading the label on the product to be sprayed. No applications will be done before the equipment can be shown to be appropriately calibrated.

Calibration of backpack applicators and aerial application equipment used to apply granular formulations of larvicides will be conducted annually prior to larviciding treatments being undertaken. As these products broadcast spread the larviciding granules, the applicators must be aware of the spread pattern and its correlation to application rate. Spread-pattern "posters" will be used to teach applicators to visualize appropriate application rates. Applicators will be trained on the appropriate use of backpack granular applicators prior to use so that they are able to adjust their calibration as they walk through and around standing water (i.e. to walk slower or faster with a higher or lower throttle and flow rate).

4.7. PROCEDURES FOR MONITORING WEATHER CONDITIONS AND STRATEGIES FOR MODIFYING PESTICIDE APPLICATION METHODS FOR DIFFERENT WEATHER CONDITIONS [IPMR SECTION 58(3)(B)(VI)]

As currently required by Section 35(1)(i) of the *IPMR*, prior to, and periodically during larviciding and adulticiding applications, measurements will be made to record weather conditions including:

- Wind speed and direction;
- Precipitation; and,
- Air temperature.

It should be noted that amendments are currently being considered to Section 35(1)(i) of the IPMR that would eliminate the requirement for recording wind speed, temperature, and precipitation during the granular application of larvicides for mosquito reduction. If this amendment shall come into force during the term of this PMP, the TNRD shall comply with all amended regulations.

Environment Canada shall be consulted for up-to-date local precipitation forecasts. Efforts shall be made to ensure that weather conditions are suitable for insecticide application and are consistent with pesticide label requirements.

Adulticiding applications (under Order from a Medical Health Officer) will be terminated/suspended if any of the following apply:

- The maximum/minimum temperature stated on the insecticide label is exceeded; or,
- Unprotected people enter the treatment area; or,
- The wind speed exceeds or is less than the optimum wind speeds as described on the product label; or,
- The wind speed and direction causes the insecticide to drift outside the treatment area and/or miss the intended target.

Larviciding applications (by hand, backpack blower, helicopter, (or drone if approved during the term of this PMP)) may be postponed if any of the following apply:

- Significant rain events can cause larvicide granules to clump in the application equipment and affect application rates (precipitation rarely impacts ground application of granular larvicide);
- High winds can cause the granular larvicides to drift outside of the treatment area (i.e. the applicator is no longer able to control the placement of the granules accurately), or
- Air temperature will be recorded as per the *IPMR* and aerial larviciding may be postponed when extreme high temperatures are expected as this can impact the lift power of a helicopter.

5.0 INSECTICIDES PROPOSED FOR USE, THEIR PROPERTIES, MANNER OF APPLICATION AND EQUIPMENT REQUIRED FOR APPLICATION [IPMR SECTION 58(3)(C)]

The following sections will provide an overview of the pesticides used to treat mosquitoes, their modes of action, manners of application (ground and/or air), and the equipment required for their application.

5.1. BACTERIAL LARVICIDES

The bacterial larvicides proposed in this PMP are safe for both humans and the environment, while being highly effective. Therefore, treatment of larvae using a biological larvicide will be the preferred and most common approach for reducing mosquitoes in the TNRD. The registered biological mosquito larvicides listed in Table 2, may be used, and this PMP may be updated with any new larvicides that become registered in Canada during the course of this PMP.

5.1.1. *Bacillus thuringiensis* var *israelensis* Strain H-14(AM65-52) or H-14(BMP-144)

Most of the larval treatment within the TNRD will be with granular larvicides containing strains of the active ingredient *Bacillus thuringiensis* var *israelensis* (*Bti*) (trade names Vectobac and Aquabac). During its spore-forming stage, *Bti* produces an endotoxin that contains proteins that can be digested in the alkaline gut of mosquito larvae. The toxin is attached to crushed corncob that serves as a carrier. Once digested, the proteins become toxic to the larvae and work to destroy the larvae's gut.

The granular formulations are applied by manual placement, backpack applicator, granular spreader, helicopter or fixed-wing aircraft. Application rates for the granular formulations vary from 2.5 to 20 kilograms per hectare (with the higher rates applied to polluted or highly organic water), although most sites are treated at about 5 to 10 kilograms per hectare. Liquid formulations of these products may also be used and these can be applied with applied with a backpack sprayer, truck or ATV-mounted sprayer, helicopter or fixed-wing aircraft at applications rates between 250 ml and 2400 ml per hectare depending on the product. *Bti* Mosquito Dunks, another formulation, are always applied by manual placement.

There have been recent trials of granular and liquid *Bti* applications by drone. The TNRD may use drones for treatment if, during this term of this PMP, the use of drones is approved and added to any of the larvicide labels.

Bti can be applied to virtually any standing water except finished, treated drinking water, or permanent, fish-bearing bodies of water or waters that have a permanent, direct, surface-water connections with fish bearing bodies of water. The exception to this is if the BCCDC has advised the public that it has identified WNV in mosquitoes in the region of the Province where the pesticide is to be applied, and the mosquitoes to be treated are vectors of WNV, then *Bti* products may also be applied to permanent, fish bearing bodies of water or waters that have permanent, direct, surface-water connections with fish bearing bodies of water (*IMPR* Section 78(1.1)).

***Benefits of* Bacillus thuringiensis *var* israelensis**

There are many benefits to using *Bti* larvicides. When applied at label rates, *Bti* larvicides are specific to mosquito larvae and non-toxic to fish, amphibians, reptiles, mammals and most other insects. They are easy to apply and have no residual effect. They are the most economical of the larvicides.

Bti larvicides work best when applied to larvae in their 2nd and 3rd instars, however good effect can be achieved when applied to 1st and early 4th instar larvae as well. Death of the larvae usually occurs within 24 hours. This allows for technicians to be able to assess effectiveness soon after application.

***Limitations of* Bacillus thuringiensis *var* israelensis**

There are very few disadvantages associated with the use of *Bti*. One limitation is that *Bti* products have no residual effect, and therefore only the larvae present at the time of application are affected. In habitats where multiple generations of larvae appear, more than one application of larvicide may be necessary. Another possible disadvantage is the short window for treatment with optimum reduction of the larvae in the 2nd and 3rd instars.

5.1.2. *Bacillus sphaericus*

Bacillus sphaericus is a naturally occurring bacterium that acts as an endotoxin to mosquito larvae. *Bacillus sphaericus* formulations contain living sporulated bacteria and a crystal protoxin that is released by alkaline conditions in the gut. The toxin destroys the lining of the intestine of the mosquito larvae that then releases lethal chemicals into the larvae's haemocoel. The bacteria recycle, and spores from dead larvae can remain suspended for extended periods of time. The duration of activity depends on many biotic and abiotic factors. Three products containing *Bacillus*

sphaericus are registered as larvicides under the trade name VectoLex and the manner of application and the application methods are detailed in Table 2

When VectoLex products are used at label rates, they will reduce several species of mosquito larvae in freshwater marshes, salt marshes, flood plains, flooded fields and pastures, wetlands, ponds, storm water detention/retention and seepage ponds, wastewater sewage effluent, sewage lagoons, oxidation ponds, log ponds, impounded waste water, septic ditches, drainage ditches including open storm sewers and irrigation ditches, although applicators must read each label carefully as the different formulations are registered for use in different habitats. If the BCCDC has advised the public that it has identified WNV in mosquitoes in the region of the Province where the pesticide is to be applied, and the mosquitoes to be treated are vectors of WNV, *Bacillus sphaericus* products may also be applied to permanent, fish bearing bodies of water or waters that have permanent, direct, surface-water connections with fish bearing bodies of water (*IPRM* Section 78(1.1)). *Bacillus sphaericus* will not be applied to any water sites that serve as a source of treated finished drinking water.

***Benefits of* Bacillus sphaericus**

The benefits of *Bacillus sphaericus* are similar to those of *Bti* in that it is virtually non-toxic to non-target organisms while being very effective at reducing mosquito larval numbers. This product works better than *Bti* when applied to highly organic larval habitats and it has the added benefit of maintaining its effectiveness for up to 28 days and thus can reduce multiple generations of larvae with a single application. The *Bacillus sphaericus* formulated as VectoLex WSP is the larvicide of choice in catch basins due to its low toxicity no non-target organisms, easy manual application, and extended action of up to 28 days.

***Limitations of* Bacillus sphaericus**

The greatest disadvantage of *Bacillus sphaericus* is its cost, and therefore it will only be considered in larval development sites where multiple generations of larvae are known to occur. In these cases, the increased cost of the larvicide may be warranted as fewer applications would be required over the course of the summer.

5.2. CHEMICAL LARVICIDES

The only chemical larvicide included in this PMP is methoprene.

5.2.1. Methoprene

Methoprene is a synthetic mimic of a naturally occurring growth hormone (called juvenile hormone) that keeps insects in the juvenile or immature stage. When applied to habitat with larvae, methoprene interferes with the mosquito life cycle and prevents the mosquito from reaching maturity. The mosquito dies during the pupal stage or as the adult mosquito attempts to emerge from the pupal case.

Methoprene is available in two formulations under the trade name Altosid (Table 2). The pellets and briquettes can both be applied by hand (manual application) and the pellets can also be applied using a backpack applicator. Methoprene is only applied by ground (no aerial application).

Methoprene is of very low to moderate toxicity to terrestrial non-target organisms when used at label rates. In aquatic habitats, this product can have a wide range of toxicity to invertebrates and fish. Under this PMP methoprene will only be used in storm water catch basins or to man-made bodies of water that would never become contiguous with natural bodies of water. A recent amendment to the *IPMR* [See Section 71(5) & 71(13)] has exempted methoprene from the requirement to maintain a no-treatment zone when used in storm water runoff catch basins for the management of mosquitoes. This amendment was made following a determination that the use of methoprene would have no likely environmental impact when used in this aquatic habitat. Studies have shown that methoprene breaks down quickly in water and soil and will not leach into groundwater.

Methoprene generally remains active for up to 30 days under typical environmental conditions, but some formulations remain active for up to 150 days. Because methoprene is an insect growth regulator, proper timing of applications is critical.

If the BCCDC has advised the public that it has identified WNV in mosquitoes in the region of the Province where the pesticide is to be applied, and the mosquitoes to be treated are vectors of WNV, products containing methoprene may also be applied to permanent, fish bearing bodies of water or waters that have permanent, direct, surface-water connections with fish bearing bodies of water (IMPR Section 78(1.1)).

Products containing methoprene will not be applied to any water sites that serve as a source of treated, finished drinking water.

5.3. CHEMICAL ADULTICIDES

If a Medical Health Officer issues an Order to adulticide, the TNRD will use the adulticide chosen by the Medical Health Officer. In accordance with Section 78(4)(C) of the *Integrated Pest Management Regulation*, all adulticiding for mosquitoes will be conducted between sunset and sunrise. Adulticiding for mosquitoes will be done with strict adherence to the Operational and Environmental Guidelines outlined in sections 3.0 & 4.0 . All applications will be done by individuals that hold valid British Columbia Pesticide Applicator Certificates in the Mosquito and Biting Fly Category. The pesticide labels will be carefully followed to confirm acceptable rates, meteorological parameters, and appropriate application equipment. **No adulticiding will be considered outside of an Order from a Medical Health Officer.**

5.3.1. Malathion

Malathion is an organophosphate, contact insecticide that works by inhibiting cholinesterase and thereby causing paralysis of the insect. This insecticide is the most commonly used mosquito adulticide in North America. It is applied by ground non-thermal ULV sprayers. Ecologically, malathion is moderately toxic to birds, has a wide range of toxicity to fish, and is highly toxic to aquatic invertebrates, amphibians, and honeybees. Malathion will break down rapidly in sunlight, with a reported half-life in air of about 1.5 days. The half-life of a pesticide is the time that it takes for the active ingredient to break down to one half of the originally applied concentration.

The ***benefits*** of this adulticide are its low cost (compared to other adulticides), and ease of use (no mixing required) and rapid knock down of mosquitoes in the treatment area.

The ***limitations*** include strong odour, a propensity to cause paint damage (if applied incorrectly) and, in some areas of North America, resistance among mosquito populations has developed. Also, there is a limited duration of effect and mosquitoes from around the treatment area can quickly re-infest the treatment area.

5.3.2. Pyrethrins

Pyrethrins are natural chemicals that are produced in the flowers of chrysanthemums. Pyrethrin pesticides affect sodium channel function in the neurological system of the insect. Natural pyrethrins are formulated with additives such as piperonyl butoxide and N-octyl bicycloheptene dicarboximide to enhance the effectiveness and stability of the pyrethrins. All are applied by non-thermal ULV generators.

There are many ***benefits*** of the pyrethrins. First, they have rapid knockdown properties. They are unstable when exposed to light and break down quickly. Unlike malathion, pyrethrins are non-corrosive and have a less offensive smell. They are considered to have a very low mammalian toxicity. Finally, they can be applied at lower temperatures than malathion.

There are ***limitations*** to the use of pyrethrins as well. Pyrethrins are very expensive insecticides. Also, they pose a slightly higher risk to applicators as some formulations need to be diluted prior to use (thus there is increased handling and increased chance of spill). They are toxic to non-target organism, and especially toxic to fish.

6.0 RECORDS AND REPORTING

Under the *Integrated Pest Management Regulation* the TNRD is required to maintain records of all pesticide applications and submit an Annual Record of Pesticide Use for Confirmation Holders and an annual Notice of Intent to Treat.

6.1. TREATMENT RECORDS [*IPMR* SECTION 37(1)]

The TNRD will maintain, for at least three years from the date of treatment, operation records of all pesticide applications including:

1) treatment location;
2) pre-treatment monitoring results (larval dips);
3) treatment date and time;
4) type of pest targeted (mosquito larvae or adult);
5) trade name of pesticide used and its PCP number;
6) method of application;
7) rate of application;
8) total quantity of pesticide used;
9) relevant meteorological conditions (*i.e.* wind, precipitation, temperature);
10) result of post-treatment monitoring and evaluation;
11) for adulticiding, how the public was notified (*e.g.* door to door); and
12) if the applicator decides that the 30 m non-treatment zone around a water supply intake or well used for domestic or agricultural purposes may be reduced, the information upon which the decision was based.

6.2. RECORDS OF LARVAL DEVELOPMENT SITES

The TNRD will maintain updated records of all larval development sites, including:

1) GPS location or description of the location of the site;
2) name, address and phone number of owner or manager of the treatment site; and
3) information concerning no-treatment areas or areas where permission has not been granted by the landowner.

6.3. ANNUAL REPORT OF PESTICIDE USE [*IPMR* SECTION 39 (1)(2)]

The TNRD will submit an Annual Report of Pesticide Use for Confirmation Holders to the Administrator of the *Integrated Pest Management Regulation* by January 31 of every year, which will include a summary of the previous calendar year's use including:

1) the name and address of the TNRD and its Confirmation number;
2) for each pesticide used in the year, the trade name, PCP registration number, active ingredient name(s) and amount of pesticide product used in kilograms; and
3) maps of the gross boundaries of the area treated.

6.4. ANNUAL NOTICE OF INTENT TO TREAT

A Notice of Intent to Treat will be provided to the Administrator *Integrated Pest Management Regulation* 21 days prior to the commencement of the project in each calendar year of the PMP Confirmation. The Notice of Intent to Treat will contain the following information:

1) the name and business location of the Confirmation Holder;
2) a description of the proposed treatment locations for the calendar year and a map or diagram that clearly identifies those locations;
3) a description of the proposed treatment for each area, including the pesticide to be used and its method of application; and
4) the total area of the treatment areas in the proposed treatment locations for the calendar year.

7.0 CONSULTATIONS & ENGAGEMENT [*IPMR* SECTION 61(1)]

The *Integrated Pest Management Regulation* specifies that persons preparing a PMP must conduct public consultations. The *Integrated Pest Management Regulation* specifies that the consultation must include newspaper notices and "reasonable" efforts to contact and consult with individuals who have the potential to be impacted by a proposed pesticide use under the PMP. The Regional District has completed all necessary consultations as described in the following sections.

7.1. PUBLIC CONSULTATIONS

Prior to submitting a Pesticide Use Notice to the Ministry of Environment and Climate Change Strategy for PMP Confirmation, the plan holder must carry out a consultation process with the public throughout the proposed PMP area.

The objectives of conducting consultations when this PMP was at the draft stage are:

- To increase public awareness of the PMP process and of the principles of Integrated Pest Management which are embodied in the PMP;

- To ensure that the public have an opportunity to identify concerns, and for the plan holder(s) to address those concerns before the PMP is finalized and a Pesticide Use Notice submitted for Confirmation;
- To ensure a transparent and accountable review process for the PMP;
- To educate the public on the need to manage the larval stage; and,
- To explain how the planning process that is described in the PMP recognizes the need to protect human health and the environment.

The public was notified via notices in local community newspapers within the geographic boundaries of the mosquito surveillance and reduction area. As per Section 61(1) of the *IPMR*, at least 45 days before submitting a Pesticide Use Notice, the first of two notices, at least 40 cm^2 in size, was published within a two-week period in newspapers circulated in the various communities (or nearest communities). The published advertisements were placed in the main or legal sections of the newspapers with the heading "DEVELOPMENT OF A PEST MANAGEMENT PLAN". A copy of the advertisement that was placed in newspapers within the mosquito treatment areas can be found in Appendix C.

During the public consultation process, the draft PMP was accessible on the TNRD website at www.tnrd.ca.

Table 5. Names and location of newspapers and date of publishing of Plan Development advertisement.

Newspaper	Community	Date of 1st Publishing	Date of 2nd Publishing
Kamloops This Week	Kamloops	Dec 16, 2020	Dec 23, 2020
The Chase Sunflower	Chase	Dec 18, 2020	Jan 1, 2021
Clearwater Times	Clearwater & Blue River	Dec 17, 2020	Dec 24, 2020
Barriere Star Journal	Barriere/ North Thompson	Dec 17, 2020	Dec 24, 2020
Sun Peaks Independent News	Sun Peaks	Dec 19, 2020- for four weeks	
Merritt Herald	Electoral Areas "M" & "N"	Dec 17, 2020	Dec 24, 2020

7.1.1. Summary of Public Consultation

There were two responses from the public during the consultation phase of the PMP development. First, an email was received from a resident of Chase, BC who opposes mosquito control out of concern for non-target species. The individual asked that no one respond.

The second email came from a Beekeepers' Club in Clearwater, BC. The members of the club requested that they be informed should adulticiding be required. The Club was assured that adulticiding would only be conducted under Order from a Medical Health Officer and that the TNRD would expect that notice would be given to all residents prior to any kind of spray campaign. The following wording was added to pg 18 of this document:

> *"If a Medical Health Officer issues a Pesticide Application Order, the TNRD would apply pesticides following the parameters of the Order. It is expected that if an Order is issued, the Medical Health Officer will consider the need for the protection of fish bearing waters and other sensitive habitats. Further, it is expected that the BCCDC would acquire updated information from the Bee Keepers Registry and would provide this info to spray personnel so that Bee Keepers could be notified of any planned sprays in the areas near their hives."*

7.2. FIRST NATIONS ENGAGEMENT

First Nations engagement was conducted in compliance with Section 61(2) of the *IPMR*. This legislation requires that:

> *"If a proposed pesticide use under a pest management plan has the potential to **significantly impact** an individual or a member of an organization or community, the Confirmation holder must make reasonable efforts, starting at least 45 days before submitting a pesticide use notice to the administrator, to contact and consult these individuals"*

Apart from meeting this legislative requirement, the objectives of conducting First Nations engagement were:

- To increase First Nation awareness of the PMP process and of the principles of Integrated Pest Management which are embodied in the PMP;
- To ensure that First Nations have an opportunity to identify concerns, and for the plan holder(s) to address those concerns before the PMP is finalized and a Pesticide Use Notice submitted for Confirmation;
- To ensure a transparent and accountable review process for the PMP;
- To explain how the planning process that is described in the PMP recognizes the need to protect human health and the environment.

7.2.1. Draft Guidelines for First Nations Engagement

When the *Integrated Pest Management Act (IPMA)* and Regulation (IPMR) was introduced in December 2004, the provincial government made a commitment to develop and implement procedures for First Nations consultation. Appropriate engagement is necessary when industry or government agencies develop plans for pest management activities that may potentially adversely impact First Nations' rights or title interests.

The Ministry of Environment has prepared guidelines that are to be used by pest managers as guidance when First Nations engagement is required. These guidelines are largely based on

previous requirements for First Nations consultation under the former *Pesticide Control Act*. The Ministry asks that proponents (persons who prepare Pest Management Plans) to use the interim guidelines when pest management activities are in areas where a First Nation asserts aboriginal interests or has treaty rights. The Ministry will monitor industry use of the guidelines. In instances where aboriginal interests or treaty rights might be adversely impacted by pest management activities under the *IPMA*, the Ministry will assess the proponent's conduct and fulfillment of the engagement steps in the guidelines.

There are forty First Nations governments with asserted aboriginal interested within the proposed treatment area. Attempts were made to engage with each of these governments to determine whether there are any concerns of adverse effects on their land and resource use. Appendix D contains a sample of the letter that was sent along with a complete copy of the Draft PMP to each of the following First Nations governments.

- Adams Lake Indian Band
- Ashcroft Indian Band
- Bonaparte Indian Band
- Boston Bar Indian Band
- Boothroyd Indian Band
- Canim Lake Indian Band
- Coldwater Indian Band
- Cook's Ferry Indian Band
- Esh-kn-am Cultural Resource Management Services
- High Bar First Nation
- Little Shuswap Indian Band
- Lower Similkameen Indian Band
- Lower Nicola Indian Band
- Lytton First Nation
- Neskonlith Indian Band
- Nicola Tribal Association
- Nicomen Indian Band
- Nlaka'pamux Nation Tribal Council
- Nooaitch Indian Band
- Northern Shuswap Tribal Council
- Okanagan Indian Band
- Okanagan Nation Alliance
- Oregon Jack Creek Indian Band
- Penticton Indian Band
- Qwelminte Secwepemc
- Shackan Indian Band
- Siska Indian Band
- Simpcw First Nation (North Thompson Indian Band)
- Skeetchestn Indian Band
- Skuppah Indian Band

- Splats'in First Nation
- Spuzzum First Nation
- Skeetchestn/Tk'emlups te Secwepemc (SSN)
- Tk'emlups (Kamloops) Indian Band
- Tsilhqot'in National Government
- Ts'kw'aylaxw First Nation (Pavilion Indian Band)
- Upper Nicola Indian Band
- Upper Similkameen Indian Band
- Westbank First Nation
- Whispering Pines/Clinton Indian Band

7.2.2. Summary of First Nations Engagement

To facilitate Ministry consideration of the adequacy of First Nations engagement and of the plan holder response to any issues raised, the TNRD prepared a report that described the engagement process and outcomes. This report was submitted to the Administrator, *IPMA*, in conjunction with the submission of the Pesticide Use Notice application.

The following Nations had special requests associated with the PMP:

1. Lower Nicola Indian Band has requested that they be notified annually when a Notice of Intent to Treat has been submitted to the Administrator. They would also like a map with all sites that could potentially be treated with methoprene to be submitted each year. These will be submitted annually as requested.
2. Splatsin First Nation expressed concern regarding the recommendation for scraping ditches to ensure that they are draining properly. When ditches are not draining, stagnant pools can form which can support mosquito larvae. Splatsin pointed out that some ditches can be habitat for fish, amphibians and other biota. Page 4 of this document was amended to include the following wording:

   "Scraping of sediment from the bottom of roadside ditches every few years can make the ditches unattractive for mosquito larvae. Ditches that are slow to drain may form a series of pocket pools and support lush grasses and weeds, thereby becoming prime larval development sites. It is important to note that some ditches can be habitat for other organisms including amphibians and fish, and so prior to working in ditches potential impacts to other species should be considered on a case-by-case basin."
3. The Scw'exmx Tribal Council requested that a Chance Find Procedure be incorporated into the PMP and *Section **4.3** Chance Find Procedure for Protection of Archaeological Sites* was added to this document.

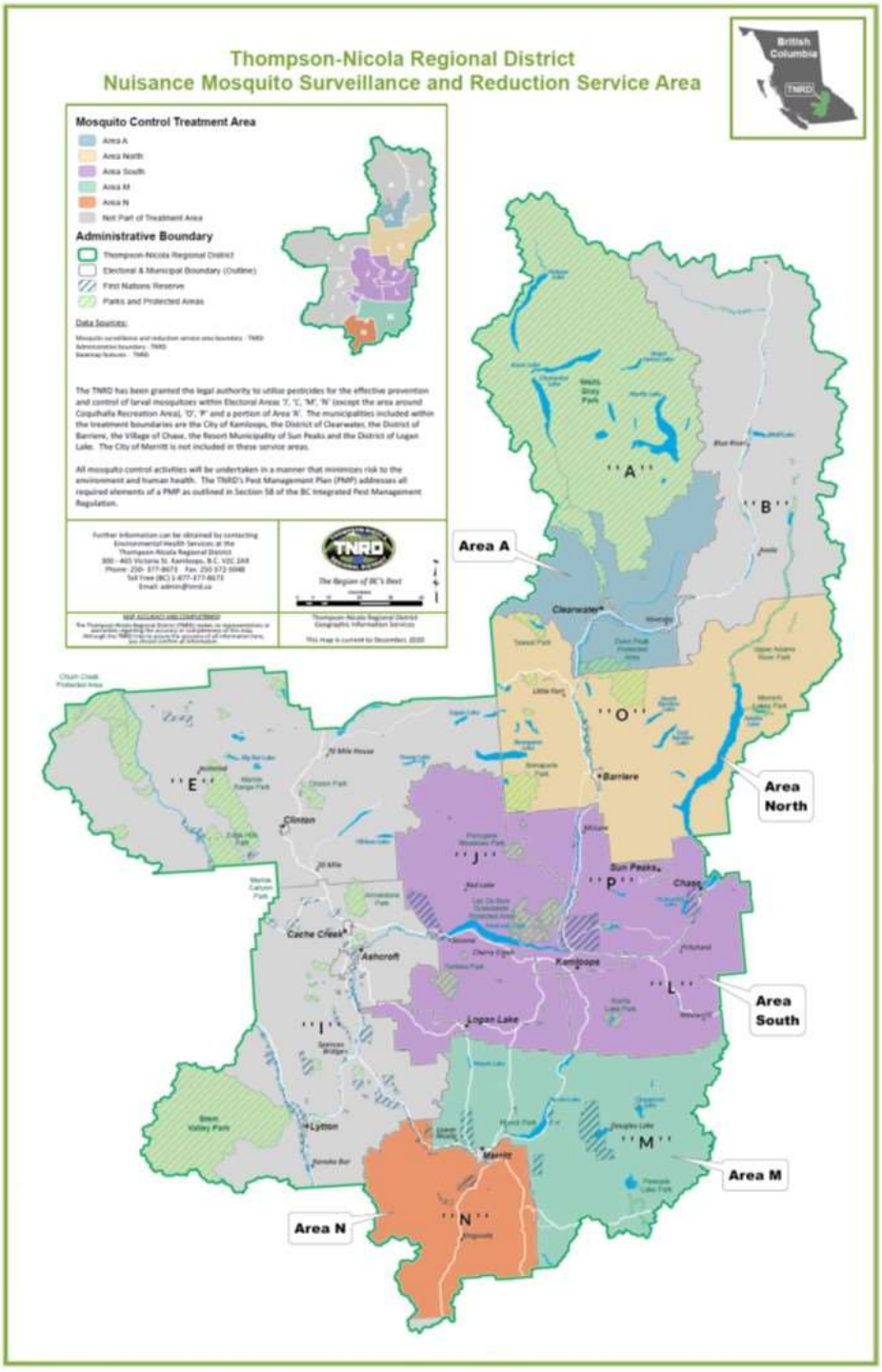
APPENDIX A: CHECKLIST OF REQUIRED INFORMATION FOR THE DEVELOPMENT OF A PEST MANAGEMENT PLAN (FROM SECTION 58 OF THE *INTEGRATED PEST MANAGEMENT REGULATION*)

Checklist for required contents of a Pest Management Plan (from Section 58 of the *Integrated Pest Management Regulation*).

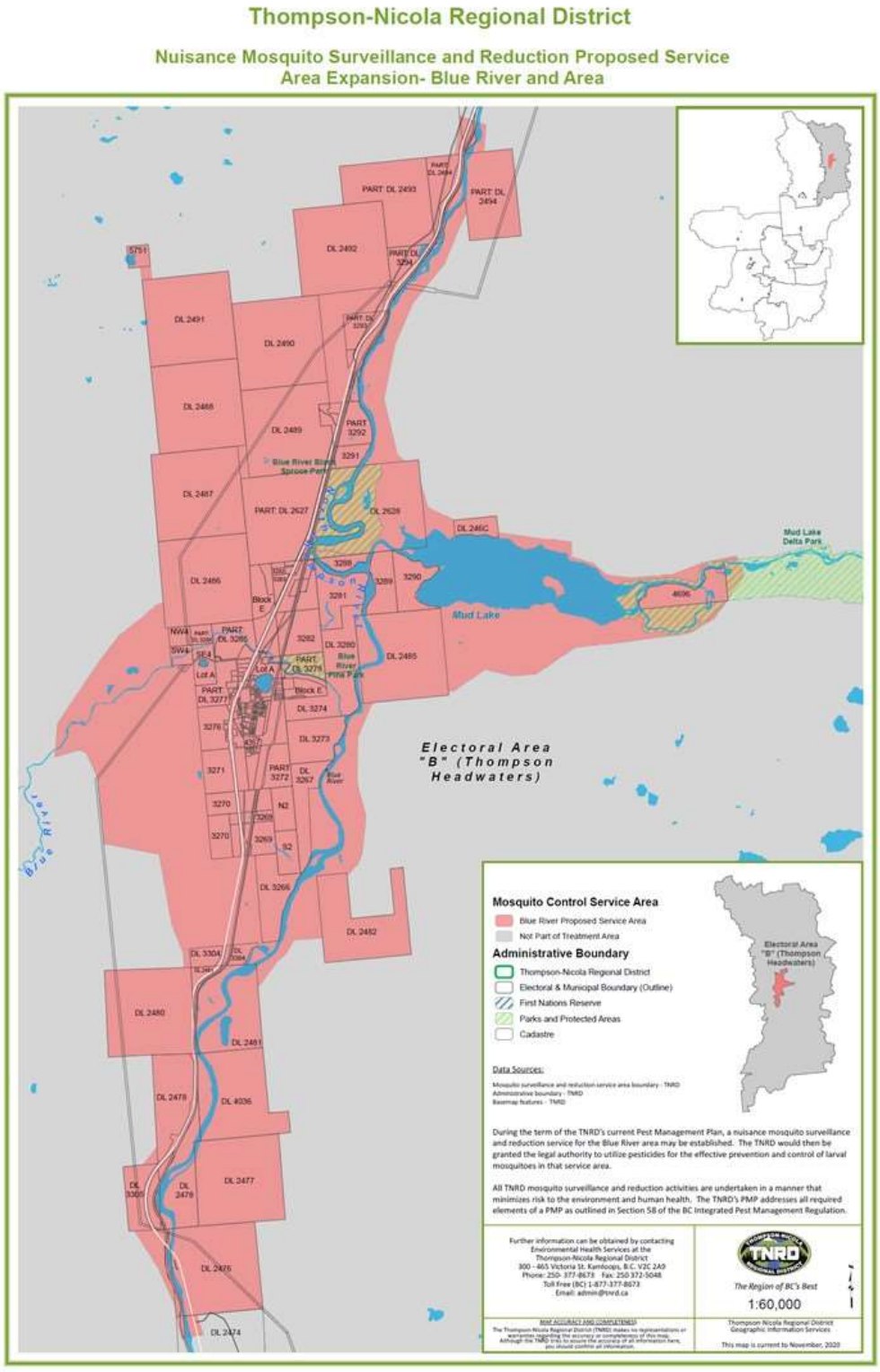
	Section of *IPMR*	Task	Associated Section Within this PMP
☒	58 1(a)	Description of geographic boundaries with maps etc	Section 1.1.2, Appendix B
☒	58 1(b)	Person responsible for managing pests in relation to land described above	Section 1.1.1
☒	58 1(c)	Name & phone number of individual who is the principal contact for information relating to the PMP	Section 1.1.1
☒	58 2(a)	Description of the program to prevent organisms from becoming pests	Section 2.1.
☒	58 2(b)	(i) a description of the program that will be employed to identify pests targeted by the plan, or (ii) identification of the pests targeted by the plan	Section 2.2.
☒	58 2(c)i	Description of the monitoring methods that will be used to assess pest populations, environmental conditions and damage caused by pests	Section 2.3.
☒	58 2(c)ii	Description of monitoring frequency before and during pesticide use	Section 2.3.
☒	58 2(c)iii	Description of the data that will collected before and during pesticide use	Section 2.3.
☒	58 2(d)i	Description of the treatment threshold and how it was chosen	Section 2.4.
☒	58 2(d)ii	Description of how treatment threshold will be applied	Section 2.4.
☒	58 2(e)i	Description of the pesticide & non-pesticide treatment methods	Section 2.5.
☒	58 2(e)ii	Rational for selecting a specific treatment method	Sections 2.5.1 to 2.5.4
☒	58 2(e)iii	Benefits and limitations for each possible method under sec 2(e)i	Sections 2.5.1 to 2.5.4
☒	58 2(e)iv	Description of how treatment method will be chosen	Section 2.5.5
☒	58 2(f)i	Description of post-treatment monitoring methods used to determine pesticide efficacy and any environmental effects	Section 2.6.1
☒	58 2(f)ii	Description of frequency of post-treatment monitoring	Section 2.6.1
☒	58 2(f)iii	Description of data collected during post-treatment monitoring	Section 2.6.
☒	58 3(a)i	Procedures for safely transporting pesticides	Section 3.1.
☒	58 3(a)ii	Procedures for safely storing pesticides	Section 3.2.
☒	58 3(a)iii	Procedures for safely mixing, loading, and applying pesticides	Section 3.3.
☒	58 3(a)iv	Procedures for the safe disposal of empty pesticide containers and unused pesticides	Section 3.4.
☒	58 3(a)v	Procedures for responding to pesticide spills	Section 3.5.
☒	58 3(b)i	Strategies to protect community watersheds & other domestic & agricultural water sources	Section 4.1.

☒	58 3(b)ii	Strategies to protect fish, wildlife, riparian areas & wildlife habitat	Section 4.2.
☒	58 3(b)iii	Strategies to prevent human food contamination	Section 4.4.
☒	58 3(b)iv	Pre-treatment procedures for identifying treatment area boundaries	Section 4.5.
☒	58 3(b)v	Procedures for calibrating & maintaining application equipment	Section 4.6.
☒	58 3(b)vi	Procedures for monitoring weather conditions and strategies for modifying pesticide application methods for different weather conditions	Section 4.7.
☒	58 3 (c)	Identification of each pesticide that will be used under the plan, the manner of its application and the type of equipment required for each manner of application	Section 5.0

APPENDIX B. MAPS OF THE GEOGRAPHIC BOUNDARIES OF THE PMP AREA



The five shaded service areas indicate the geographic boundaries of the TNRD Mosquito Surveillance and Reduction Program in Electoral Areas 'A' (excluding Wells Gray Provincial Park),'J', 'L', 'M', 'N' (excluding the Coquihalla Summit Recreation Area), 'O', &'P'. Also included within this area are the municipalities of Kamloops, Clearwater, Barriere, Chase, Sun Peaks and Logan Lake.



Blue River and surrounding area in Electoral Area 'B' is also included in the TNRD Mosquito Surveillance and Reduction Program.

APPENDIX C: COPY OF THE ADVERTISEMENT PUBLISHED IN LOCAL NEWSPAPERS THROUGHOUT THE MOSQUITO SURVEILLANCE AND REDUCTION AREAS.

DEVELOPMENT OF A PEST MANAGEMENT PLAN
Pest Management Plan Number:
TNRD-MOSQ-2020

Applicant: The Thompson-Nicola Regional District, 300- 465 Victoria St, Kamloops, BC V2C 2A9 Tel: (250) 377-7199 Fax: 250-374-6489 Attention: Martin Dickson, Environmental Services Technologist

Location: The TNRD intends to apply pesticides to reduce mosquitoes within designated mosquito surveillance and reduction areas in Electoral Area 'A', 'B', 'J', 'L', 'M', 'N', 'O', & 'P'. This includes the municipalities of Kamloops, Sun Peaks, Logan Lake, Chase, Barriere, & Clearwater but excludes the City of Merritt.

Pesticides: The active ingredients and trade names of the Pesticides proposed for use under this plan are as follows:

Larvicides: *Bacillus thuringiensis* var *israelensis* Strain H-14 (AM65-52) (Vectobac 200G & Vectobac 1200L); *Bacillus thuringiensis* var *israelensis* Strain H-14 (BMP-144) (Mosquito Dunks, Aquabac XT & Aquabac 200G); *Bacillus sphaericus* (VectoLex WSP, VectoLex CG & VectoLex WDG); Methoprene (Altosid XR briquets & Altosid Pellets).

Adulticides : **ADULTICIDES WILL ONLY BE USED UNDER ORDER FROM A MEDICAL HEALTH OFFICER** malathion (Fyfanon ULV Concentrate, & Malathion 95 ULV insecticide), pyrethrin +piperonyl butoxide (Pyrocide Fogging Formula 7067), pyrethrin + piperonyl butoxide+ N-Octyl bicycloheptene dicarboximide (Gardex Commercial Industrial micro spray concentrate).

Application Methods: Larvicides: Backpack applicator, granular spreader, & manual placement for Vectobac 200G, Aquabac 200G & Altosid Pellets. Manual placement only for Mosquito Dunks, Altosid XR Briquettes & VectoLex WSP. Backpack sprayer & truck/ATV mounted sprayer for Vectobac 1200L, VectoLex WDG & Aquabac XT. Helicopter or fixed wing aircraft for Vectobac 200G, Vectobac 1200L, Aquabac 200G, Aquabac XT, VectoLex CG & VectoLex WDG. If the use of Drones is approved and added to any larvicide label during the term of the PMP, they may also be used for treatments. Adulticides: Truck/ATV mounted or backpack, non-thermal ULV generators for all adulticides as listed above.

The selection of insecticides has been chosen to target mosquito populations in the most environmentally responsible manner. The pesticide applications will occur within the boundary areas outlined in the Pest Management Plan.

The proposed duration of the Pest Management Plan is from March 1, 2021 to Feb 28, 2026.

A draft copy of the Pest Management Plan may be viewed online at www.tnrd.ca or a hardcopy can be viewed at the Thompson-Nicola Regional District, 4th Floor, 465 Victoria Street, Kamloops, V2C 2A9

A person wishing to contribute information about a proposed treatment site, relevant to the development of the Pest Management Plan, may send copies of the information to the consultant at the address below within 30 days of the publication of this notice.

BWP Consulting Inc
Attention: Cheryl Phippen
6211 Meadowland Cres S
Kamloops, BC V2C 6X3
Email: BWP@shaw.ca
Phone: 250-573-1750

APPENDIX D: LETTER SENT TO THE FIRST NATIONS REQUESTING INPUT CONCERNING THIS PMP.

BWP Consulting Inc.
6211 Meadowland Cres S
Kamloops, BC V2C 6X3

Dec 9, 2020

Address

Attention "Contact":

This letter is to advise you that a proposed application of pesticide for the reduction of mosquitoes by the Thompson-Nicola Regional District (TNRD) in accordance with the requirements of the British Columbia *Integrated Pest Management Act* and regulations. This application of pesticide is being proposed as part of a Pest Management Plan (PMP) process. A draft of the proposed PMP (No. TNRD-MOSQ-2020) is now complete and in the Public and First Nations Engagement phase of development.

Pursuant to British Columbia Ministry of Environment guidelines, BWP Consulting Inc. is seeking comment from the "XXXX First Nation/Indian Band/Agency/etc" on the proposed pesticide application. Please be advised that this letter forms part of the Crown's engagement process for the following proposed pesticide use:

The active ingredients and trade names of the mosquito larvicides proposed for use under this plan include:

- *Bacillus thuringiensis* var *israelensis* Strain H-14 (AM65-52) (Vectobac 200G, and Vectobac 1200L);
- *Bacillus thuringiensis* var *israelensis* Strain H-14 (BMP-144) (Mosquito Dunks, Aquabac XT, & Aquabac 200G);
- *Bacillus sphaericus* (VectoLex WSP, VectoLex CG and VectoLex WDG); and
- Methoprene (Altosid XR briquets and Altosid Pellets).

In the event that adult mosquito treatment is ordered by a Medical Health Officer for the protection of human health, the following adulticides may be considered for use (please note that NO adulticiding will be conducted as part of the TNRD Mosquito Surveillance & Reduction Program):

- malathion (Fyfanon ULV Concentrate, & Malathion 95 ULV insecticide);
- pyrethrin +piperonyl butoxide (Pyrocide Fogging Formula 7067);
- pyrethrin + piperonyl butoxide+ N-Octyl bicycloheptene dicarboximide (Gardex Commercial Industrial micro spray concentrate).

Mosquito surveillance and reduction activities will begin as early as March and may extend as late as September each year. The proposed term of the PMP is from March 2021 to February 2026.

Treatments under this PMP may occur within the specified mosquito surveillance and reduction service areas in Electoral Areas 'A', 'J', 'L', 'M', 'N', 'O' & 'P' including all private, public and First Nations Reserve lands by permission of the applicable landowners, local government or agency. This includes the municipalities of Kamloops, Logan Lake, Chase, Sun Peaks, Barriere, and Clearwater. In addition, treatments may take place in or within a 10km radius of Blue River, BC. Maps of the geographic boundaries to which this PMP applies can be found in Appendix B of the enclosed PMP.

In accordance with the requirements of the British Columbia *Integrated Pest Management Act* and Regulation, we are required to ask you following questions;

a. What traditional activities have been or are being practiced within the proposed area and where have they taken place?
b. Do you have any technical or traditional knowledge of the area under application which would assist us in assessing the impact of this application on First Nations asserted aboriginal interests or treaty rights?
c. Do you have any concerns regarding potential impacts of our proposed activities on your asserted aboriginal interests or treaty rights, and if so, can you provide proposals on how we may address those concerns?

We would welcome an opportunity to meet with a representative of your Nation with the intent being to carry out meaningful engagement as needed. Alternately, we welcome you to submit information pertaining to the enclosed plan in writing or by calling Cheryl Phippen of BWP Consulting Inc (250) 573-1750. Please contact Cheryl by January 15, 2021 if you would like to discuss the plan or to arrange a meeting. If you prefer to respond in writing, send response by mail to Cheryl Phippen at 6211 Meadowland Cres. S., Kamloops, BC V2C 6X3 or by email to bwp@shaw.ca

If you would like to speak to a Ministry representative directly about the proposed pesticide use outlined in this letter, please contact the Ministry of Environment Regional Office at 102 Industrial Place, Penticton, BC V2A 7C8, phone 250-490-8200.

Sincerely,

Cheryl Phippen, BSc, RN
President, BWP Consulting Inc.

c.c. Integrated Pest Management Program, Ministry of Environment, Surrey, BC.