APPENDIX A **Ecological Effects**

a. Ecological Effects Data

(1) Terrestrial Animal Data

Avian Acute Toxicity

Avian Acute Oral Toxicity Findings			
Species	**% Test Material (TGAI)**	**LD_{50}**	**Conclusion**
Bobwhite Quail	92.8	940 mg/kg	slightly toxic

These results show that linuron is slightly toxic to birds on an acute basis. The guideline requirement for the avian acute oral LD_{50} study is fulfilled. (MRID 00150170)

Avian Subacute Dietary Toxicity

No acceptable avian dietary toxicity studies on technical linuron have been submitted for review. However, the following data from the USFWS (United States Fish and Wildlife Service) using a 50% formulation were considered. Some toxicity in formulation testing may be due to ingredients other than the active ingredient. Other formulations may be more or less toxic, depending on their ingredients. Technical testing allows prediction of the toxicity due to the active ingredient across all formulations. Therefore, tests with the technical material are still required.

Avian Subacute Dietary Toxicity Findings			
Species	**% Test Material**	**LC_{50}**	**Conclusions**
Mallard Duck	50	1700 ppm	slightly toxic
Japanese Quail	50	>5,000 ppm	practically nontoxic
Ring-necked Pheasant	50	3438 ppm	slightly toxic

The USFWS extrapolation suggests that 100 precent active ingredient material would be considered "slightly toxic" to the mallard and ring-necked pheasant and "practically nontoxic" to the Japanese quail. (MRID 00034769).

Avian Reproductive Toxicity

Avian reproduction studies are required when birds may be exposed repeatedly or continuously through persistence, bioaccumulation, or multiple applications, or if mammalian reproduction tests indicate reproductive hazard. Because linuron is persistent and can be applied more than one time during a season these studies were required.

Avian Reproductive Toxicity		
Species	**% Test Material**	**Results**
Mallard Duck	98.4	NOEL = 100 ppm LOEL = 300ppm(1)
Bobwhite Quail	98.4	NOEL = 100 ppm LOEL = 300 ppm(2)

(1) Treatment-related effects in adult body weight, feed consumption, egg production, and eggshell thickness.
(2) Treatment-related effects in egg production, hatchability, and offspring survival.

There are sufficient data to characterize the effects of linuron on avian reproduction. The No Observable Effects Level for the mallard duck is 100 ppm and the Lowest Observable Effects Level is 300 ppm. (MRID 42541802)

The No Observable Effects Level for the bobwhite quail is 100 ppm and the Lowest Observable Effects Level is 300 ppm. (MRID 42541801)

Toxicity to Mammals

Mammalian Acute Oral Toxicity Findings		
Species	**LD_{50}(mg/kg)**	**Conclusion**
Rat	2600	practically nontoxic

The available data indicate that at a lowest acute oral LD50 of 2600 mg/kg, linuron is practically nontoxic to the rat.

Toxicity to Insects

The minimum data required to establish the acute toxicity to honey bees is an acute contact LD_{50} study with the technical material.

Acute Toxicity to Insects			
Species	**% Test Material**	**LD_{50}**	**Conclusion**
Apis mellifera	not reported	>120.86 ug/bee	practically nontoxic

There is sufficient information to characterize linuron as practically non-toxic to bees. (MRID 00018842).

(2) Aquatic Animal Data

Freshwater Fish Toxicity

Acute testing with the TGAI

In order to establish the toxicity of a pesticide to freshwater fish, the minimum data required on the technical grade of the active ingredient are two freshwater fish toxicity studies. One study should use a coldwater species (preferably the rainbow trout), and the other should use a warmwater species (preferably the bluegill sunfish).

Freshwater Fish Acute Oral Toxicity			
Species	**% Test Material (TGAI)**	**LC_{50}**	**Conclusions**
Rainbow trout	96.2	3 ppm	moderately toxic
Bluegill sunfish	96.2	9.6 ppm	moderately toxic

The results of the 96-hour acute toxicity studies indicate that linuron can be characterized as being moderately toxic to both cold and warm water fish. (MRIDs 40445501 and 40354201).

Acute testing with the formulated product

Formulated product testing is specified if there is direct application to an aquatic environment or if EECs are greater than or equal to the LC50. Linuron is registered for use on rights-of-way (ROWs) which can result in a direct application to aquatic environments.

Freshwater Fish Acute Testing with the Formulated Product			
Species	**% A.I.**	**Result LC50**	**Conclusions**
Rainbow trout	Lorox 50 (WP)	16.4 ppm	slightly toxic
Bluegill sunfish	Lorox 50 (WP)	16.2 ppm	slightly toxic
Bluegill sunfish	Lorox 50 (DF)	9.2 ppm	moderately toxic

The results of the 96-hour EC50 studies indicate that Lorox 50 WP (wettable powder) is slightly toxic to rainbow trout and bluegill sunfish. Lorox 50 DF (dry flowable) is considered moderately toxic to bluegill sunfish. (MRIDs 00018165, 00018165, and 00018198).

Chronic Test-Early Life Stage

The fish early life stage is required to support reregistration of a chemical if exposure is expected to be continuous, recurrent or persistent, and multiple applications of the chemical may occur. The minimum data required to establish chronic toxicity of linuron to fish is the early life stage toxicity test based on survival of fish embryos and post-hatch larvae. There are no data available.

Freshwater Invertebrate Toxicity

Acute testing with the TGAI

The minimum testing required to assess the hazard of a pesticide is a freshwater aquatic invertebrate toxicity test, preferably using first instar *Daphnia magna* or early instar amphipods, stoneflies, mayflies, or midges.

Freshwater Invertebrate Toxicity Findings

Species	% Test Material (TGAI)	EC_{50}	Conclusion
Daphnia magna	94.4	0.12 ppm	highly toxic

There is sufficient information to characterize linuron as highly toxic to aquatic invertebrates. (MRID 00142932).

Chronic Test-life cycle

The *Daphnia* Life Cycle is required to support reregistration if the chemical's presence in water is likely to be continuous, recurrent or persistent, and multiple applications of the chemical may occur. The minimum data required to establish chronic toxicity of linuron to invertebrates is the Daphnia life cycle test based on reproduction, growth and survival.

Chronic Test-Life Cycle

Species	% A.I.	Results
Daphnia magna	98.4	MATC > 0.13 < 0.24 ppm

Based on the data submitted, the MATC is greater than 0.13 and less than 0.24 ppm. The Agency has chronic invertebrate data that appear inconsistent with acute data: chronic effects were not seen until levels higher than those causing acute effects. Also, invertebrates were more sensitive than fish in acute tests, but appear considerably less sensitive in the chronic test. Therefore, additional testing is required based on inconsistent results with the acute toxicity data. (MRID 42153401)

Estuarine/Marine Toxicity

Acute testing with the TGAI

Acute toxicity testing with estuarine and marine organisms is required when an end-use product is intended for direct application to the marine/estuarine environment or is expected to reach this environment in significant concentrations.

The requirements under this category include a 96-hour LC_{50} for an estuarine fish, a 96-hour LC_{50} for shrimp, and either a 48-hour embryo-larvae study or a 96-hour shell deposition study with oysters.

Estuarine/Marine Acute Toxicity Findings			
Species	**% Test Material (TGAI)**	**LC_{50}**	**Conclusions**
Sheepshead minnow	98.4	0.89 ppm	highly toxic
Eastern oyster	98.4	5.4 ppm	moderately toxic
Mysid shrimp	98.4	3.3 ppm	moderately toxic

There is sufficient information to characterize the TGAI of linuron as highly toxic to the sheepshead minnow and moderately toxic to the eastern oyster and mysid shrimp. (MRIDs 42061801, 42061802, and 42061803).

Acute testing with the formulated product

Marine and estuarine testing using the formulated products is required due to the ROW (Rights-of-way) use. ROWs could cross virtually any habitat, including marine aquatic habitat such as salt marshes. Data are not currently available. Testing is required with at least the most sensitive species in acute testing (sheepshead minnow) using the DF (dry flowable) formulation. A DF formulation was found to be more toxic than expected based on active ingredient testing. Because of the ROW (right-of-way) use, there could be direct exposure to the aquatic environment by the formulated product. TEP testing will enable the Agency to assess the risk of specific formulation(s) actually used on ROWs. Additional species and/or formulations may also be required.

Chronic effects

Chronic marine and estuarine testing are indicated based on the same criteria as freshwater species. In the case of linuron, these indications include (1) LC50 value less than 1 mg/l, (2) EEC 0.01 LC50 and (3) aquatic half-life of less than 4 days. Sheepshead minnow and mysid shrimp should be tested.

(3) Non-Target Plants Data

Toxicity to Terrestrial Plants

Data requirements for determining toxicity to terrestrial plants (Tier 2) remain outstanding. These data are required for linuron because it is an herbicide registered for use on terrestrial food and nonfood sites and the vapor pressure is 1.0×10^{-5}. Labeling indicate that aerial application can be used for soybeans, as well as ground boom spray for other crops. However, a plant risk assessment for linuron cannot be performed without the phytotoxicity data.

Toxicity to Aquatic Plants

Only one of the five required species for testing for toxicity to aquatic plants has been submitted. Testing for *Lemna gibba*, *Skeletonema costatum*, *Anabaena flos-aquae*, and a freshwater diatom remain outstanding. These data are required for linuron as it is an herbicide registered for use on terrestrial food/nonfood sites, has a vapor pressure $\geq 1.0 \times 10^{-5}$ mm Hg, and a water solubility greater than 10 ppm. These data are required to conduct the plant risk assessment for linuron.

Aquatic Plant Toxicity		
Species	**% A.I.**	**EC_{50}**
Selenastrum capricornutum	**100**	**5-day = 0.067 mg ai/l**

With a 5-day exposure of 0.067 mg active ingredient per liter of linuron, *S. capricornutum* can be expected to sustain a 50% reduction in density or number of cells. (MRID 42086801).