



Diquat Concentrations in the Steilacoom Lake Outlet (Chambers Creek) Following Reward® Applications During 1997

Abstract

During the summer of 1997, Ecology analyzed diquat in water samples from the Steilacoom Lake outlet (Chambers Creek) following treatment of Steilacoom Lake with the aquatic herbicide Reward®¹. Eight of the 15 samples collected were split with the herbicide applicator to conduct additional diquat analysis using an alternative laboratory method.

Objectives were to (1) determine if split samples analyzed for diquat by different methods yielded comparable results, (2) obtain additional data on diquat persistence in the water column following Reward® applications, and (3) provide data on diquat concentrations discharged to Chambers Creek in order to refine the permissible Reward® treatment regime in Steilacoom Lake.

The primary objective of the study was not met due to an absence of diquat data from the herbicide applicator. Results of Ecology's sample analysis showed diquat cation concentrations in Chambers Creek ranged from < 0.5 µg/L to 10.3 µg/L following Reward® applications. Concentrations were highest following treatment of the northern basin and most persistent when the northern basin was treated eight days after Reward® application to the southern basin. The highest diquat concentrations measured were one-half the maximum contaminant level/goal of 20 µg/L for drinking water. The 1997 Reward® treatment regime for Steilacoom Lake resulted in Chambers Creek diquat concentrations that complied with the labeled drinking water use restriction of 2-3 days following treatment.

¹ Reward® is a dibromide salt of diquat manufactured exclusively by Zeneca Inc. It contains 3.73 lbs. diquat dibromide or 2 lbs. diquat cation per gallon

Introduction

Background

Diquat [6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium ion] is a broad-spectrum contact herbicide which is effective at controlling submersed and floating aquatic weeds. The Washington State Department of Ecology (Ecology) does not currently permit the use of diquat in Washington lakes due to a variety of factors, including the lack of critical information about its persistence and drift from treated areas (Ecology, 1992). However, state legislation enacted in 1996 (ESSB 6666) requires Ecology to "... expedite requests for approval for the application of state or federally registered pesticides by licensed pesticide applicators, including the use of herbicides such as copper sulfate or diquat, to control nuisance and noxious weeds in lakes managed under chapter 90.24 RCW." To this end, Ecology is reviewing and acquiring new data on diquat and its potential environmental impact, including persistence and drift in treated lakes, before considering its acceptability for aquatic use.

Ecology permitted an experimental use of the aquatic herbicide diquat in Steilacoom Lake to control aquatic weeds during 1996. The treatment was permitted along with monitoring in order to fill critical data gaps about the persistence and drift of diquat in the water column of treated lakes. Among the results of this monitoring were indications that

- Diquat persisted in the water column at detectable levels for at least 12 days following treatment,
- Diquat drifted to untreated areas, including the Steilacoom Lake outlet (Chambers Creek) within 24 hours after application, and
- The use restriction for drinking water specified on the product (Reward®) label was not sufficient to protect human health (Serdar, 1997).

Diquat treatment was again permitted on an experimental basis in Steilacoom Lake during 1997. Like the previous year, it was permitted on conditions that monitoring be done to obtain additional drift and persistence data. However, the 1997 treatment permit issued by Ecology (Administrative Order DE 97WQ-S101) included conditions that 1) diquat be applied in a manner to prevent *any* concentration from entering Chambers Creek, and 2) the applicator (Allied Aquatics) develop a sampling plan, to be approved by Ecology, which includes monitoring downstream diquat concentrations.

Although Allied Aquatics submitted an adequate sampling and analysis plan prior to treatment, Ecology's Water Quality Program requested the Environmental Investigations and Laboratory Services Program to conduct additional monitoring of downstream diquat concentrations. This request was made partly to expand the set of downstream data, but it was primarily intended to obtain data on comparability of two different methods for diquat analysis. The issue of method comparability was raised after Zeneca Inc. criticized Ecology's use of EPA Method 549.1 to analyze lake water samples for diquat (Shaw

et al., 1997). They argued that their method, RAM 254/01, was more appropriate for analyzing water from lakes. Therefore, a plan was developed to split samples, with the applicator using RAM 254/01 and Ecology using EPA 549.1, to assess the comparability of the two methods.

Objectives

Objectives were to:

1. Determine if split samples analyzed for diquat by different methods yielded comparable results;
2. Obtain additional data on diquat persistence in the water column following Reward applications; and
3. Provide data on diquat concentrations discharged to Chambers Creek in order to refine the permissible Reward® treatment regime in Steilacoom Lake.

Methods

Sampling

Allied Aquatics treated Steilacoom Lake with Reward® at a rate of 1-1.5 gallons/acre on June 28, July 7, and July 28, 1997 to control *Elodea* (*Elodea canadensis*), pondweeds (*Potamogeton spp.*), and coontail (*Ceratophyllum demersum*). Water samples were collected prior to each treatment, within 24 hours post-treatment, and at 2, 4, and 8 days post-treatment. The exception was during the second (July 7) treatment when no pre-treatment sample was collected. Temperature, pH, and specific conductivity were measured on-site several times during the study.

Samples were collected by hand-dipping off the Chambers Creek right bank directly below the Steilacoom Lake outlet structure. One-liter amber PVC bottles were used for diquat samples and one-liter clear PE bottles for TSS. Samples were placed on ice immediately following collection and delivered to the Manchester Laboratory the following business day.

Chemical Analysis

Diquat was analyzed according to EPA Method 549.1 using high performance liquid chromatography with ultraviolet detection. Because EPA 549.1 is a drinking water method, the samples first had to be filtered using Empore® particle extraction disks. Diquat was then eluted from both the filtrate and particles captured on the filter. The practical quantitation limit was 0.5 µg/L (parts per billion). TSS was analyzed using EPA Method 160.2 with a quantitation limit of 1 mg/L (parts per million).

Data Quality

Quality assurance memoranda were prepared by the chemists at Manchester and are included in the Appendix. Diquat analyses were performed within acceptable holding times. No analytes were detected in laboratory blanks. Instrument calibration was within control limits except for a higher-than-acceptable peak response for the final sample batch. The sample collected on August 1 was the only one affected and the result (0.9 µg/L) is an estimate.

Accuracy and precision of the diquat data were assessed through the analysis of matrix spikes and matrix spike duplicates (MS/MSD), replicate field samples submitted blind, a fortified blank, performance evaluation sample, and a field spiked sample submitted blind (Table 1).

Overall quality of the diquat data is good, although MS/MSD recoveries for the sample collected on July 7 were low and the result (1.5 µg/L) is therefore an estimate. Other measures of accuracy are good except for the low recovery of the field-spiked sample. Excellent results were obtained for the performance evaluation sample analyzed as part of EPA's Water Supply Study WS039. Overall precision of the data is high as indicated by results of field replicate analyses. Quality of the TSS data is also good (Appendix).

Table 1. Accuracy and Precision Data for Diquat Analysis.

Sample Type	Sample Number	Date Collected	Recovery	RPD
MS/MSD	97-27-8230	28 June	171/108%	45%
" "	97-27-8235	7 July	36/32%	12%
" "	97-27-8240	28 July	105/112%	6%
Field Reps. (µg/L)	97-31-8243/8244	30 July	4.3/4.7	9%
Fortified Blank	--	--	80%	--
Performance Eval.	--	--	106%	--
Field Spike	--	--	40%	--

RPD=Relative Percent Difference (difference/mean x 100%)

Results

Diquat and TSS concentrations are shown in Table 2. Figure 1 shows diquat concentrations in relation to the location and extent of Reward® applications in Steilacoom Lake.

TSS concentrations during the initial four days of sampling were moderately elevated (6-7 mg/L) due to high lake levels, then afterward decreased to very low levels

(<1-2 mg/L) for the remainder of the study. Temperature, specific conductance, and pH were within the range normally seen in Steilacoom Lake and Chambers Creek (KCM, 1996).

There was little response in diquat concentration at the outlet following the initial southern basin application. The second treatment resulted in concentrations around 10 µg/L for several days. Eight days after this treatment, the diquat concentration at the outlet remained at a detectable level (3.6 µg/L), possibly due to a lag in diquat drift from the initial application.

The sample collected just prior to the third and final application showed the diquat concentration returning to an undetectable level (< 0.5 µg/L) 28 days after the initial treatment and 21 days following the second treatment. Although no data were collected to assess diquat concentrations at various locations in the lake, the low level is probably due to near-complete removal of diquat from the water column (via sorption to sediments, suspended particulate matter, and plant material) and does not represent a lag in diquat transport to the outlet. This conclusion is based on data from the available literature (Reinert and Rodgers, 1987) and from Ecology's 1996 study of diquat in Steilacoom Lake (Serdar, 1997) showing diquat's water column half-life in the range of 1-4 days.

The diquat concentration at the outlet spiked at 10.1 µg/L three hours after the final treatment was completed. The rapid increase in concentration is almost certainly due to the proximity of the final treatment – as close as 400 feet from the outlet structure. Monitoring after the final Reward® application showed a steady yet quicker-than-previous decline in diquat, decreasing to undetectable levels 5-8 days after treatment.

The highest diquat concentrations in samples from Chambers Creek were half the National Primary Drinking Water Standard maximum contaminant level/goal (MCL/MCLG) of 20 µg/L. The Reward® product label specifies a drinking water use restriction of 2 or 3 days following applications of 1 gal/acre and 2 gal/acre, respectively, or until water does not contain more than the MCLG. It appears that the treatment regime used during 1997 offers a margin of safety based on compliance with label restrictions, at least with regards to Chambers Creek. By contrast, when 80% of Steilacoom Lake was treated with Reward® (@ 2 gallons/acre) in a single day during 1996, diquat concentrations at 4 sites including Chambers Creek at the lake outlet were above 20 µg/L for at least 3 days following application.

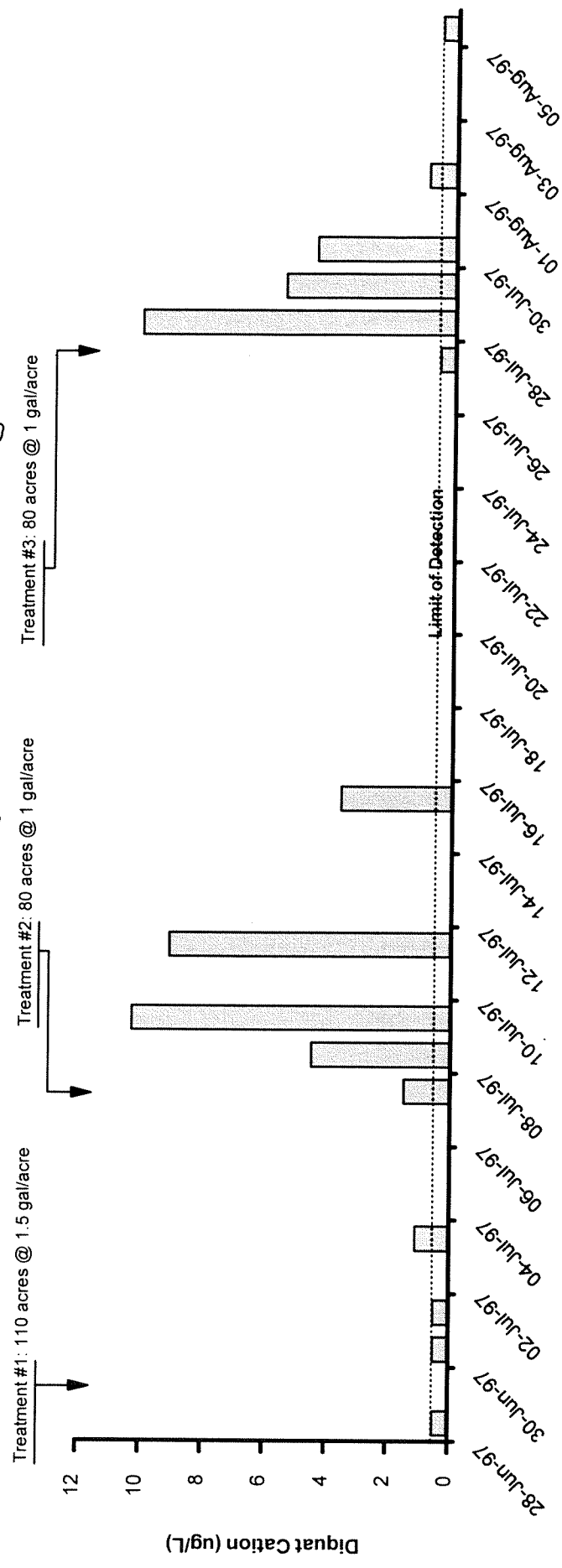
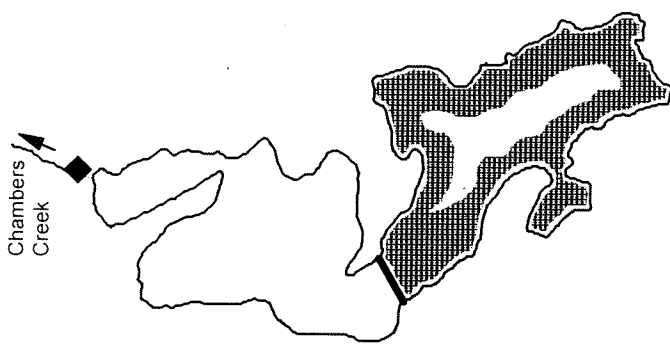
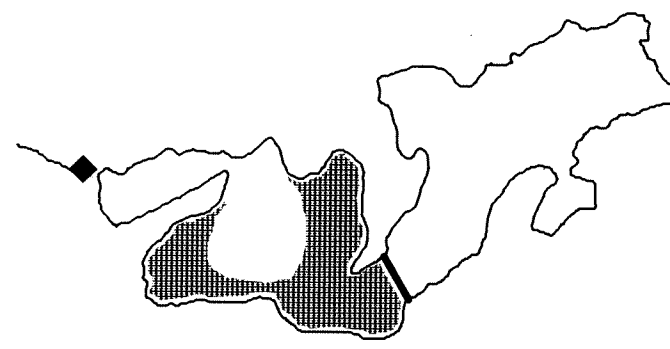
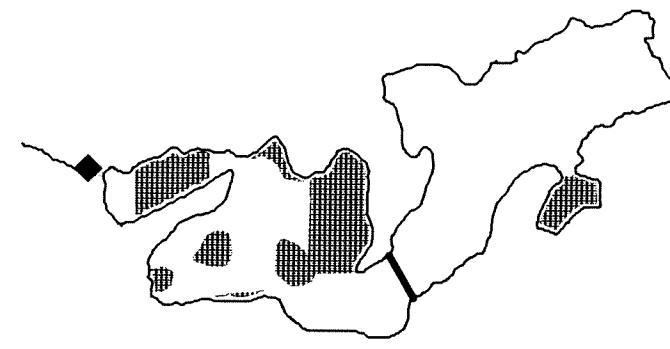
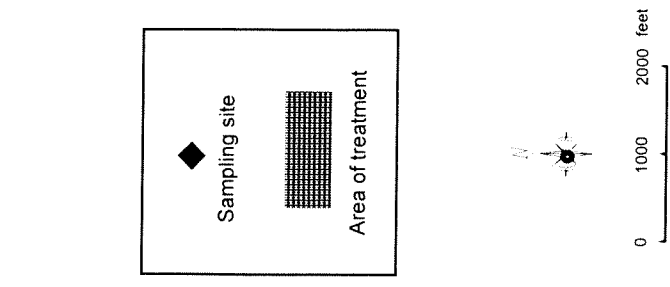


Figure 1. Digquat Cation Concentrations in the Steilacoom Lake Outlet (Chambers Creek) Following Reward® Applications in Steilacoom Lake.

Table 2. Diquat Concentrations in the Steilacoom Lake Outlet (Chambers Creek) Following Reward® Applications During 1997

Date	Time	Diquat Cation Concentration (µg/L)	TSS (mg/L)	Temp. (C)	pH	Specific Conductance (µmhos/cm)
28-Jun-97	1445	U (0.5)	7	--	--	--
30-Jun-97	1600	U (0.5)	6	--	--	--
01-Jul-97	1600	U (0.5)	7	--	--	--
03-Jul-97	1600	1.1	2	21.8	9.19	130
07-Jul-97	1445	1.5 J	1	--	--	--
08-Jul-97	1200	4.5	1	--	--	--
09-Jul-97	1200	10.3	1	--	--	--
11-Jul-97	1200	9.1	2	18.8	7.81	109
15-Jul-97	1200	3.6	1	--	--	--
27-Jul-97	0900	U (0.5)	1	--	--	--
28-Jul-97	1600	10.1	2	--	--	--
29-Jul-97	1200	5.5	1	--	--	--
30-Jul-97	1200	4.5	U (1)	23.2	8.90	118
01-Aug-97	1200	0.9 J	1	--	--	--
05-Aug-97	1200	U (0.5)	1	--	--	--

U=Undetected at concentration in parentheses

J=Estimated concentration

Unfortunately, there are no data available to fulfill the primary objective of this study – comparison of the diquat analysis methods EPA 549.1 and RAM 254/01. As mentioned previously, 8 of the 15 samples collected by Ecology were split with the applicator, yet Allied Aquatics never reported the results.

Conclusion

The 1997 Reward® treatment regime for Steilacoom Lake resulted in Chambers Creek diquat concentrations that complied with the labeled drinking water use restriction of 2-3 days following treatment. However, the application did not fulfill the condition that diquat be applied in a manner to prevent any concentration from entering Chambers Creek as specified in Ecology's Administrative Order DE 97WQ-S101. Results of this study and monitoring conducted during 1996 suggest that downstream transport of diquat may be unavoidable following any large-scale Reward® application.

Acknowledgements

Doug Dorling of Allied Aquatics provided information on herbicide applications and assisted in sampling. Dickey Huntamer of the Manchester Laboratory performed the diquat analysis and Becky Bogaczyk of Manchester did the general chemistry. Will White and Pam Covey delivered and tracked the samples. Dale Norton, Steve Saunders, and Loree Randall reviewed this report, and Joan LeTourneau proofread and formatted the final copy. I thank all these people for their help.

References

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- KCM, 1996. Steilacoom Lake Phase I Restoration Study. Prepared by KCM, Inc., Seattle, WA for Tacoma-Pierce County Health Department, Tacoma, WA.
- Reinert, K. H. and J. H. Rodgers, 1987. Fate and Persistence of Aquatic Herbicides. Reviews of Environmental Contamination and Toxicology. 98:61-99.
- Serdar, D., 1997. Persistence and Drift of the Aquatic Herbicide Diquat Following Application at Steilacoom and Gravelly Lakes. Pub. No. 97-301, Washington State Department of Ecology, Olympia, WA.
- Shaw, J. L., C. J. Spillner, E. Roper, J. Dyson, and M. J. Hamer, 1997. Zeneca Response to a Washington State Department of Ecology Report on the "Persistence and Drift of the Aquatic Herbicide Diquat Following Application at Steilacoom and Gravelly Lakes". Zeneca Ag Products, Wilmington, DE and Richmond, CA USA, and Zeneca Agrochemicals, Bracknell, Berks, UK.

Contacts

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 Environmental Investigations and Laboratory Services Program
 (360) 407-6772

If you have special accommodation needs, please contact Joan LeTourneau (360) 407-6764 (voice). Ecology's telecommunication device for the deaf (TDD) number at Ecology Headquarters is (360) 407-6006.

APPENDIX

- Quality Assurance Memoranda
- Reward® Label

Manchester Environmental Laboratory

7411 Beach Dr E
Port Orchard Washington 98366
November 17, 1997

Project: **Diquat in Chambers Creek**
Samples: 97-278230 through 97-278234, 97-288235 through 97-288238, 97-298239,
97-308240 through 97-308241, 97-318242 through 97-318245, 97-328246
By: Karin Feddersen *KF*

Sample Summary:

These samples were analyzed by EPA Method 549.1, for Diquat. The identities of all positively detected results were subsequently confirmed as Diquat.

The peak response for the low calibration standard analyzed on August 7 was higher than acceptable. Results below 1 ug/L for samples analyzed on this day are therefore estimated. 97318245 is the only sample affected. The result for this sample has been qualified as an estimate ("J").

This data is acceptable for use with the qualifications mentioned.

Holding Times:

These samples were extracted within the method holding time of seven days from collection. Most extracts were analyzed within the method holding time of twenty-one days from extraction. The analyst has demonstrated that Diquat is still detected in a sample extract up to one year after extraction. All samples were analyzed within an acceptable holding time.

Method Blanks:

No analytes of interest were detected in the method blanks.

Matrix Spikes:

Aliquots of samples 97-278230, 97-278235 and 97-278240 were analyzed as matrix spikes. Recoveries were acceptable (82% to 129%) in samples 97-278230 and 97-278240.

Subtracting the native amount in 97-278235 from the spiked analyses resulted in recoveries of 32% and 36% for the spikes. Re-analysis of the extracts produced recoveries of 34% in each. The value spiked was close to the amount apparently present in the sample.

We investigated the possibility that Diquat was accidentally spiked into all three aliquots of the sample. However, the spike mixture also contains Paraquat, which co-elutes with Diquat on the second channel. Therefore, if Diquat and Paraquat had been added to the sample, then the ratio between the two channels would be comparable to the ratio for the spikes. The ratio for this sample is not consistent with this theory. Thus, it is unlikely that it was inadvertently spiked, and Diquat is most likely native to this sample.

The result for sample 97-278235 has been qualified as an estimate.

A fortified blank, spiked with 2.1 mg/L Diquat, was also analyzed. Recovery was acceptable at 80%.

Water Supply Study 39 WS039 Performance Evaluation Sample:

Manchester Lab received the results from our participation in USEPA's WS039. Manchester reported a value of 30.2 micrograms per liter for the performance evaluation sample - a 6% Difference from the true value of 32.2 micrograms per liter. A copy of all results from this study have been included with this report.

DATA QUALIFIER CODES:

- U - The analyte was not detected at or above the reported value.
- J - The analyte was positively identified. The associated numerical value is an estimate.
- UJ - The analyte was not detected at or above the reported estimated result.

**Washington State Department of Ecology
Manchester Laboratory**

August 14, 1997

TO: Dave Serdar

FROM: Becky Bogaczyk, Chemist ^{B²}

SUBJECT: General Chemistry Quality Assurance memo for Diquat in Chambers Creek

SUMMARY

The data generated by the analysis of these samples can be used noting the qualifications discussed in this memo. All analyses requested were evaluated by established regulatory quality assurance guidelines.

SAMPLE INFORMATION

Samples for Diquat in Chambers Creek project were received by Manchester Laboratory on 07/01, 02, 07-10, 14, 16, 29-31/97, 08/04, & 06/97 in good condition.

HOLDING TIMES

All analyses were performed within established EPA holding times.

ANALYSIS PERFORMANCE

Instrument Calibration

Balances are calibrated yearly and verified monthly. Ovens temperatures are recorded before and after every analytical run.

Procedural Blanks

The procedural blanks associated with these samples showed no significant analytical levels of analytes.

Precision Data

Duplicate sample results were used to evaluate precision on this sample set. Relative Percent Difference (RPD) for general chemistry parameters was within the 20% acceptance window for all duplicate analysis. Laboratory duplication is performed at a frequency of at least 10%.

Laboratory Control Sample (LCS) Analyses

LCS analyses were within the windows established for each parameter.

Other Quality Assurance Measures and Issues

The "U" qualification indicates the analyte was not detected at or above the reported result.

Please call Becky Bogaczyk at (360) 871-8830 to further discuss this project.

cc: Project File

ZENECA Professional Products

REWARD

Cardinal and Aquatic Herbicide

LABEL FOR '97 STELLA ALOOM LAKE ARK.

PULL HERE TO OPEN
PRESS TO RESEAL

TO PREVENT ACCIDENTAL POISONING, NEVER PUT INTO FOOD,
DRINK OR OTHER CONTAINERS AND USE STRICTLY IN
ACCORDANCE WITH ENTIRE LABEL

DO NOT USE THIS PRODUCT FOR REFORMULATION

ACTIVE INGREDIENT:

Diquat dibromide [6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium dibromide]	36.4%
INERT INGREDIENTS	63.6%

TOTAL 100.0%

Contains 2 lbs. diquat cation per gal. as 3.73 lbs. salt per gal.

EPA REG. NO. 10182-404

EPA EST. NO. 10182-AR-1

KEEP OUT OF REACH OF CHILDREN

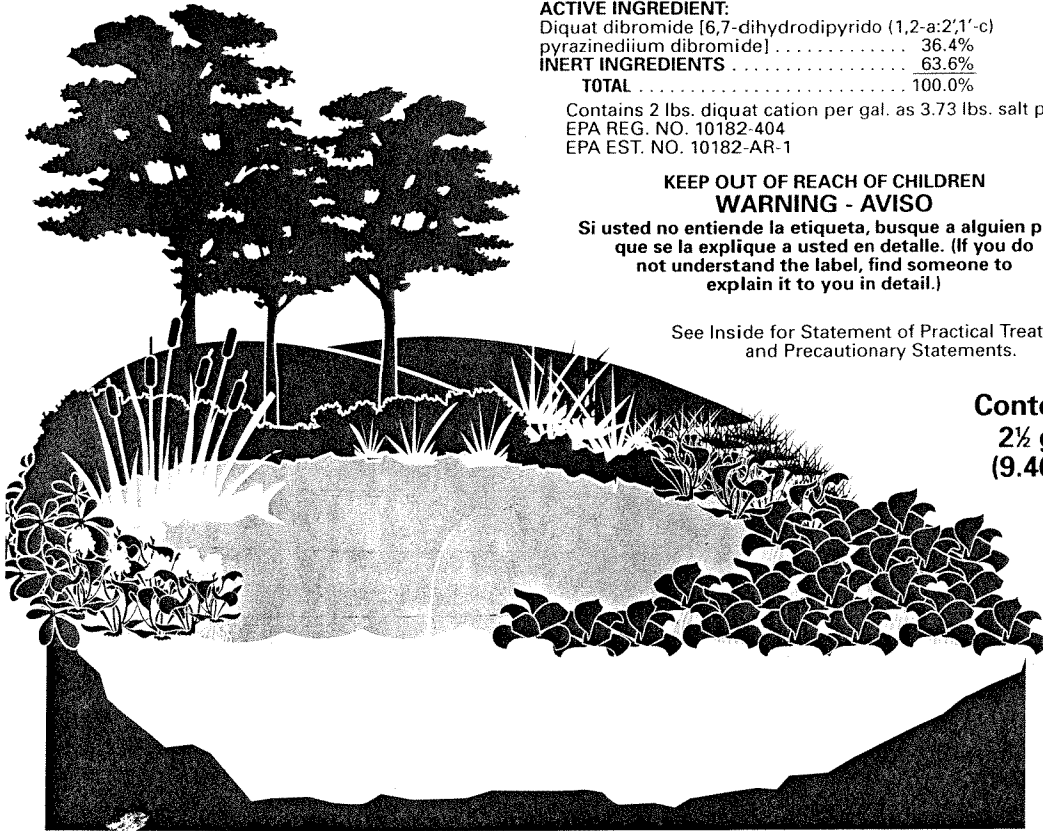
WARNING - AVISO

Si usted no entiende la etiqueta, busque a alguien para
que se la explique a usted en detalle. (If you do
not understand the label, find someone to
explain it to you in detail.)

See Inside for Statement of Practical Treatment
and Precautionary Statements.

Contents:

2½ gal
(9.46 L)



04004328
019701

**CONDITIONS OF SALE
AND LIMITATION OF WARRANTY AND LIABILITY**

NOTICE: Read the entire Directions for Use and Conditions of Sale and Limitation of Warranty and Liability before buying or using this product. If the terms are not acceptable, return the product at once, unopened, and the purchase price will be refunded.

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TABLE OF CONTENTS

	Page
STATEMENT OF PRACTICAL TREATMENT	1
PRECAUTIONARY STATEMENTS	1
HAZARDS TO HUMANS AND DOMESTIC ANIMALS	1
PERSONAL PROTECTIVE EQUIPMENT	1
ENVIRONMENTAL HAZARDS	2
DIRECTIONS FOR USE	2
DIRECTIONS	3
AGRICULTURAL USE REQUIREMENTS	3
NON-AGRICULTURAL USE REQUIREMENTS	4
AQUATIC USE DIRECTIONS	6
STORAGE AND DISPOSAL	9

STATEMENT OF PRACTICAL TREATMENT

WALLOWED: IMMEDIATELY give water or milk to drink and induce vomiting by inserting finger in throat. Do not induce vomiting or give anything by mouth to an unconscious person. Take person and product container to the nearest hospital or physician fast. **PROMPT TREATMENT IS ESSENTIAL TO COUNTERACT POISONING** and should be initiated before signs and symptoms of toxicity appear.

SKIN: IMMEDIATELY wash with soap and water. See a doctor if diquat contacts a skin cut, abrasion or area of irritation.

EYES: IMMEDIATELY wash eyes with water for at least 15 minutes and get medical attention.

INHALED: IMMEDIATELY get away from spray mist. Stop and check spray procedure. See a doctor if irritation persists.

NOTE TO PHYSICIANS: Call ZENECA Medical Emergency Information Network 1-800-F-A-S-T-M-E-D-8633 at any hour to obtain toxicology information and a diquat analysis. To be effective, treatment for diquat poisoning must begin **IMMEDIATELY**. Treatment consists of binding diquat in the gut with suspensions of activated charcoal or bentonite clay, administration of cathartics to enhance elimination, and removal of diquat from the blood by charcoal hemoperfusion or plasmapheresis.

24-HOUR EMERGENCY MEDICAL ASSISTANCE CALL 1-800-F-A-S-T-M-E-D (327-8633)
CHEMICAL EMERGENCY: Spill, leak, fire, exposure, or accident call CHEMTREC 1-800-424-9300.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS & DOMESTIC ANIMALS

WARNING

BE FATAL IF SWALLOWED, INHALED OR ABSORBED THROUGH THE SKIN. CAUSES IRRITATION, BUT TEMPORARY. EYE INJURY. CAUSES SKIN IRRITATION. CONTACT WITH IRRITATED SKIN, OR A CUT, OR REPEATED CONTACT WITH INTACT SKIN MAY RESULT IN POISONING. Do not get in eyes, on skin or on clothing. Do not breathe spray mist. Do not feed from treated crops to livestock. Keep livestock and pets out of treated fields and crop areas.

PERSONAL PROTECTIVE EQUIPMENT

Handlers and other handlers must wear:
• Coveralls over short-sleeved shirt and short pants or coveralls over long-sleeved shirt and long pants.
• Respirator.
• Protective gloves.
• Chemical-resistant footwear plus socks.
• Protective eyewear.

• Chemical-resistant headgear for overhead exposure.

• Chemical-resistant apron when cleaning equipment, mixing or loading.

EXCEPTION: At a minimum, applicators for AQUATIC SUBSURFACE APPLICATIONS must wear (Note—Mixers and Loaders for this application method must still wear the personal protective equipment (PPE) as described in the above section):

- Short-sleeved shirt and short pants.
- Waterproof gloves.
- Chemical-resistant footwear plus socks.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides (40 CFR 170.240(d)-(4-6)), the handler PPE requirements may be reduced or modified as specified in the WPS. Mixers, loaders, and applicators using closed systems who meet these requirements may wear: long-sleeved shirt and long pants, protective eyewear, waterproof gloves, shoes plus socks, and a chemical-resistant apron when mixing, loading or cleaning equipment. If handling tasks are performed from inside an enclosed cab or aircraft with enclosed cockpits that meet these requirements may wear: long-sleeved shirt, long pants, shoes and socks for the labeling specified PPE. All labeling-specified PPE must be immediately available for use in an emergency. All applicable requirements as specified in 40 CFR 170.240(d)(4-6) must be followed.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS (TERRESTRIAL AND AQUATIC USES)

This pesticide is toxic to wildlife. Do not apply directly to water except as specified on this label. For **Terrestrial Uses**, do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters. For **Aquatic uses**, treatment of dense weed areas may result in oxygen loss from decomposition of dead weeds. This loss of oxygen may cause fish suffocation. Therefore, treat only 1/10 to 1/2 of the dense weed areas at a time and wait 14 days between treatments. Necessary approval and/or Permits should be obtained prior to application if required. Consult the responsible State Agencies (i.e., Fish and Game agencies or Department of Natural Resources) before making applications to public waters.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH PRECAUTIONARY STATEMENTS AND DIRECTIONS, AND WITH APPLICABLE STATE AND FEDERAL REGULATIONS.

DIRECTIONS

REWARD* Landscape and Aquatic Herbicide is a nonvolatile herbicidal chemical for use as a general herbicide to control weeds in noncrop and aquatic areas. Absorption and herbicidal action is usually quite rapid with effects visible in a few days. REWARD Landscape and Aquatic Herbicide controls weeds by interfering with photosynthesis within green plant tissue. Weed plants should be succulent and actively growing for best results. Rinse all spray equipment thoroughly with water after use. AVOID SPRAY DRIFT to crops, ornamentals, and other desirable plants during application as injury may result. Application to muddy water may result in reduced control. Minimize creating muddy water during application. Use of dirty or muddy water for REWARD Landscape and Aquatic Herbicide dilution may result in reduced herbicidal activity. Avoid applying under conditions of high wind and wave action.

Do not apply this product through any type of irrigation system.

AGRICULTURAL USES:

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 24 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls over short-sleeved shirt and short pants, or coveralls over long-sleeved shirt and long pants.
- Waterproof gloves.
- Chemical-resistant footwear plus socks.
- Protective eyewear.
- Chemical-resistant headgear for overhead exposure.

COMMERCIAL GREENHOUSES AND NURSERIES: For general weed control in commercial greenhouses (beneath benches), field grown and container stock), and other similar areas. REWARD Landscape and Aquatic Herbicide may be applied preplant or postplant preemergence in field grown ornamental nursery plantings or postemergence as a directed spray. REWARD Landscape and Aquatic Herbicide may also be applied preemergence in ornamental seed crops (U.S., except California). Avoid contact with desirable foliage as injury may occur. Do not use on food or feed crops.

Spot spray: 1 to 2 qts. REWARD Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per 100 gallons water or 0.75 oz. (22 mls) REWARD Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per 1 gallon water.

Broadcast: 1 to 2 pints REWARD Landscape and Aquatic Herbicide in a minimum of 15 gallons water per acre. Add the labeled rate of a 75% or greater nonionic surfactant per 100 gallons spray mixture. Use an adequate spray volume to insure good coverage.

ORNAMENTAL SEED CROPS (FLOWERS, BULBS, ETC.) U.S., except California: For preharvest desiccation of ornamental seed crops. NOT FOR FOOD OR FIBER CROPS. **Broadcast (Air or Ground):** 1.5 to 2 pints REWARD Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per acre in sufficient water (minimum of 5 gallons by air, 15 gallons by ground) for desiccation and weed burndown. Repeat as needed at no less than 5 day intervals up to three applications. Do not use seed, screenings, or waste as feed or for consumption.

NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses. Keep all unprotected persons out of operating areas or vicinity where there may be drift.

For terrestrial uses, do not enter or allow entry of maintenance workers into treated areas, or allow contact with treated vegetation wet with spray, dew or rain, without appropriate protective clothing until spray has dried.

For aquatic uses, do not enter treated areas while treatments are in progress.

DIRECTIONS FOR LANDSCAPE, INDUSTRIAL, RECREATIONAL, COMMERCIAL, RESIDENTIAL, AND PUBLIC AREAS:

REWARD provides fast control of broadleaf and grassy weeds in industrial, recreational, golf course, commercial, residential, and public areas.

REWARD is a non-selective herbicide that rapidly kills undesirable aboveground weed growth in 24 to 36 hours. Avoid application of REWARD to desirable plants.

REWARD is a contact/desiccant herbicide, it is essential to obtain complete coverage of the target weeds to get good control. Improper application technique and/or application to stressed weeds may result in unacceptable weed control. For best results apply to actively growing, young weeds.

Difficult weeds (such as perennial or deeply rooted weeds) can often be controlled by tank mixing Reward with other systemic-type herbicides. Refer to other product labels for specific application directions.

For residual weed control, tank mix Reward with a preemergent herbicide labeled for the intended use site. When mixing Reward with another herbicide, it is recommended to mix just a small amount first to determine if the mixture is physically compatible before proceeding with larger volumes.

Zeneca has not tested all possible tank mixtures with other herbicides for compatibility, efficacy or other adverse effects. Before mixing with other herbicides Zeneca recommends you first consult your state experimental station, state university or extension agent.

Grounds maintenance weed control:

Reward can be used as a spot or broadcast spray to control weeds in public, commercial and residential landscapes, including landscape beds, lawns, golf courses and roadsides. Reward can also be used for weed control around the edges and nonflooded portions of ponds, lakes and ditches.

Trim and Edge weed control:

Reward can be used to eliminate undesired grass and broadleaf plant growth in a narrow band along driveways, walkways, patios, cart paths, fence lines, and around trees, ornamental gardens, buildings, other structures and beneath noncommercial greenhouse benches. Vegetation control with Reward is limited to the spray application width.

Reward, since it does not translocate systemically, can be used as an edging or pruning tool when precisely applied to select areas of grass or to undesirable growth on desirable ornamental bedding plants, ground covers, etc.

Industrial weed control:

Reward can be used as a spot or broadcast spray either alone or in combination with other herbicides to control weeds in rights-of-ways, railroads beds/yards, highways, roads, dividers and medians, parking lots, pipelines, pumping stations, public utility lines, transformer stations and substations, electric utilities, storage yards and other non-crop areas.

Spot spray: 1 to 2 qts. REWARD Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per 100 gallons water or 0.75 oz. (22 ml) REWARD Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per 1 gallon water.

Broadcast: 1 to 2 pints REWARD Landscape and Aquatic Herbicide in a minimum of 15 gallons water per acre. Add the labeled rate of 75% or greater nonionic surfactant per 100 gallons spray mixture. Use an adequate spray volume to insure good coverage.

TURF RENOVATION (All Turf Areas Except Commercial Sod Farms)

To desiccate golf course turf and other turf areas prior to renovation, apply 1 to 2 pints of REWARD Landscape and Aquatic Herbicide per acre plus the labeled rate of a 75% or greater nonionic surfactant in 20 to 100 gallons of water (4 teaspoons of REWARD Landscape and Aquatic Herbicide plus the labeled rate of 75% or greater nonionic surfactant per 1 gallon of water) using ground spray equipment. Apply for full coverage and thorough contact with the turfgrass. Apply only when the turf is dry, free from dew and incidental moisture. For enhanced turf desiccation, especially in the case of thick turfgrass, water volumes should approach 100 gallons of water per acre.

For **suppression** of regrowth and quick desiccation of treated turfgrass, REWARD Landscape and Aquatic Herbicide may be mixed with other systemic non-selective or systemic postemergence grassy weed herbicides. Refer to other product labels for specific application directions and restrictions.

Avoid spray contact with, or spray drift to, foliage of ornamental plants or food crops.

Do not graze livestock on treated turf or feed treated thatch to livestock.

DORMANT ESTABLISHED TURFGRASS (Bermudagrass, zoysiagrass) NONFOOD OR FEED CROP

For control of emerged annual broadleaf and grass weeds, including Little Barley*, Annual Bluegrass, Bromes including Rescuegrass, Sixweeks fescue, Henbit, Buttercup, and Carolina Geranium in established dormant bermudagrass lawns, parks, golf courses, etc.

Apply 1 to 2 pts. REWARD Landscape and Aquatic Herbicide per acre in 20 to 100 gallons spray mix by ground as a broadcast application. Add the labeled rate of a 75% or greater nonionic surfactant per 100 gallons spray mixture.

Bermudagrass must be dormant at application. Application to actively growing bermudagrass may cause delay or permanent injury. Users in the extreme Southern areas should be attentive to the extent of dormancy at the time of application.

*For control of Little Barley, apply REWARD Landscape and Aquatic Herbicide prior to the mid-boot stage.

AQUATIC USE DIRECTIONS

Necessary approval and/or permits should be obtained prior to application if required. Consult the responsible State Agencies (i.e., Fish and Game agencies or Department of Natural Resources).

For application only to ponds, lakes, and drainage ditches where there is little or no outflow of water and which are totally under the control of the product's user;

and/or

For applications to **public waters** in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, streams, rivers and other slow moving or quiescent bodies of water for control of aquatic weeds. For use by:

- Corps of Engineers, or
- Federal or State Public Agencies (i.e., Water Management District personnel, municipal officials), or
- Applicators and/or Licensees (Certified for aquatic pest control) that are authorized by the State or Local government.

Treated water may be used according to the following table or until such time as an approved assay (example: PAM II Spectrometric Method) shows that the water does not contain more than the designated maximum contaminant level goal (MCLG) of 0.02 mg/l. (ppm) of diquat dibromide (calculated as the cation):

WATER USE RESTRICTIONS FOLLOWING APPLICATIONS WITH REWARD Landscape and Aquatic Herbicide (Days)

Application Rate	Drinking	Fishing and Swimming	Livestock Consumption	Spray Tank Applications** to Turf and Ornamentals	Spray Tank Applications** Irrigation/ Food Crops
2 gal/surface acre	3 days	0	1 day	3 days	5 days
1 gal/surface acre	2 days	0	1 day	2 days	5 days
0.75 gal/surface acre	2 days	0	1 day	2 days	5 days
0.50 gal/surface acre	1 day	0	1 day	1 day	5 days
Spot Spray* (< 0.5 gal/surface acre)	1 day	0	1 day	1 day	5 days

*Rates refer to total surface area.
 **For preparing agricultural sprays for food crops, turf or ornamentals (to prevent phytotoxicity). When the contents of more than one spray tank is necessary to complete a single aquatic application, no water holding restrictions apply between the consecutive spray tanks.
 No applications are to be made in areas where commercial processing of fish, resulting in the production of fish protein concentrate or fish meal, is practiced. Before application, coordination and approval of local and/or State authorities must be obtained.
 Apply REWARD Landscape and Aquatic Herbicide in accordance with the following table:

WEED SPECIES	SUBSURFACE OR BOTTOM PLACEMENT GALS/SURFACE ACRE*	SURFACE GALS/SURFACE ACRE*
Bladderwort (<i>Utricularia</i> spp.)	1-2	2
Coontail (<i>Ceratophyllum demersum</i>)	2	2
Elodea (<i>Elodea</i> spp.)	2	2
Naiad (<i>Najas</i> spp.)	1-2	2
Pondweeds* (<i>Potamogeton</i> spp.)	2	2
Watermilfoil (<i>Myriophyllum</i> spp.)	1-2	2
Hydrilla (<i>Hydrilla verticillata</i>)	2	0.5-0.75
Waterlettuce* (<i>Pistia Stratiotes</i>)	NA	0.5-0.75
Waterhyacinth* (<i>Eichhornia crassipes</i>)	NA	0.5-0.75
Pennywort* (<i>Hydrocotyle</i> spp.)	NA	0.5-0.75
Frog's Bit* (<i>Limnobium spongia</i>)	NA	0.5-0.75
Salvinia* (<i>Salvinia</i> spp.)	NA	1
Duckweed* (<i>Lemna</i> spp.)	NA	1-2
Cattails* (<i>Typha</i> spp.)	NA	2
Algae* (<i>Spirogyra</i> spp. & <i>Pithophora</i> spp.)	1-2	2

*For water less than or equal to 2 feet in average depth use a maximum of 1 gallon REWARD Landscape and Aquatic Herbicide per surface area.

REWARD Landscape and Aquatic Herbicide controls *Potamogeton* species except Richardson's pondweed (*P. richardsonii*). For control of *P. richardsonii*, applications must be made when the plants are in the early stages of growth such as in Spring and early Summer.

For salvinia, waterlettuce and water hyacinth, use the labeled rate of REWARD Landscape and Aquatic Herbicide in 75 to 200 gallons water plus the labeled rate of a 75% or greater nonionic surfactant per acre for surface sprays and for aerial application for waterlily and water hyacinth control, apply the labeled rate of REWARD Landscape and Aquatic Herbicide in 10 to 24 gallons water plus the labeled rate of a 75% or greater nonionic surfactant per acre.

For Pennywort and cattail control, apply in 50-150 gallons of water plus the labeled rate of a 75% or greater nonionic surfactant per acre for full coverage and thorough contact. Repeat treatments may be necessary to control regrowth. For best results, apply before flowering (cattail).

For duckweed control, apply as an overall spray in 50-150 gallons of water plus the labeled rate of a 75% or greater nonionic surfactant per acre. Retreatment may be necessary for plants missed in previous applications and regrowth.

For suppression of certain filamentous algae species including *Spirogyra* and *Pithophora*, apply according to the submerged use directions.

*Not for use in California.

APPLICATION: In mixed weed populations, use the high rate of application as indicated by weeds present.

SUBSURFACE APPLICATIONS: Where the submerged weed growth, especially Hydrilla, has reached the water surface, apply either in a water carrier or an invert emulsion through boom trailing hoses carrying nozzle tips to apply the dilute spray below the water surface to insure adequate coverage.

BOTTOM PLACEMENT: Where the submerged weeds, especially Hydrilla, Bladderwort, and Coontail growth have reached the water surface or where water is slowly moving through the submerged weed growth that has reached the water surface, especially Hydrilla, Bladderwort, and Coontail control may be enhanced when applied in an invert emulsion carrier injecting diluted REWARD Landscape and Aquatic Herbicide near the bottom with weighted hoses. The addition of a copper-based algaecide will improve control. Where algae are present along with the submerged weeds, pretreatment with copper-based algaecide at recommended rates is advised for best results.

SURFACE APPLICATION: For submerged aquatic weeds, apply REWARD Landscape and Aquatic Herbicide either as concentrate slowly poured directly from the container in strips or as a spray in sufficient carrier. Applications should be made to ensure complete coverage of the weed areas. In mixed weed populations, use the high rate of application as indicated by weeds present.

IF POSTING IS REQUIRED BY YOUR STATE OR TRIBE—CONSULT THE AGENCY RESPONSIBLE FOR PESTICIDE REGULATIONS FOR SPECIFIC DETAILS.

GENERAL RECOMMENDATIONS FOR "POSTING NOTIFICATION"

- **Flowing water:** "post" the restricted area (within 1600 feet downstream of treatment) for the duration of the water use restriction.
- **Standing water:** "post" the restricted area (within 400 feet of treatment) for the duration of the water use restriction.

No "posting" is necessary where water use is greater than 1600 feet downstream of treated water in flowing water bodies or where water use is greater than 400 feet from treated water in standing water bodies.

"Posting" should be removed at the end of the restriction period.

STORAGE AND DISPOSAL

PROHIBITIONS: Do not contaminate water, food or feed by storage, disposal or cleaning of equipment. Open dumping is prohibited.

STORAGE: Keep pesticide in original container. Do not put concentrate or dilute into food or drink containers. Do not contaminate feed, foodstuffs or drinking water. Do not store or transport near feed or food. Store at temperature above 32°F. For help with any spill, leak, fire or exposure involving this material, call CHEMTREC (1-800-424-9300).

PESTICIDE DISPOSAL: Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL: Triple rinse (or equivalent). Do not reuse container. Incinerate, burn, or puncture and dispose of in a sanitary landfill, or dispose of by other procedures allowed by State and local authorities. If burned, stay out of smoke.

CONTAINER IS NOT SAFE FOR FOOD, FEED OR DRINKING WATER!

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ZENECA Professional Products

Wilmington, Delaware 19850-5458

ZENECA Professional Products

TO PREVENT ACCIDENTAL POISONING, NEVER PUT INTO FOOD, DRINK OR OTHER CONTAINERS AND USE STRICTLY IN ACCORDANCE WITH ENTIRE LABEL DO NOT USE THIS PRODUCT FOR REFORMULATION

ACTIVE INGREDIENT:

Diquat cation (6,7-dihydrodipyrido (1,2-a:2',1'-c)

pyrazinonum dibromide) 36.4%

INERT INGREDIENTS 63.6%

TOTAL 100.0%

Contains 2 lbs. diquat cation per gal. as 3.73 lbs. salt per gal.

EPA REG. NO. 10182-404

EPA EST. NO. 10182-AR-1

**KEEP OUT OF REACH OF CHILDREN
WARNING - AVISO**

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED: IMMEDIATELY give water or milk to drink and induce vomiting by inserting finger in throat. Do not induce vomiting or give anything by mouth to an unconscious person. Take person and product container to the nearest hospital or physician as fast as possible. **PROMPT TREATMENT IS ESSENTIAL TO COUNTERACT POISONING** and should be initiated before signs and symptoms of injury appear.

IF ON SKIN: IMMEDIATELY wash with soap and water. See a doctor if diquat contacts a skin cut, abrasion or area of irritation.

IF IN EYES: IMMEDIATELY wash eyes with water for at least 15 minutes and get medical attention.

IF INHALED: IMMEDIATELY get away from spray mist. Stop and check spray procedure. See a doctor if irritation persists.

NOTE TO PHYSICIANS: Call ZENECA Medical Emergency Information Network 1-800-F-A-S-T-M-E-D (327-8633) at any hour to obtain toxicology information and a diquat analysis. To be effective, treatment for diquat poisoning must begin **IMMEDIATELY**. Treatment consists of binding diquat in the gut with suspensions of activated charcoal or bentonite clay, administration of cathartics to enhance elimination, and removal of diquat from the blood by charcoal hemoperfusion or continuous hemodialysis.

FOR 24-HOUR EMERGENCY MEDICAL ASSISTANCE CALL 1-800-F-A-S-T-M-E-D (327-8633) FOR CHEMICAL EMERGENCY. Spill, leak, fire, exposure, or accident call CHEMTREC 1-800-424-9300.

Contents: 2 1/2 gal (9.46 L)

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PRESS TO RESEAL

Pat. 448922