PESTICIDE DISCHARGE MANAGEMENT PLAN (PDMP)

for

Pest Management Area Name:

Portions of the Colorado-Big Thompson Project and the Windy Gap Project owned and/or managed by Northern Water

Prepared by:

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as required for:

Part 5 of COG860000 Colorado Discharge Permit System (CDPS) General Permit for Discharges from the Application of Pesticides to Waters in Colorado

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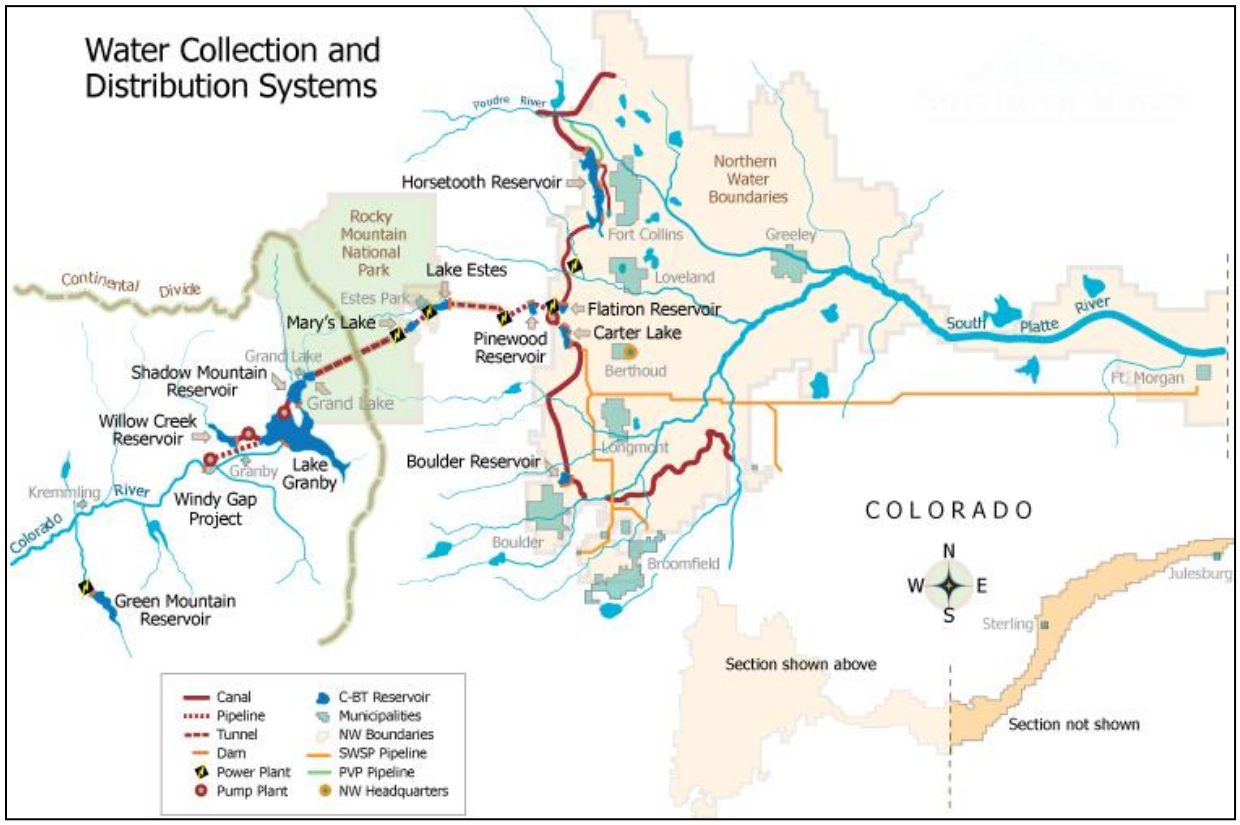
1.0 INTRODUCTION

The Northern Colorado Water Conservancy District (Northern Water), a public agency created in 1937, provides water for agricultural, municipal, domestic and industrial uses to an eight-county service area in Northeastern Colorado with a population of approximately 1 million people. Northern Water and the U.S. Bureau of Reclamation (USBR) operate the Colorado-Big Thompson (C-BT) Project, which collects water on Colorado's West Slope and delivers it to Northeastern Colorado through a 13-mile tunnel beneath Rocky Mountain National Park. Twelve reservoirs, 35 miles of tunnels, 95 miles of canals, and 700 miles of transmission lines comprise the complex collection, distribution and power system (Figure 1.1).

Figure 1.1. Map of the C-BT System



The C-BT Project annually delivers an average of 213,000 acre feet (ac-ft) of water to northeastern Colorado. Deliveries provide a supplemental raw drinking water source to the cities of Fort Collins, Greeley, Loveland, Longmont, Boulder, Louisville, Lafayette, and Broomfield, and many smaller communities, rural and domestic water districts and local industries. Deliveries are also made to approximately 120 ditch, reservoir and irrigation companies serving about 640,000 irrigated acres of farm and ranch land between April and October, the primary growing season.

Northern Water also operates the Windy Gap Project which came online in 1985 to serve municipal and industrial water needs. The Windy Gap Project consists of a diversion dam on the Colorado River below the

confluence with the Fraser River, one reservoir, a pump plant and a six-mile pipeline to Granby Reservoir. C-BT infrastructure is used to move Windy Gap Project water to the East Slope. The Windy Gap Project was designed to annually deliver an average of 48,000 ac-ft of water, primarily between April and July. The Windy Gap Firming Project, expected to be in operation in 2024, is a collaboration between 12 northeastern Colorado water providers to improve the reliability of water supplies from the Windy Gap Project. Chimney Hollow Reservoir will be constructed west of Carter Lake to provide dedicated storage to annually supply a reliable 30,000 ac-ft of water.

The C-BT and Windy Gap Projects are major drinking water supply sources and serve a public with an increased awareness of water quality and environmental issues. From a public health perspective, drinking water providers are concerned with the use of chemical pesticides in and around the canals and reservoirs associated with the projects. Northern Water's Collaborative Compounds of Emerging Concern Monitoring Program has shown trace concentrations of the herbicides 2,4-D, diuron and fluridone in water samples collected from East Slope project components that supply drinking water treatment plants (see Compounds of Emerging Concern Monitoring Program Reports at https://www.northernwater.org/WaterQuality/WaterQuality.aspx). Potential impacts of chemical pesticide applications on aquatic life are also a concern since C-BT and Windy Gap Project waters are released into the Colorado River and six tributaries of the South Platte River (Cache la Poudre River, Big Thompson River, Little Thompson River, Saint Vrain Creek, Lefthand Creek, and Boulder Creek). Additionally, C-BT Project reservoirs, including Granby Reservoir, Horsetooth Reservoir and Carter Lake, are managed as fisheries by Colorado Parks and Wildlife. *Northern Water strives to balance the need to control pests that impact operations with the need to protect human health and the environment.*

Northern Water's Pesticide Discharge Management Plan. Northern Water has prepared this Pesticide Discharge Management Plan (PDMP) to meet the requirements of the Colorado Discharge System (CDPS) General Permit (COG860000) for Discharges from the Application of Pesticides to Waters in Colorado (https://www.colorado.gov/pacific/cdphe/wq-pesticides-permits). This permit is referred to here as the Pesticide General Permit. The permit applies to the discharge of pesticides (biological pesticides, or chemical pesticides that leave a residue) to Waters of the State of Colorado when the pesticide application is for one of the following pesticide use patterns:

a. **Mosquito and Other Flying Insect Pest Control** – to control public health/nuisance and other flying insect pests that develop or are present during a portion of their life cycle in or above standing or flowing water.
b. **Weed and Algae Pest Control** – to control weeds, algae, and pathogens that are pests in water and at water's edge, including ditches and/or canals.
c. **Animal Pest Control** – to control animal pests in water and at water's edge. Animal pests in this use category include fish, lampreys, insects, mollusks, and pathogens.
d. **Forest Canopy Pest Control** – application of a pesticide to a forest canopy to control the population of a pest species (e.g., insect or pathogen) where, to target the pests effectively, a portion of the pesticide unavoidably will be applied over and deposited to water.

Northern Water's pesticide use falls into the "**Weed and Algae Pest Control**" use pattern. This PDMP focuses only on activities, control measures, and actions directly related to this specific use pattern.

Northern Water is directly responsible (as the **"Decision Maker"** and/or as the "**Applicator"**, as defined in the Pesticide General Permit) for weed and algae control associated with 47.8 miles of canals and adjacent canal roads on the East Slope and 5.2 miles of canals and adjacent canal roads on the West Slope (Table 1.1, Figures 1.2 and 1.3). Northern Water is also responsible for maintaining the upstream and downstream faces of the dams and dikes associated with seven reservoirs: Windy Gap, Willow Creek, Granby, Shadow Mountain, Horsetooth, Carter Lake, and Boulder.

The control of terrestrial weeds, aquatic plants, and algae at the facilities listed on Table 1.1 is conducted by Northern Water to meet the goals outlined on Table 1.2, including maintaining canal capacity, avoiding excessive plugging of bar screens, controlling noxious weeds, allowing for unimpeded inspection of dam and dike faces, and maintaining the structural integrity of dams and dikes.

EPA Pesticide General Permit. Pesticide applications to federal facilities in Colorado are covered by the EPA Pesticide General Permit: U.S. EPA NPDES General Permit for Discharges from the Application of Pesticides to, over, or near Waters of the United States (http://www.epa.gov/npdes/pesticide-applications-1). This includes applications by Northern Water to the federally-owned portions of the C-BT Project facilities listed on Table 1.1. The **U.S. Bureau of Reclamation is the "Decision Maker" for the federally-owned** portions of the C-BT system and is, therefore, responsible for meeting the permit requirements of the EPA Pesticide General Permit. This includes the preparation of their own PDMP and submittal of the EPA Annual Report for the federally-owned portions of the C-BT Project facilities listed on Table 1.1.

Colorado Pesticide General Permit. The Colorado Pesticide General Permit applies to pesticide applications at the Northern Water-owned facilities. **Northern Water is the "Decision Maker" for the Northern Water-owned facilities** listed on Table 1.1 and shown on the maps in Attachment A, and is responsible for meeting the permit requirements of the Colorado Pesticide General Permit, including preparation of a PDMP and submittal of Annual Reports to the Colorado Department of Public Health and Environment (CDPHE). Northern Water's PDMP meets the requirements of the Colorado Pesticide General Permit. However, note that this document also includes information for the weed and algae control at the federally-owned parts of the CBT system listed on Table 1.1 since Northern Water is the Applicator for these areas and it is logical to consider all areas together in a more comprehensive PDMP.

Table 1.1. Summary of Northern Water's Pest Management Areas

FACILITY		OWNERSHIP (DECISION-MAKER)	DESCRIPTION OF APPLICATION AREA	PESTICIDE APPLICATOR
EAST SLOPE				
Canals	Windsor Extension Canal	Northern Water	0.5 mile canal along Poudre River	Northern Water
	Charles Hansen Supply Canal	Northern Water	5.4 mile canal (Horsetooth Res to Poudre River) & canal road	Northern Water
	Charles Hansen Feeder Canal	Federal	13.2 mile canal (Flatiron Res to Horsetooth Res) & canal road	Northern Water
	St. Vrain Supply Canal	Northern Water	10 mile canal (Carter Lake Res to St. Vrain Ck) & canal road	Northern Water
	Boulder Feeder Canal	Northern Water	13 mile canal (St. Vrain Ck to Boulder Res) & canal road	Northern Water
	Boulder Creek Supply Canal	Northern Water	2.7 mile canal (Boulder Res to Boulder Ck) & canal road	Northern Water
	Dixon Feeder Canal	Northern Water	3 mile canal (Soldier Canyon Dam to Dixon Res) & canal road	Northern Water
Reservoirs	Horsetooth Reservoir	Federal	Downstream faces of Spring, Dixon, Soldier & Horsetooth dams & Satanka dike & road on dams (60 acres)	Larimer County Weed District (downstream dam faces) & Northern Water (top of dams along guard rails)
	Carter Lake Reservoir	Federal	Downstream faces of Dams 1, 2 & 3 and road on dams (30 acres)	Northern Water
	Boulder Reservoir	City of Boulder	Faces of Dams 1 & 2 and road on dams (10 acres)	No pesticide applications
Other	Pleasant Valley Pipeline Diversion	Northern Water	300 yards of canal, 0.5 acres around structure	Northern Water
WEST SLOPE				
Canals	Willow Creek Pump Canals	Federal	3.4 miles of canals (between Willow Creek Res & Granby Res) & canal road	Northern Water
	Granby Pump Canal	Federal	1.8 mile canal (Granby to Shadow Mtn Res) & canal road	Northern Water
Reservoirs	Windy Gap Reservoir	Northern Water Mun. Subdistrict	Dam faces, toes & top (20 acres)	Northern Water
	Willow Creek Reservoir	Federal	Dam faces, toes & top and downstream gage (5.5 acres)	Northern Water
	Granby Reservoir	Federal	Dikes and dam faces, toes & tops and downstream gage (3 acres)	Northern Water
	Shadow Mountain Reservoir	Federal	Dam face, toes, top & seep flume (3.2 acres)	Northern Water
Other	Farr Pumping Plant	Federal	Yard surfaces (2 acres)	Northern Water
	Fraser Gauging Station	Northern Water	5 acres	Northern Water
	Windy Gap Pipeline Road	Northern Water	129 acres with 2 acres near water	Northern Water

Figure 1.2. Components of Northern Water's East Slope Pest Management Area.

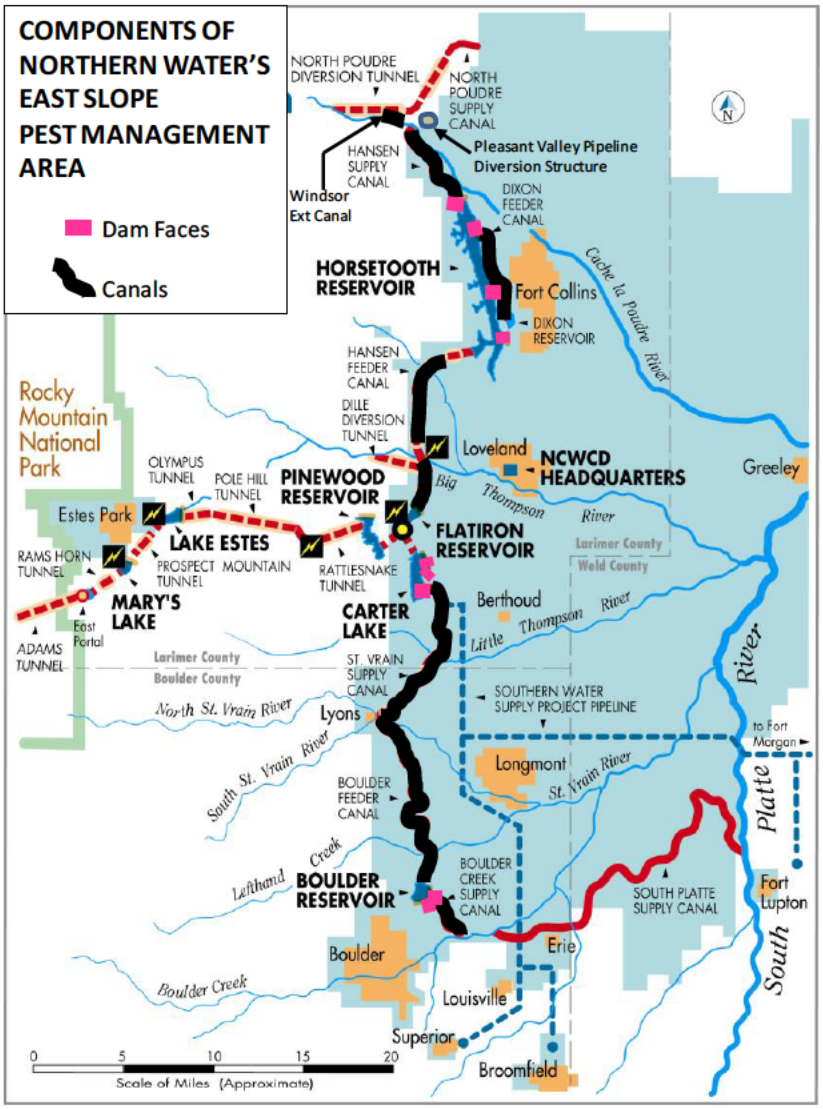


Figure 1.2b. Hansen Supply Canal

Figure 1.2c. Hansen Feeder Canal

Figure 1.2d. Boulder Feeder Canal: attached algae & Sago Pondweed, October 2008

Figure 1.2e. Saint Vrain Supply Canal

Figure 1.3. Components of Northern Water's West Slope Pest Management Area.

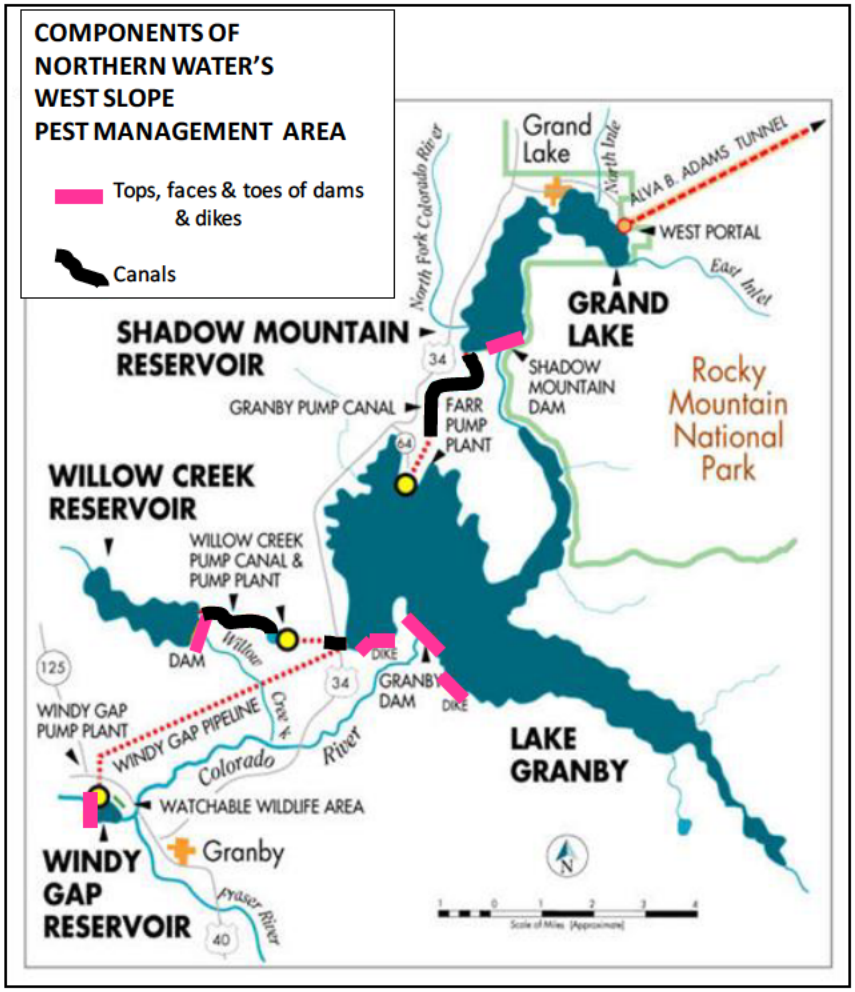


Figure 1.3c. Granby Dam

Figure 1.3d. Granby Pump Canal

Figure 1.3b. Willow Creek Pump Canal

Figure 1.3e. Farr Pump Plant

Table 1.2. Goals of Northern Water's Pest Control Activities.

PEST LOCATION	GOAL OF PEST CONTROL ACTIVITIES
Within Canals	Control aquatic plants, algae & other weeds below high water level to maintain canal capacity and avoid excessive plugging of bar screens and flumes
Roads adjacent to Canals	Eliminate/prevent weed growth on canal roads
Area between canal high water level and edge of canal roads	Control noxious weeds & promote growth of grasses.
Dam/dike Faces	Eliminate/prevent weed/shrub/tree growth to protect structural integrity of dams/dikes and to allow unimpeded inspection of dam/dike faces
Road on Dams (side of road along guard-rail of dam)	Control noxious weeds and woody shrubs.

The Pesticide General Permit contains non-numeric, technology-based effluent limitations (see Part 2.0 of the Colorado Pesticide General Permit at https://www.colorado.gov/pacific/cdphe/wq-pesticides-permits). To meet the effluent limitations, Decision-Makers and Applicators are required to minimize the discharge of pesticides to Waters of the U.S. and Colorado through the use of Pest Management Measures. Six pest management options (including a combination of these options) must be evaluated while developing the Pest Management Measures: No Action, Prevention, Mechanical or physical methods, Cultural Methods, Biological control agents, and Pesticides. These options must be evaluated with respect to impact on water quality, impact to non-target organisms, feasibility, and cost effectiveness. The Pesticide General Permit also requires the following:

- Apply pesticides only when the action threshold has been met, using the lowest effective amount and frequency necessary to control the target pests.
- Perform regular maintenance activities on pesticide mixing tanks and application equipment to prevent leaks, spills, or other unintended discharges.
- Calibrate equipment to prevent unintended discharges.
- Conduct surveillance prior to each pesticide application to assess the treatment area and determine when action thresholds have been met.
- Assess weather conditions (temperature, precipitation, and wind speed) in the treatment area to ensure that pesticide application is consistent with all applicable regulatory requirements.
- Conduct visual monitoring during and after pesticide application to identify possible and observable adverse incidents (including unanticipated death or distress of non-target organisms and disruption of wildlife habitat, recreational use or municipal water use).
- Take corrective actions to assess and correct problems (i.e., an unauthorized discharge, adverse incidents, Pest Management Measures are not adequate to meet applicable water quality standards,

failure to meet technology-based effluent limitations, etc) to ensure that the problems are not repeated in the future.

This PDMP documents how Northern Water will implement the effluent limitations and other requirements of the Colorado Pesticide General Permit. It addresses Northern Water's evaluation and implementation of Pest Management Measures to minimize the discharge of pesticides to waters of the U.S. and State. Northern Water's pesticide discharge management team is identified in Section 2.0 and a description of Northern Water's pest problem and pest management area is presented in Section 3.0. An evaluation of Northern Water's pest management options is contained in Section 4.0. Section 5.0 contains spill response and adverse incident response procedures. Section 6.0 outlines recordkeeping, equipment calibration and maintenance, visual monitoring, annual reporting, and update of the PDMP.

Northern Water has Integrated Pest Management (IPM) Plans for both its East Slope and West Slope facilities (see Attachments B and C). These plans include the goals for weed control; information about noxious weeds and State and County mandated noxious weed control; site-specific control information (including mechanical, cultural, and chemical control methods); and chemicals used and their application rates. Some portions of the Integrated Pest Management Plans have been directly incorporated into this Pesticide Discharge Management Plan.

2.0 PESTICIDE DISCHARGE MANAGEMENT TEAM

The names and contact information of the individuals that comprise Northern Water's Pesticide Discharge Management Team are listed in Table 2.1. Jerry Gibbens, Northern Water Director of Operations, has ultimate responsibility for meeting the effluent limitations of the Colorado Pesticide General Permit and minimizing the discharge of pesticides to Waters of the United States and Waters of the State of Colorado for applications where Northern Water is the "Decision-Maker".

Table 2.1. Northern Water's Pesticide Discharge Management Team.

Name	Position	Contact No.	Manage Pests	Update PDMP	Develop & Implement Corrective Actions	Water Quality Monitoring	Adverse Incident & Spill Response	Prepare & Submit Annual Report to CDPHE
Jerry Gibbens	Director of Operations	(970) 622-2299 (970) 775-3695 jgibbens@northernwater.org	X		X		X	X
Lu Pena	Distribution Systems Dept Manager	(970) 622-2228 (970) 635-3326 lpena@northernwater.org	X		X		X	
Gage Lee	Distribution Systems O&M Fieldman	(970) 481-4363 glee@northernwater.org	X	X	X	X	X	X
Craig Friar	Collection Systems Dept Manager	(970) 627-7332 (970) 685-1710 cfriar@northernwater.org	X	X	X		X	
Isreal Allen	Collection Systems O&M Fieldman	(970) 685-2707 iallen@northernwater.org	X	X	X		X	
Kimberly Mihelich	Source Water Protection Specialist	(970) 622-2211 kmihelich@northernwater.org		X		X	X	X
Curtis Hartenstine	Water Quality Dept Manager	(970) 622-2246 chartenstine@northernwater.org				X	X	
Alan Halley	Field Services Dept Manager	(970) 622-2242 ahalley@northernwater.org				X		
Esther Vincent	Director of Environmental Services	(970) 622-2356 evincent@northernwater.org					X	
Bernie Lodge	Emergency Management Specialist	(970) 622-2216 blodge@northernwater.org					X	

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3.0 PROBLEM IDENTIFICATION

Section 3.0 documents Northern Water's weed and algae pest problems and the action thresholds for Northern Water's pest management area. It also includes maps showing locations of target pests and a subsection (3.4 Water Quality Standards) to document relevant issues related to Tier 3 waters (Outstanding Waters), impaired waters, and drinking water standards.

3.1 PEST PROBLEM DESCRIPTION

Section 3.1 contains information about the pest problems, including target species identification, their locations and extent, the possible factors causing or contributing to the pest problems, and the sources of data used to identify the target pests. The discussion is divided into three subsections: attached algae, aquatic plants, and terrestrial weeds.

3.1.1 TARGET PESTS: ATTACHED ALGAE

Attached algae and aquatic plants in the East Slope canals present an ongoing challenge for Northern Water. The presence of attached algae and aquatic weeds in the canals can significantly impact water transport and impedes the use goals for the water. Note that attached algae and aquatic weeds are generally not an issue in the West Slope canals.

Target Species. Northern Water has conducted a monitoring program since 2008 for attached algae (periphyton) in the Hansen Supply Canal (HSC), Hansen Feeder Canal (HFC), St. Vrain Supply Canal (SVSC), and Boulder Feeder Canal (BFC) since 2008. Periphyton sampling in these canals is conducted by Northern Water Field Services staff one to three times a year, from spring to early fall, depending on conditions in the canals. Algal speciation is conducted through Timberline Aquatics, Inc (Fort Collins, CO). Note that the current sampling method used by Northern Water for collection of attached algae samples does not provide for quantifying algal mass. The samples provide for speciation and for the species to be qualitatively ranked for abundance; each species is assigned an estimate of the percent contribution that it makes to the total sampled algae biomass. The dominant algal species identified in the samples are listed on Figure 3.1 and Table 3.1; the listed species are those species that made up 20% or more of the sample biomass during two or more sampling events.

The canal periphyton sampling conducted since 2008 shows that a range of algal groups and species can be dominant at any given location and time. The data indicate that the diatom *Didymosphenia geminate*, the green algae *Oedogonium rivulare*, and several species of the green algae *Ulothrix* are the most common attached algae in the canals in terms of percent dominance, spatial occurrence, and frequency of occurrence since 2008. Other species that have been dominant at one or more sites during one or more sampling events include the diatoms *Cymbella mexicana* and *Fragilaria sp.,* the green algae *Cladophora glomerata, Rhizoclonium fontanum, Spirogyra sp,* and *Zygnema sp,* and the golden-brown algae *Hydrurus foetidus*.

Cyanobacteria (blue-green algae) species making up more than 20% of the sample biomass have been found during the 2008-2019 sampling period only at the HFC site downstream of Flatiron Reservoir. The cyanobacteria

Phormidium autumnale (more recent taxonomic name is *Microcoleus autumnalis*) has made up significant portions of the total sample biomass at this site during four sampling events (9/2008: 100%; 8/2009: 45%; 10/2009: 35%; 9/2013: 90%), while *Lyngbya martensiana* made up a significant portion of the total sample biomass during one sampling event (8/2018: 100%). *Phormidium autumnale* is a suspected geosmin and cyanotoxin producer. Some species of *Lyngbya* have been identified as geosmin producers, but the literature does not currently indicate *Lyngbya martensiana* as a potential geosmin producer.

Figure 3.1. Locations of attached algae sampling sites & dominant species found at each site for samples collected 2008 – 2019 (not all species found every year).

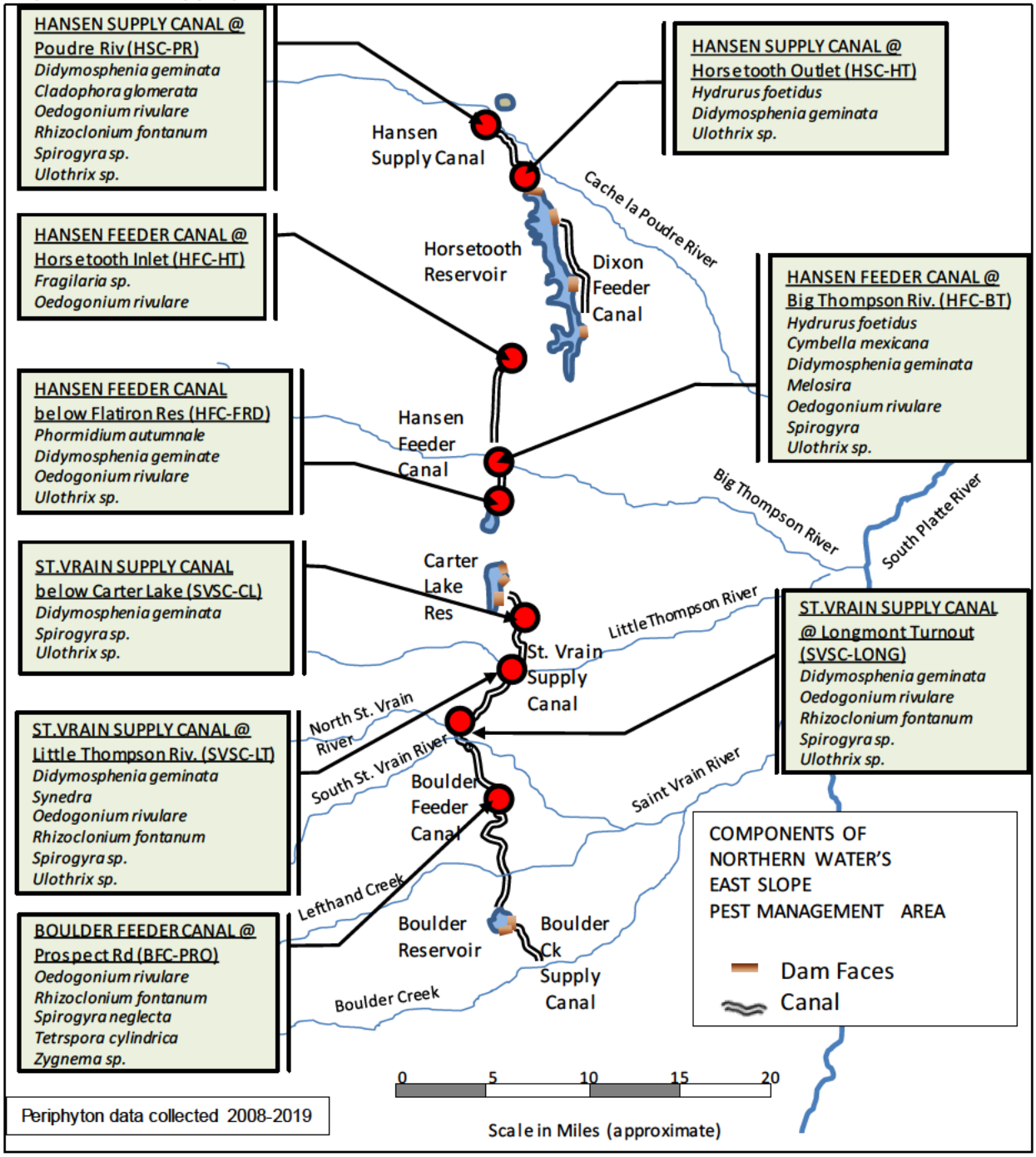
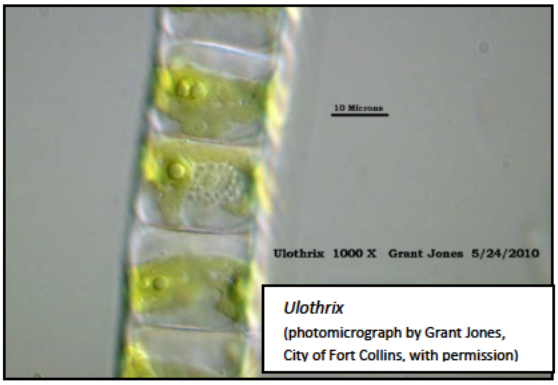


Table 3.1. Summary of common attached algal species identified in canals maintained by Northern Water (2008-2019).

Algal Group	Species	Description
BACILLARIOPHYTA (diatoms)	*Cymbella mexicana*	Forms long stalks
	Didymosphenia geminata	Commonly known as "didymo"
	Fragilaria sp.	
	Melosira	
	Synedra	
CHLOROPHYTA (green algae)	*Cladophora glomerata*	
	Oedogonium rivulare	Common in streams (i.e. cool, clear flowing sites)
	Rhizoclonium fontanum	Can form long strands.
	Spirogyra sp.	
	Tetraspora cyl.	
	Ulothrix sp.	Common in streams (i.e. cool, clear flowing sites)
	Zygnema sp.	
CHRYSOPHYTA (golden-brown algae)	*Hydrurus foetidus*	Brown and feathery
CYANOBACTERIA (blue-green Algae)	*Phormidium autumnale*	Potential geosmin & cyanotoxin producer

Didymosphenia geminata (also referred to as "didymo" or "rock snot") is a diatom that attaches to substrate with a stalk and can form thick mats made up of the stalks. The stalks have a rough (not slimy) texture and look like toilet paper (http://www.invasivespeciesinfo.gov/aquatics/didymo.shtml; https://pubs.usgs.gov/of/2007/1425/report.pdf). It is known to thrive on the stable flow regime and substrate of canals systems. It is considered a nuisance species around the world, with an expanding geographical occurrence. There has been recent concern about the occurrence of high densities of D*idymosphenia geminata* in Front Range streams. The 2008-2019 sampling events have shown the presence of *Didymosphenia geminata* at sites on the Hansen Feeder Canal, Hansen Supply Canal, and the Saint Vrain Supply Canal.



Ulothrix
(photomicrograph by Grant Jones, City of Fort Collins, with permission)

Ulothrix is an unbranched, filamentous green algae. The filaments are made up of a single row of cylindrical cells. They attach to surfaces by a basal holdfast cell or are free-floating. *Ulothrix* thrive in low temperature waters, and when the temperature rises above 10°C, the filaments degrade (see http://fmp.conncoll.edu/Silicasecchidisk/LucidKeys3.5/Keys_v3.5/Carolina35_Key/Media/Html/Ulothrix_Ecology.html). The 2008-2019 sampling events have identified four species of *Ulothrix* at sites on the Hansen Supply Canal, the Hansen Feeder Canal, and the Saint Vrain Supply Canal.

Oedogonium rivulare is an unbranched filamentous green algae. It grows in cold waters and attaches to submerged plants, rocks, and concrete surfaces. Blooms can form when nutrients are readily available. *Oedogonium*, along with *Cladophora* and *Ulothrix*, can significantly clog irrigation canals when growth on the concrete surfaces becomes excessive (see http://fmp.conncoll.edu/Silicasecchidisk/LucidKeys3.5/Keys_v3.5/Carolina35_Key/Media/Html/Oedogonium_Ecology.html). During the 2008-2019 sampling events, *Oedogonium rivulare* was present at sites on the Hansen Supply Canal, the Hansen Feeder Canal, the Saint Vrain Supply Canal, and the Boulder Feeder Canal.

Factors causing or contributing to the problem. Water temperature, sunlight, flow rates, water levels, substrate conditions, and nutrients are all important factors that impact the growth of attached algae in the canals. The presence of nutrients (nitrogen and phosphorus) is a potentially controllable factor that impacts the growth, proliferation and abundance of algae. Northern Water has an ongoing Nutrient Project to identify and assess nutrient–related water quality issues in the West Slope and East Slope C-BT system, and develop feasible options for control. In addition, Northern Water's Baseline Monitoring Program includes collection of nutrient data for the canals, reservoirs, and associated streams. Nutrient concentrations in waters of the C-BT system are generally low. However, the aquatic ecosystems are sensitive to small changes in nutrient inputs which makes it very difficult to predict where and when related problems will occur. Northern Water's water quality monitoring program will continue to collect and assess nutrient data to help provide a better understanding of the cause and effect relationships.

3.1.2 TARGET PESTS: AQUATIC PLANTS (AQUATIC VASCULAR PLANTS AND AQUATIC MOSS)

Similar to the attached algae, the presence of aquatic plants in the canals can significantly impact water transport and impedes the use goals for the water.

Target Species

Northern staff use *Aquatic and Riparian Weeds of the West* (J.M. DiTomaso and E.A. Healy, 2003, published by University of California, Davis) to properly identify aquatic vascular plants. The moss speciation was determined by Timberline Aquatics, Inc (Fort Collins, CO) at the same time that the algae speciation was conducted (Section 3.1.1). The aquatic plants found in the East Slope canals are summarized on Table 3.2 and Figure 3.2. Note that *Fontinalis antipyretica* is a very common moss that is also called willow moss or brook moss.

Table 3.2. Target species of aquatic plants found in the East Slope canals.

CANAL	CANAL DESCRIPTION	TARGET SPECIES OF AQUATIC PLANTS
Dixon Feeder Canal	3 mile canal (Soldier Canyon Dam to Dixon Res)	None
Charles Hansen Supply Canal	5.1 mile canal (Horsetooth Res to Poudre River)	Sago Pondweed (*Stuckenia pectinatus*) True Moss (*Fontinalis antipyretica*)
Charles Hansen Feeder Canal	13.2 mile canal (Flatiron Res to Horsetooth Res)	True Moss (*Fontinalis antipyretica*)
St. Vrain Supply Canal	9.8 mile canal (Carter Lake Res to St. Vrain Ck)	Sago Pondweed (*Stuckenia pectinatus*) Common Elodea (*Elodea Canadensis*) Waterbuttercup (*Ranunculus aquatilis*) Parrotfeather (*Myriophyllum aquaticium*) Cattail (*Typha sp.*) Reed Canarygrass (*Phalaris arundinacea*) True Moss (*Fontinalis antipyretica*)
Boulder Feeder Canal	13 mile canal (St. Vrain Ck to Boulder Res)	Sago Pondweed (*Stuckenia pectinatus*) Common Elodea (*Elodea Canadensis*) Waterbuttercup (*Ranunculus aquatilis*) Parrotfeather (*Myriophyllum aquaticium*) Cattail (*Typha sp.*) Reed Canarygrass (*Phalaris arundinacea*) True Moss (*Fontinalis antipyretica)*
Boulder Creek Supply Canal	2.7 mile canal (Boulder Res to Boulder Ck)	None

Contributing Factors

Water temperature, sunlight, flow rates, water levels, substrate conditions, and nutrients are all important factors that impact the growth of aquatic plants in the canals. The most significant problems with aquatic plants occur within the Boulder Feeder Canal since this canal is entirely earth lined. The sections of the Boulder Feeder Canal that have historically been the most problematic (shown on Figure 3.3) have been those sections downstream of seeps/springs that provide a continuous supply of moisture such that they never dry out, even

after the canal has been dewatered for the winter. However, the aquatic weeds have spread such that they are now a problem throughout most of the canal. Aquatic plants are generally not a problem in the Boulder Creek Supply Canal because of the intermittent nature of the flows in this canal. The Hansen Feeder Canal and Hansen Supply Canal are both concrete-lined which minimizes the ability of most aquatic plants to thrive.

Figure 3.2. Map showing East Slope locations of target pest aquatic plants.

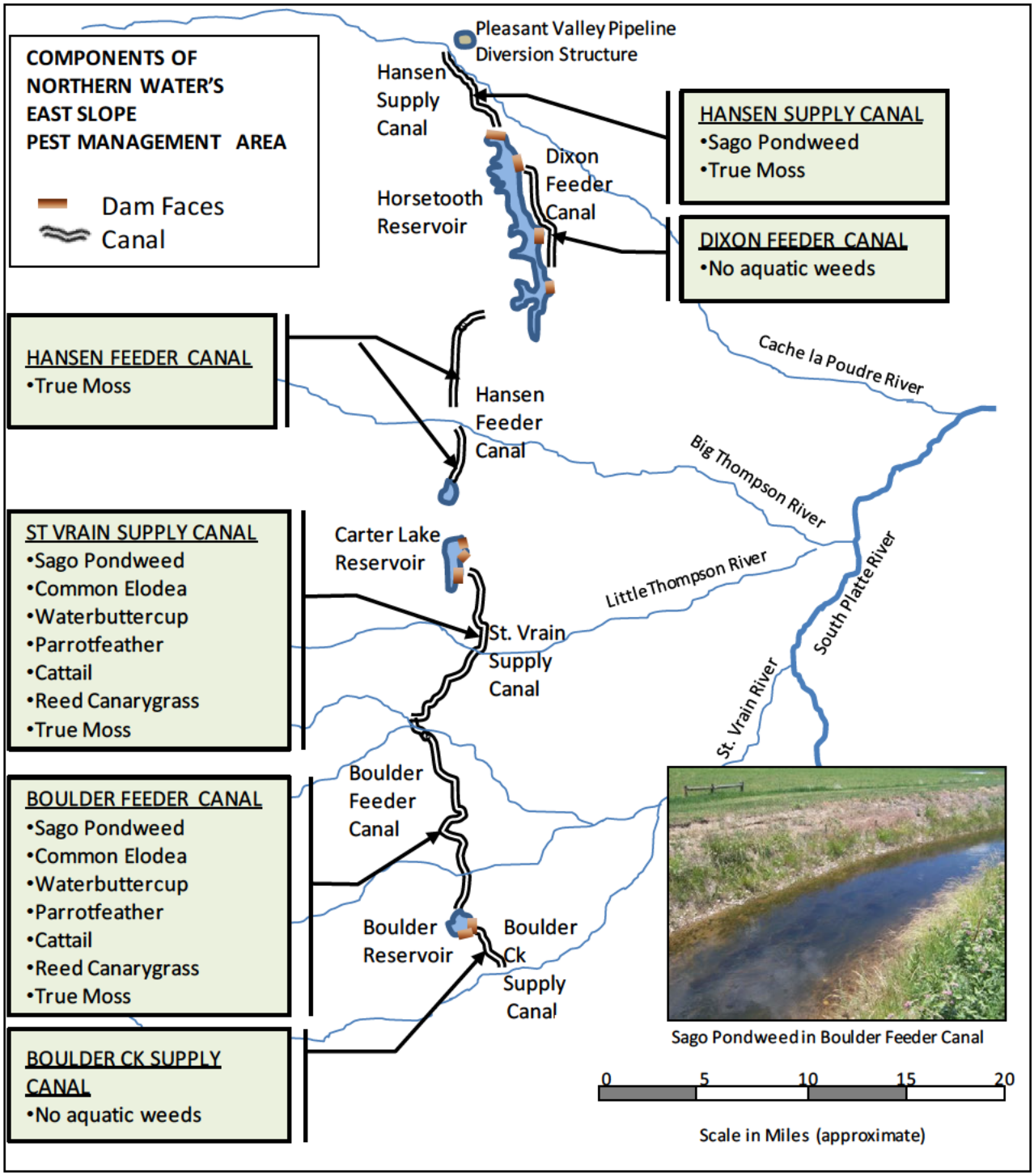
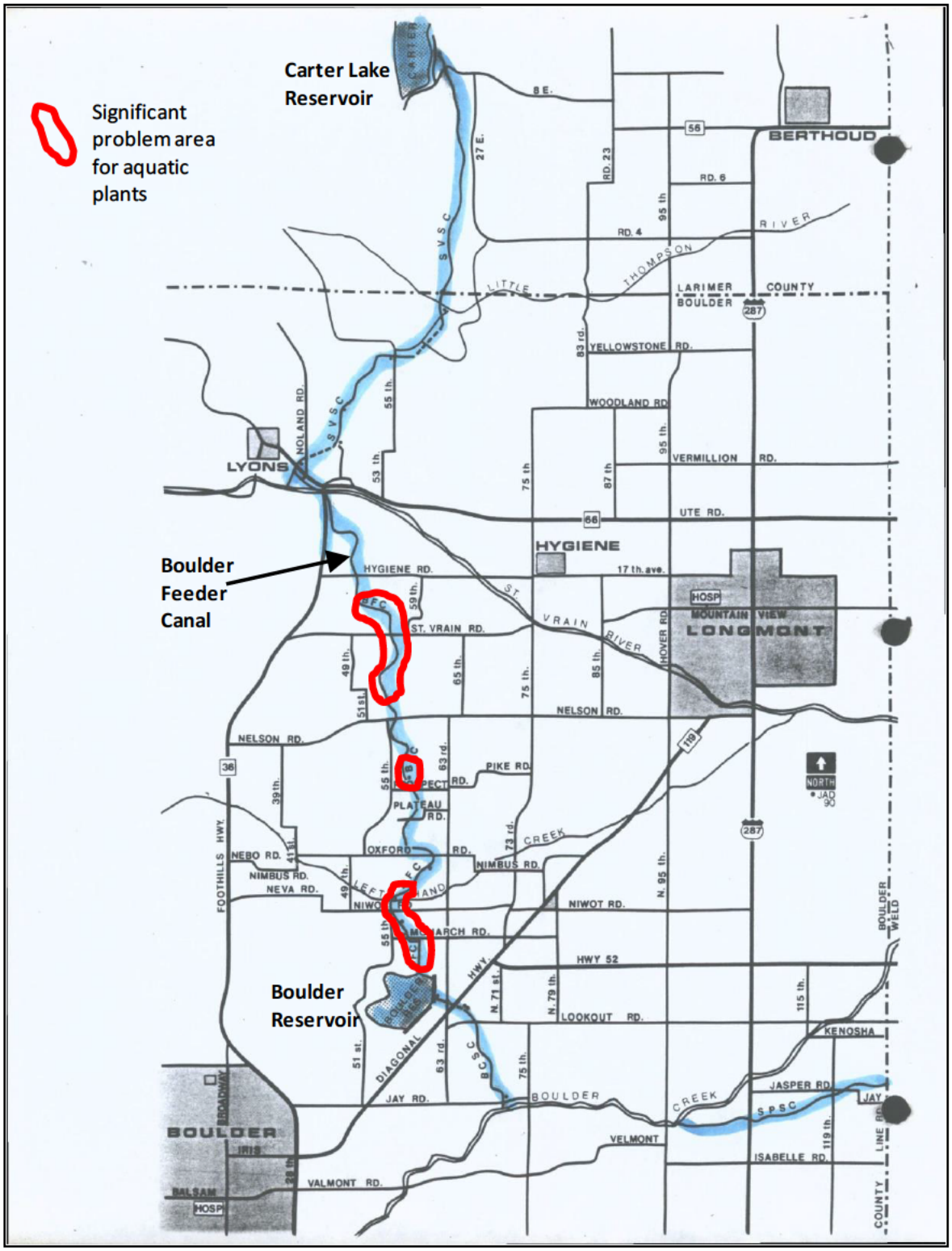


Figure 3.3. Map showing locations of the most significant aquatic plant problems south of Carter Lake.



3.1.3 TARGET PESTS: TERRESTRIAL WEEDS

The presence of terrestrial weeds within Northern Water's pest management area can impact proper operation and maintenance of the C-BT and Windy Gap project components. On the dam and dike faces, broadleaf weeds and woody vegetation must be eliminated or suppressed to protect the structural integrity of the dams and to allow unimpeded inspection of the structures. The canal and dam road beds are kept clear of weeds to protect road function and integrity. Between the roads and the canals, broadleaf weeds are controlled to promote the growth of grass and to eliminate noxious species. All woody vegetation within the inside of the canals is controlled to maintain the function of the canals.

In all areas, many of the targeted weeds are invasive, noxious weeds listed on the Colorado or county noxious weed lists. The Colorado Noxious Weed Act has specific requirements for the eradication or management of these species. Weed species on Colorado's List A are designated by the Colorado Department of Agriculture Commissioner for eradication. List B weed species are species for which the Commissioner develops and implements state noxious weed management plans designed to stop the continued spread of these species. List C weed species are species for which the Commissioner "will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands." Targeted terrestrial weeds in Northern Water's pest management area that occur on one or more noxious weed lists are shown on Table 3.3.

Northern staff identify terrestrial weed species in their pest management area through a number of resources. The book *Weeds of the West* (edited by Tom D. Wilson, published by Wyoming Agricultural Extension, 2001) is a primary source of information. The Colorado noxious weed website (http://www.colorado.gov/cs/Satellite/ag_Conservation/CBON/1251618780047) and County offices are also sources of information about the identification of noxious weeds species as well as eradication requirements.

East Slope Targeted Woody Vegetation. All woody vegetation that is found on the dam faces or within the canals is controlled. The most frequently encountered trees and shrubs on the East Slope dam faces include:

- Choke Cherry (*Padas virginiana* Var. *melandcarpa*)
- Cottonwood (*Populus* ssp.)
- Mountain Mahogany (*Cerocarpus ledifolius*)
- Rabbit Brush (*Chrysothamnus*)
- Russian Olive (*Elaeognus angustifolial*)
- Sage (*Artemisia* spp.)
- Salt cedar (*Tamarix ramosissima* L.)
- Wild Plum (*Prunus Americana*)
- Willow (*Salix* ssp.)

Table 3.3. Target Terrestrial Weeds on Colorado, Grand County, Larimer County, or Boulder County Noxious Weed Lists.

Common Name	Scientific Name	West Slope or East Slope	Colo. Noxious Weed List A	Colo. Noxious Weed List B	Colo. Noxious Weed List C	Larimer County Noxious Weed	Boulder County Noxious Weed	Grand County Noxious Weed
Mediterranean sage	*Salvia aethiopis*	E	X				X	
Orange hawkweed	*Heiracium aurantiacum*	W	X					X
Black henbane	*Hyoscyamus niger*	W		X				X
Bull thistle	*Cirsium vulgare*	E		X		X	X	
Canada thistle	*Cirsium arvense*	W, E		X		X	X	X
Common teasel	*Dipsacus fullonnum*	E		X		X	X	
Dalmatian Toadflax	*Linaria dalmatica*	E		X			X	
Dalmatian Toadflax	*Linaria genistifolia*	E		X		X		
Diffuse knapweed	*Centaurea diffusa*	W, E		X		X	X	X
Hoary cress	*Cardaria draba*	E		X				
Hounds-tongue	*Cynoglossum officinale*	E		X		X	X	
Leafy spurge	*Euphorbia esula*	E		X		X	X	
Musk thistle	*Carduus nutans*	E		X		X	X	
Oxeye daisy	*Chrysanthemum leucanthemem*	W		X				X
Russian knapweed	*Acroptilon repens*	E		X		X	X	
Russian olive	*Elaeagnus angustifolia*	E		X				
Salt cedar	*Tamarix ramosissima*	E		X		X	X	
Scotch thistle	*Onopordum acanthium*	E		X		X	X	
Spotted knapweed	*Centaurea maculosa*	E		X		X	X	
Yellow toadflax	*Linarea vulgaris*	W, E		X		X	X	X
Common burdock	*Arctium minus*	E			X			
Common mullien	*Verbascum thapsus*	W, E			X			
Field bindweed	*Convolvulus arvensis*	W, E			X			
Puncture-vine	*Tribulus terrestris*	E			X			
Sandbur	*Cenchrus L.*	E				X	X	

East Slope Targeted Broadleaf Weeds. The targeted broadleaf weeds in Northern Water's East Slope pest management area are invasive weeds and include most of the species listed on Table 3.3. The goal is to control these weeds and promote the growth of grasses to minimize weed infestations. Areas around Carter Lake and Horsetooth Reservoir have been surveyed for noxious weeds and the locations of these weeds near Northern Water's pest management area (the faces of the dams of the respective reservoirs) are shown on Figures 3.4 and 3.5. Figure 3.6 shows the target weeds that are commonly found along the canals and canal roads. These weeds are generally broadly dispersed throughout the canal areas shown. However, Mediterranean sage (List A species) is generally found in one specific location as shown on Figure 3.7. Yellow starthistle (List A species) was previously found in a location adjacent to the Saint Vrain Supply Canal but has been eliminated.

Figure 3.4. Map of Carter Lake Reservoir showing Northern Water's treatment areas and nearby locations of noxious weeds.

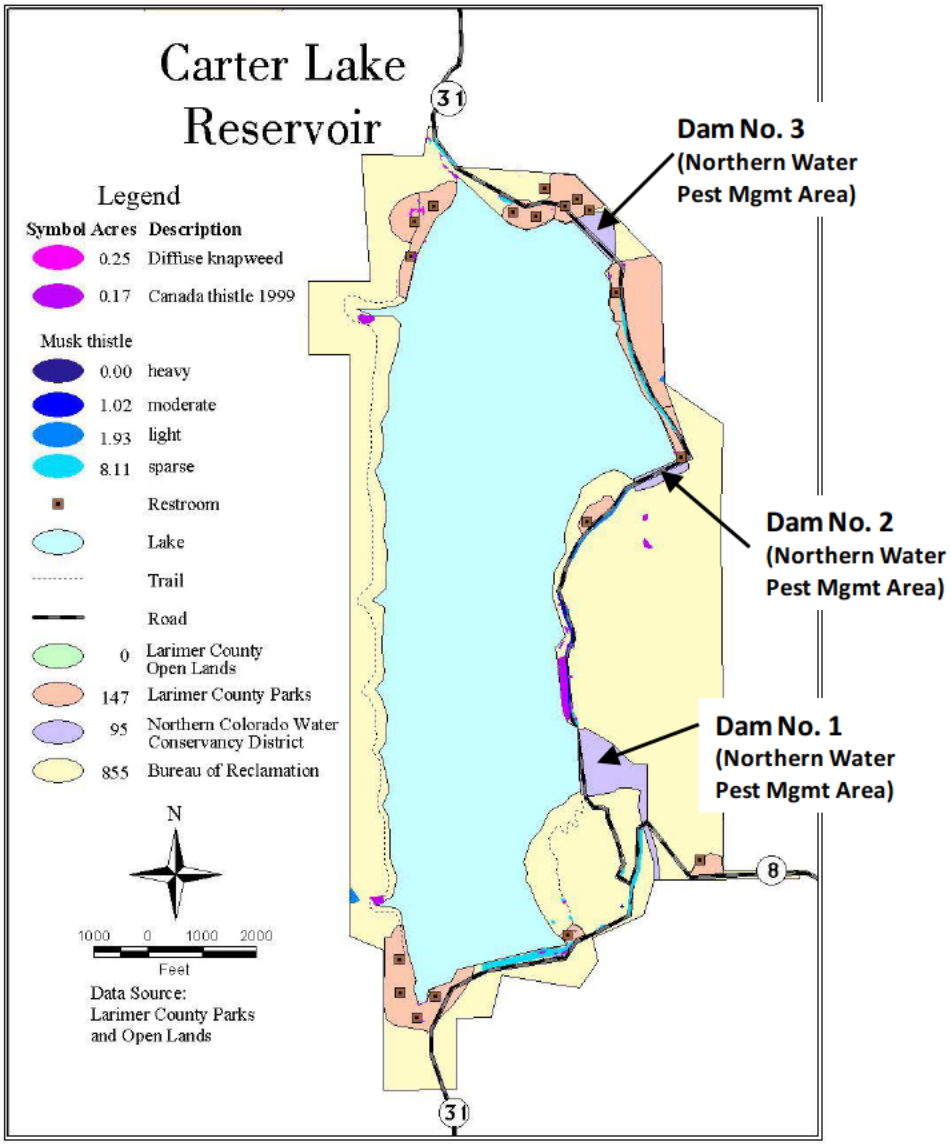


Figure 3.5. Map of Horsetooth Reservoir showing Northern Water's treatment areas and nearby locations of noxious weeds.

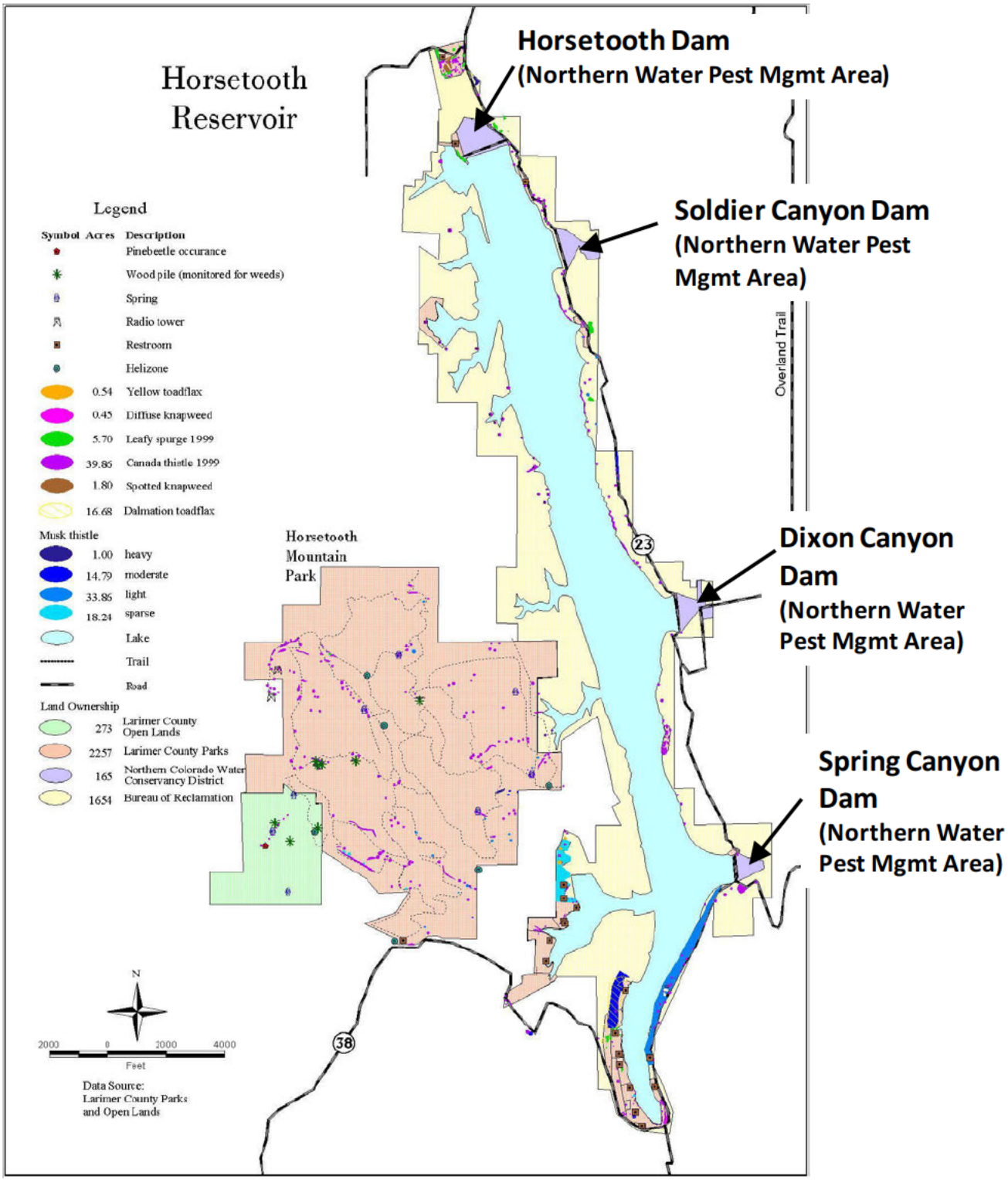


Figure 3.6. Map showing East Slope locations of target terrestrial broadleaf weeds along the canals and canal roads.

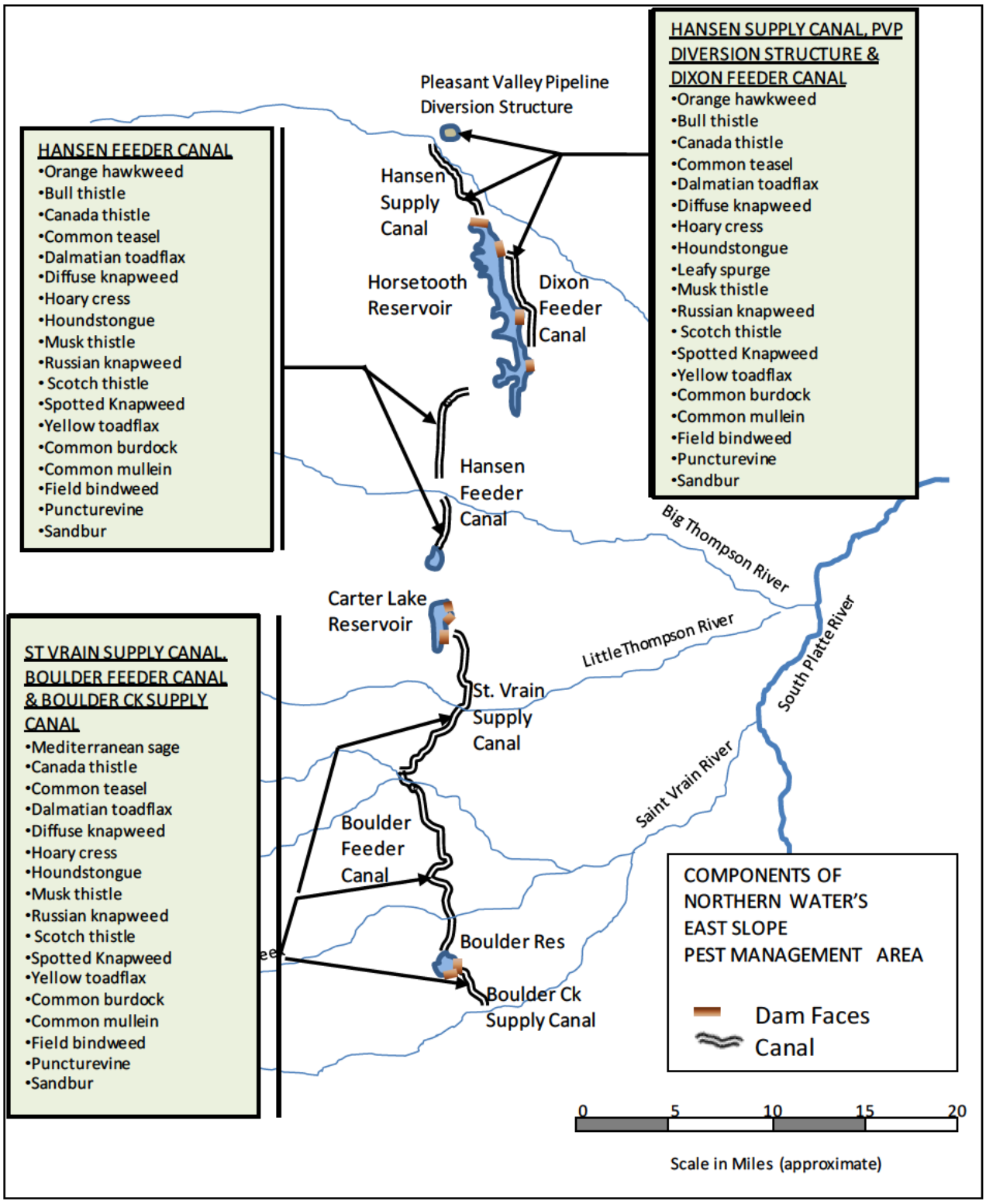
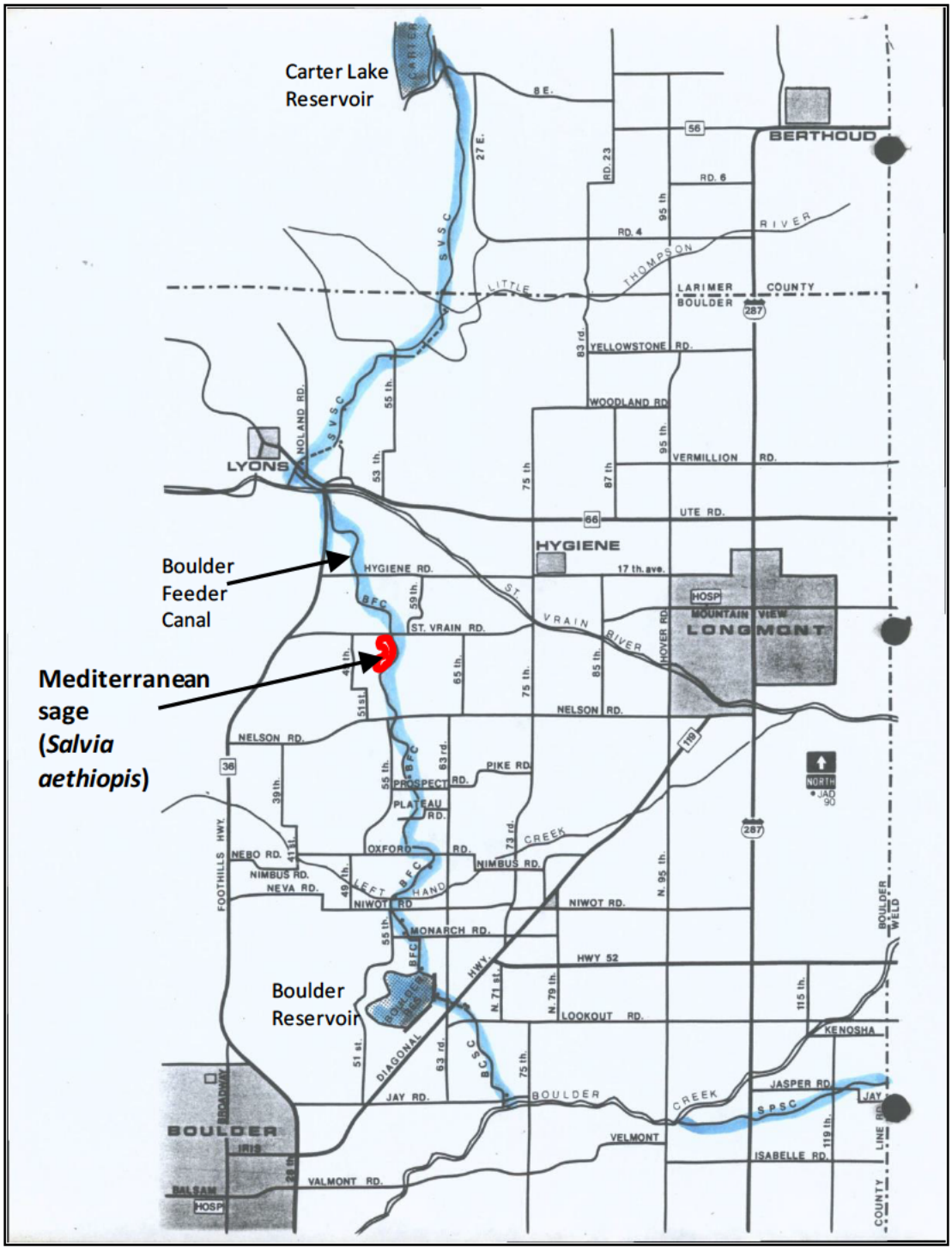


Figure 3.7. Location of Mediterranean sage.



West Slope Target Terrestrial Weeds. The most widespread target terrestrial weed within the West Slope C-BT Project and Windy Gap Project areas is the Canada thistle (*Cirsium arvense*). Other identified target weeds at each West Slope facility in Northern Water's pest management area are listed on Table 3.4. The West Slope target weeds are invasive, non-native plants, with many of the weed species on the Colorado or Grand County Noxious Weed Lists (Table 3.3). These weeds are difficult to control on C-BT and Windy Gap Project areas because there are extensive areas of weeds on adjacent and nearby sites that are beyond Northern Water's control.

Table 3.4. Summary of West Slope Target Pests: Terrestrial Weeds.

FACILITY		TARGET AREAS	TARGET WEEDS
Canals	Willow Creek Pump Canals	3.4 miles of canals and canal road between Willow Creek Res. & Granby Res.	Canada thistle (*Cirsium arvense*) Black henbane (*Hyoscyamus niger*) Field bindweed (*Convolvulus arvensis*) Western sticktight (*Lappula occidentalis*): along road edges Kochia (*Kochia scoparia*): along canal road Russion thistle (*Salsola iberica*): along canal road Pennycress (*Thlaspi arvense*): along canal road
	Granby Pump Canal	1.8 miles canal and canal road between Granby Res. and Shadow Mtn Res.	Canada thistle (*Cirsium arvense*) Black henbane (*Hyoscyamus niger*) Oxeye daisy (*Chrysanthemum leucanthemem*): along canal banks Orange hawkweed (*Heiracium aurantiacum*): along canal banks Western sticktight (*Lappula occidentalis*): along road edges Kochia (*Kochia scoparia*): along canal road Russion thistle (*Salsola iberica*): along canal road Pennycress (*Thlaspi arvense*): along canal road
Reservoirs	Windy Gap Reservoir	Dam faces, toes & top	Canada thistle (*Cirsium arvense*) Black henbane (*Hyoscyamus niger*) Common mullien (*Verbascum thapsus*) Yellow toadflax (*Linarea vulgaris*)
	Willow Creek Reservoir	Dam faces, toes & top and downstream gage	Canada thistle (*Cirsium arvense*) Black henbane (*Hyoscyamus niger*) Diffuse knapweed (*Centaurea diffusa*)
	Granby Reservoir	Dikes and dam faces, toes & tops and downstream gage	Canada thistle (*Cirsium arvense*) Black henbane (*Hyoscyamus niger*) Common mullien (*Verbascum thapsus*): on dikes Diffuse knapweed (*Centaurea diffusa*): crest of Dike #2
	Shadow Mountain Reservoir	Dam face, toes & top and seep flume	Canada thistle (*Cirsium arvense*) Black henbane (*Hyoscyamus niger*) Common mullien (*Verbascum thapsus*): downstream face of dam
Other	Farr Pumping Plant	Lawn & surrounding yard area	Canada thistle (*Cirsium arvense*) Black henbane (*Hyoscyamus niger*) Misc other weeds in sidewalks
	Fraser Gaging Station	2 acres	Canada thistle (*Cirsium arvense*) Black henbane (*Hyoscyamus niger*) Common mullien (*Verbascum thapsus*) Yellow toadflax (*Linarea vulgaris*)
	Windy Gap Pipeline Road	129 acres with 2 acres near water	Canada thistle (*Cirsium arvense*) Black henbane (*Hyoscyamus niger*) Common mullien (*Verbascum thapsus*) Western sticktight (*Lappula occidentalis*) Pennycress (*Thlaspi arvense*)

3.2 ACTION THRESHOLDS

Northern Water has established Action Thresholds for the application of chemical herbicides for the control of algae, aquatic plants, and terrestrial weeds.

Action Thresholds for Algae

Weekly checks are made by Northern Water staff to keep fully apprised of developing issues with attached algae in the flowing canals. As soon as algae growth becomes visible, it is addressed – there is no tolerance for algae growth because algae control is easier to achieve if addressed early in the vegetative growth stage. If control is delayed, the higher vegetative density will require more herbicide. In addition, a large mass of dead and decaying algae can result in the depletion of dissolved oxygen and significant loading of total organic carbon to the reservoirs.

For the herbicides currently used by Northern Water for algae control (see Section 4.1.6), the following Action Thresholds are in place:

- **Algae first becomes visible:** treat with hydrogen peroxide-based products once per week at a dose of 10 ppm (10 mg/L). GreenClean® products are currently used, either in the liquid form that is pumped into the canal or in the dry form using an herbicide blower.

- **Algae filaments greater than 1 inch in length:** apply hydrogen peroxide-based products once per week at a dose of 10 ppm. GreenClean® products are currently used, either in the liquid form or in the dry form using an herbicide blower.

- **Algae filaments greater than 6 inches in length:** GreenClean ® products are still an option at 10 ppm. As a last resort, Teton (endothall-based product) may be applied at a dose of 0.1 ppm over a 24 hours period (or a dose of 0.3 ppm over an 8 hour period, depending on impacts to water treatment plants that will close their intakes). Note, however, that Teton has not been applied to a flowing canal since 2011 and its use in flowing canals is avoided to the extent possible.

The Action Thresholds for algae apply anytime that the canals are flowing (in operation). The Hansen Feeder Canal is generally in operation year-round except for a two-week period in the fall or spring when it is off (dewatered) for routine maintenance. The Hansen Supply Canal, Saint Vrain Supply Canal, and the Boulder Feeder Canal are off (dewatered) during the period of Nov 1 through March 31.

As described in more detail in Section 4.1.6, the application of herbicides for algae control triggers the following actions:

Notification: Any time a herbicide is applied directly to the water, all downstream water treatment plants are notified of the proposed date and herbicide to be used. MSDS and herbicide labels are also

made available upon request. Weekly email notifications are sent out to all stakeholders (including water treatment plants) with all expected herbicide applications for the following two-week period.

If it becomes necessary to apply endothall products (Teton) to flowing canals, downstream water treatment plants will be notified three times prior to application (at 1 week prior, and 1 day prior, day of application). The treatment plants taking water directly from a canal where endothall will be applied will be asked to shut off their intakes; the length of time that the intakes must be off depends on the application period and dose and will be a case by case determination.

- **Operational Doses:** Applied doses of liquid hydrogen peroxide-based products are verified in the field using a Hach Field Kit. Applied doses of Teton to flowing waters will be checked by verifying the pumping rates prior to each application and by collecting water samples at the application point for laboratory determination of endothall concentrations.

- **Water Quality Monitoring:** If Teton is applied to flowing canals, water samples will be collected from the canal at various locations downstream of the application point (including upstream of diversions to drinking water treatment plants) and from downstream reservoirs (or other receiving waters) for laboratory analysis of endothall.

Action Thresholds for Aquatic Plants

Weekly checks are made by Northern Water staff to keep fully apprised of developing issues related to aquatic plants in the flowing canals, particularly in the Boulder Feeder Canal where aquatic weeds are an ongoing problem. For the herbicides currently used by Northern Water for aquatic plant control (see Section 4.1.6), the following Action Thresholds are in place:

- **May through August where Vascular Aquatic Plants are greater than 12 inches:** Consider applying Cascade/Teton (endothall products) if ability of canal to meet demands for water is (or will be) impaired.

- **After August but before canal is off for season:** Do not apply Teton/Cascade for aquatic plant control in flowing waters.

- **After Boulder Feeder Canal is off for season:** The application of herbicides to the Boulder Feeder Canal in the Fall, after it is turned off and dewatered for the season, minimizes the direct introduction of chemicals into flowing waters. Fall applications to aquatic plants have proved to be successful in this canal and will be continued.

As described in more detail in Section 4.1.6, the application of herbicides for aquatic plant control triggers the following actions:

- **Notification:** Any time a herbicide is applied directly to the water, all downstream water treatment plants are notified of the proposed date and herbicide to be used. MSDS and herbicide labels are also

made available upon request. Weekly email notifications are sent out to all stakeholders (including water treatment plants) with all expected herbicide applications for the following two-week period.

Downstream water treatment plants will be notified three times prior to Teton and/or Cascade applications to flowing canals (at 1 week prior, 3 days prior and 1 day prior to application). The treatment plants taking water directly from a canal where Teton and/or Cascade will be applied will be asked to shut off their intakes; the length of time that the intakes must be off depends on the application period and dose and will be a case by case determination.

- **Operational Doses:** Applied doses of Teton and Cascade will be checked by verifying the pumping rates prior to each application and by collecting water samples at the application point for laboratory determination of endothall concentrations.

- **Water Quality Monitoring:** If Teton or Cascade are applied to flowing canals, water samples will be collected from the canal at various locations downstream of the application point (including upstream of diversions to drinking water treatment plants) and from downstream reservoirs (or other receiving waters) for laboratory analysis of endothall.

Action Thresholds for Terrestrial Plants

Many of the terrestrial weeds in Northern Water's Pest Management Area are noxious weeds that must be controlled as mandated by State and local regulations. Because of this, there is "no tolerance" for these weeds. Other terrestrial plants must be controlled to: 1) allow for unimpeded inspection of dam and dike faces, 2) maintain the structural integrity of dams and dikes, and 3) protect road function and integrity. Because these are critical functions, there is a "no tolerance" level associated with the presence of weeds in these locations. Northern Water uses a combination of pest management options to control the target pests. However, because of the nature of the pest vegetation, the use of chemical herbicides is a primary component of Northern Water's pest management strategy.

The Action Thresholds for terrestrial plants are summarized below:

- Noxious broadleaf weeds : No tolerance
- Woody vegetation (trees and brush species): No tolerance on dam faces, on roads on top of dams, or in the canals
- Weeds on canal roads: No tolerance

Weekly email notifications are sent out to all stakeholders (including water treatment plants) with all expected herbicide applications for the following two-week period.

3.3 GEOGRAPHIC BOUNDARIES AND LOCATION MAPS

The geographic boundaries of Northern Water's pest management area were shown on Figures 1.2 and 1.3 in Section 1.0 of this Plan. Attachment A includes more detailed location maps of the herbicide application areas associated with the Northern Water-owned facilities that are covered under the Colorado Pesticide General Permit. Other maps in Section 3.1 show locations of specific target pests. Waters of the U.S. and Colorado that are downstream of Northern Water's pest management area are shown on Figures 1.2 and 1.3 and the maps in Attachment A, and are also listed below on Table 3.5.

Table 3.5. Waters of Colorado and the U.S. that are downstream of Northern Water's Pest Management Area.

Facility		Pesticide Application Area	Downstream Waters of the United States and/or Colorado
EAST SLOPE			
Other	Pleasant Valley Pipeline Diversion	300 yards of canal, 0.5 acres around structure	
Canals	Windsor Extension Canal	0.5 mile canal along Poudre River	Cache la Poudre River
	Charles Hansen Supply Canal	5.1 mile canal (Horsetooth Res to Poudre River) & canal road	Cache la Poudre River
	Charles Hansen Feeder Canal	13.2 mile canal (Flatiron Res to Horsetooth Res) & canal road	Big Thompson River, Horsetooth Reservoir
	St. Vrain Supply Canal	9.8 mile canal (Carter Lake Res to St. Vrain Ck) & canal road	Little Thompson River, Saint Vrain Creek
	Boulder Feeder Canal	13 mile canal (St. Vrain Ck to Boulder Res) & canal road	Lefthand Creek, Boulder Reservoir
	Boulder Creek Supply Canal	2.7 mile canal (Boulder Res to Boulder Ck) & canal road	Boulder Creek
	Dixon Feeder Canal	3 mile canal (Soldier Canyon Dam to Dixon Res) & canal road	Dixon Reservoir
Reservoirs	Horsetooth Reservoir	Downstream faces of Spring, Dixon, Soldier & Horsetooth dams & Santaka dike & road on dams	Horsetooth Reservoir, Cache la Poudre River
	Carter Lake Reservoir	Downstream faces of Dams 1, 2 & 3 and road on dams	Carter Lake, Little Thompson River
	Boulder Reservoir	Faces of Dams 1 & 2 and road on dams	Boulder Reservoir, Boulder Creek
WEST SLOPE			
Canals	Willow Creek Pump Canals	3.4 miles of canals (between Willow Creek Res & Granby Res) & canal road	Granby Reservoir
	Granby Pump Canal	1.8 mile canal (Granby to Shadow Mtn Res) & canal road	Shadow Mountain Reservoir, Grand Lake
Reservoirs	Windy Gap Res	Dam faces, toes & top	Granby Reservoir, Colorado River
	Willow Creek Reservoir	Dam faces, toes & top	Granby Reservoir
	Granby Reservoir	Dikes and dam faces, toes & tops	Colorado River
	Shadow Mountain Reservoir	Dam faces, toes & top	Colorado River, Granby Reservoir, Grand Lake
Other	Farr Pumping Plant	Yard surfaces	Granby Reservoir
	Fraser Gaging Stn	2 acres	Colorado River

3.4 WATER QUALITY STANDARDS & RELATED ISSUES

Outstanding Waters

The Pesticide General Permit does not allow pesticide applications that result in discharges of a pesticide to any water that is designated as Tier 3 (Outstanding National Resource Waters). Colorado uses the term "Outstanding Waters" to designate its Tier 3 or Outstanding National Resource Waters. An "Outstanding Waters" designation has been applied to certain high quality waters in Colorado that constitute an outstanding natural resource. No degradation of Outstanding Waters by regulated activities is allowed. Upper watershed sections (headwaters) of the Colorado River, Cache la Poudre River, Big Thompson River, Saint Vrain Creek, and Boulder Creek have been designated as "Outstanding Waters." However, these sections are all located in wilderness areas or Rocky Mountain National Park and are upstream of Northern Water's Pesticide Management Area.

Water Quality Impaired Waters

The Pesticide General Permit does not allow pesticide applications that result in discharges of a pesticide to water if the water is identified as impaired by a substance that is either an active ingredient in that pesticide or a degradation of the active ingredient. Colorado's most recent Section 303(d) List of Impaired Waters was adopted in Dec 2019, with an effective date of March 1, 2020, by the Water Quality Control Commission. None of the waters located within or directly downstream of Northern Water's Pest Management Area are impaired for any pesticide active ingredient (or active ingredient degradation product) associated with the pesticides that Northern Water currently uses as identified in this PDMP.

Copper Impairments

The 2020 Section 303(d) List of Impaired Waters identifies the following stream segments (or portions of segments) and lakes/reservoirs within the East Slope C-BT system as impaired for copper:

- COSPBT02_C: Big Thompson River and tributaries, from RMNP to Upper Thompson Sanitation District discharge (medium priority)
- COSPBT02_D: Big Thompson River and tributaries from Cedar Creek to Home Supply Canal (high priority)
- COSPBT03_A: Mainstem of the Big Thompson River from Home Supply Canal diversion to the Big Barnes Ditch diversion (medium priority)
- COSPBT16_B: Lake Estes (high priority)
- COSPSV05: Mainstem of Left Hand Creek, including all tributaries and wetlands from Highway 36 to the confluence with St. Vrain Creek (medium priority).

These impairments may be influenced by the prior use of copper sulfate in the C-BT system canals, although other factors may also be in play since Northern Water and the USBR discontinued the use of copper sulfate several years ago. Copper sulfate was historically used in the C-BT canals to control periphyton (attached algae) and aquatic plants, with Northern Water's use dating back to around 1964. Northern Water discontinued its use

in April 2008, while the USBR discontinued its use sometime before June 2012 when the Pole Hill canal was covered over (personal communication between J. Billica, Northern Water, and Tony Curtis, USBR, 5/8/15). Because of the 303(d) listings for copper in downstream stream segments, the use of copper-containing aquatic herbicides in C-BT canals is not allowed under the USBR's EPA NPDES Pesticide General Permit or Northern Water's Colorado Pesticide General Permit.

Some segments that were previously listed for copper on past years of the 303(d) list have since been de-listed as copper concentrations have decreased, likely as a result of the discontinued use of copper sulfate. These de-listed segments include Segment COSPBT09 - Little Thompson River from Culver Ditch Diversion to Big Thompson River, Segment COSPCP10 - Cache la Poudre River from the Munroe Gravity Canal Headgate to Shields Street, Segment COSPCP14 - Horsetooth Reservoir, and Segment COSPSV02b – St. Vrain Ck, RMNP to Hygiene Rd. However, because of the past and current copper impairments, the application of copper-containing products (including copper sulfate for algae control and copper carbonate (Clearigate) for aquatic weed control) is not considered to be a control option by Northern Water at any time in the future within any portion of Northern Water's pest management area.

Drinking Water Standards

The canals and reservoirs associated with Northern Water's pest management area are major drinking water supply sources. From a public health perspective, drinking water providers are concerned with the use of chemical pesticides in and around these canals and reservoirs. Regulatory limits to protect water supplies or treated drinking water have been adopted or are under consideration for the chemicals shown in Table 3.6 which are active ingredients in herbicides currently used by Northern Water. Maximum Contaminant Levels (MCLs) are standards established for treated drinking water under the Safe Drinking Water Act to protect public health.

Table 3.6. Drinking Water Standards associated with active ingredients in herbicides currently used by Northern Water.

Compound	CAS Number	Primary Drinking Water Maximum Contaminant Level (MCL) (mg/L)	Other Regulatory Significance
2,4-D	94-75-7	0.07	--
Endothall	145-73-3	0.10	--
Glyphosate	1071-83-6	0.70	--
Dicamba	1918-00-9	--	Water Supply Standard = 0.21 mg/L
Diuron	330-54-1	--	U.S. EPA's Fourth Contaminant Candidate List (CCL4)

2,4-D. There is a primary drinking water MCL of 0.07 mg/L for 2,4-D. 2,4-D is used by Northern Water for the control of terrestrial noxious weeds and brush species. Microorganisms readily degrade 2,4-D in aquatic environments. The half-life of 2,4-D in aerobic waters is estimated to be about two weeks (http://npic.orst.edu/factsheets/archive/2,4-DTech.html). 2,4-D is the only herbicide that has been consistently

detected as part of Northern Water's Collaborative Compounds of Emerging Concern Monitoring Program over the 2010-2017 period (most recently reported period for the program). Trace levels of 2,4-D have been routinely found in water samples collected from Boulder Reservoir/Boulder Feeder Canal, Horsetooth Reservoir, and Carter Lake. Detected concentrations over the 2010-2017 period (with a detection limit of 5 nanograms/Liter, or 5 ng/L) have ranged from 5 ng/L to 141 ng/L (0.000005 mg/L and 0.000141 mg/L) at Boulder Reservoir, 5.6 ng/L to 20 ng/L at Horsetooth Reservoir, and 7 ng/L to 22 ng/L at Carter Lake. Note that the drinking water MCL of 0.07 mg/L is 3,500 times higher than a trace level concentration of 20 ng/L (0.000020 mg/L). Trace levels of 2,4-D have also been detected in samples collected from the Hansen Feeder Canal, Saint Vrain Supply Canal, and the Upper Big Thompson River. In 2013, Northern Water began using Renovate 3 (active ingredient = triclopyr) for terrestrial weeds within the canal prism as an alternative to the use of 2,4-D based products in order to address concerns expressed by the City of Boulder and other water treatment providers. There are currently no water quality standards for triclopyr.

Endothall. There is a primary drinking water MCL of 0.1 mg/L for endothall. Endothall is the active ingredient in aquatic herbicides that may be introduced directly to the canal waters by Northern Water (Teton and Cascade), so drinking water providers have some concern regarding the use of this chemical. Endothall is rapidly degraded in water with a half-life of 24 to 36 hours at water temperatures of approximately 80° F, and a half-life of 5 to 7 days at water temperatures of approximately 50° F (personal communication with Cody Gray, Ph.D., United Phosphorus, Inc.). Microbial degradation is the primary breakdown mechanism for endothall, and the endothall half-life depends on the microbial population present in a water body. Endothall breakdown products that have been identified include amino acids (glutamic acid, aspartic acid, alanine), organic acids (acetic acid and maleic acid), water, and carbon dioxide (personal communication with Cody Gray, Ph.D., United Phosphorus, Inc , and also http://www.mass.gov/eea/docs/agr/pesticides/aquatic/endothall.pdf). These breakdown products are naturally occurring compounds that do not pose a risk to drinking water.

Glyphosate. There is a primary drinking water MCL of 0.70 mg/L for glyphosate. Glyphosate is the active ingredient in the broad spectrum, post-emergent herbicides Roundup, Rodeo, and Mad Dog that are used by Northern Water for the control of terrestrial broadleaf weeds, grasses, cattails and brush. Glyphosate strongly adsorbs to soils and is readily degraded by soil microorganisms (http://npic.orst.edu/factsheets/archive/glyphotech.html). Glyphosate's loss from water is through sediment adsorption and microbial degradation.

In August 2019, Northern Water's Collaborative Compounds of Emerging Concern Monitoring Program conducted a special sampling at 31 sites for the presence of glyphosate. The sampling sites included Carter Lake, Horsetooth Reservoir, Hansen Feeder Canal, Saint Vrain Supply Canal, and Adams Tunnel, three sites on the Big Thompson River, and raw water inflows to the City of Loveland, City of Boulder, and City of Longmont drinking water treatment plants. Glyphosate was not detected in any of the samples at a detection limit of 0.006 mg/L.

Dicamba. A primary drinking water MCL does not exist for the presence of dicamba in treated water. However, the State of Colorado adopted a water quality standard of 0.21 mg/L for dicamba to protect raw drinking water supplies (see CDPH&E Water Quality Control Commission Regulation No. 31, Basic Standards for Organic

Chemicals Table at https://www.colorado.gov/pacific/cdphe/water-quality-control-commission-regulations). Dicamba is the active ingredient in the herbicides Cruise Control and Vanquish that are used by Northern Water for the post-emergent control of noxious terrestrial weeds. Dicamba is highly mobile in soils and has a relatively short half-life (http://npic.orst.edu/factsheets/dicamba_gen.html#env; https://www.researchgate.net/publication/270893767_Environmental_Fate_and_Toxicology_of_Dicamba). Microbial degradation is the main breakdown process for dicamba. Under aerobic soil conditions, the reported half-life is six days; the half-life increases to over 140 days in anaerobic soils.

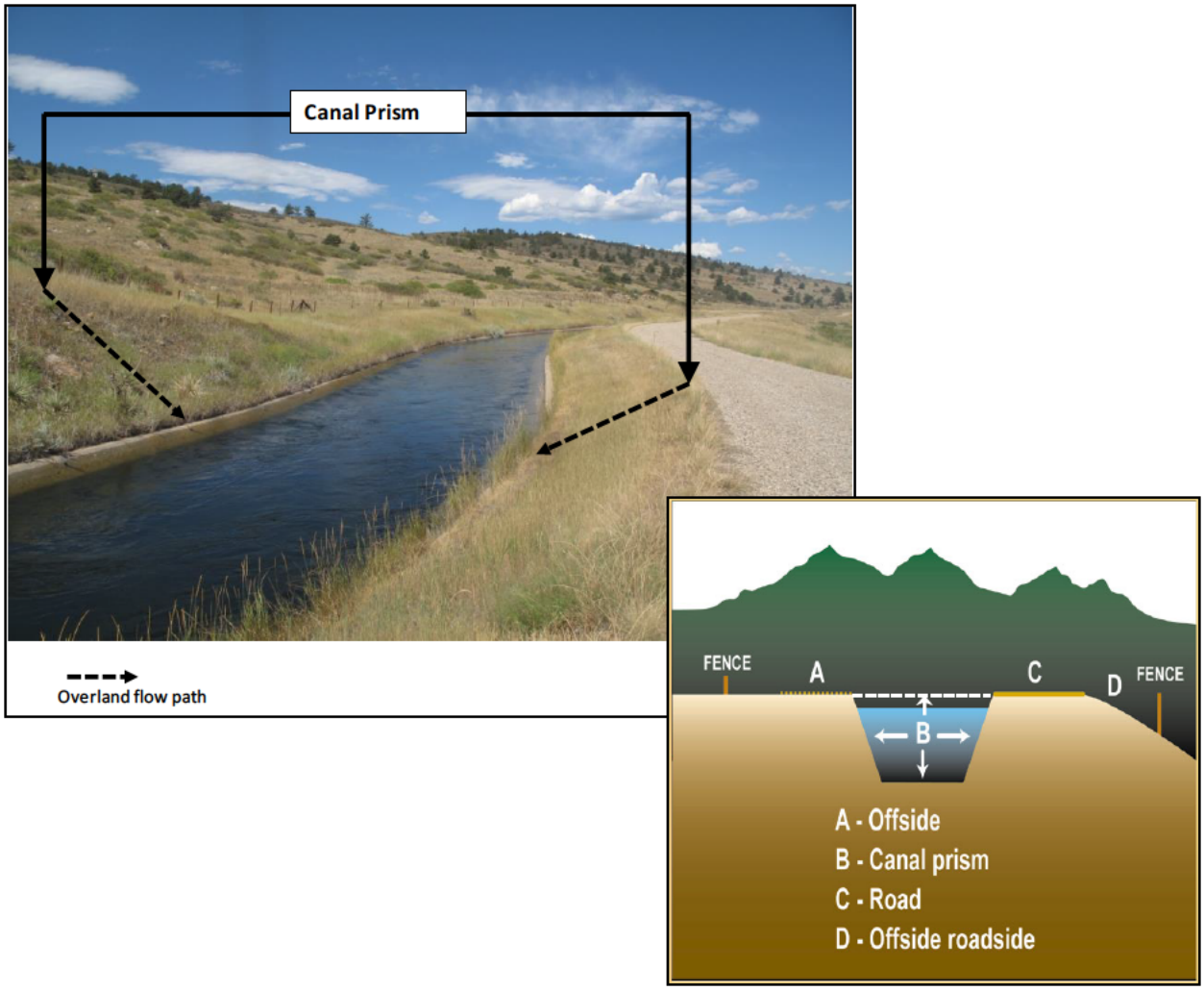
Diuron. Diuron is on the U.S. EPA's Fourth Contaminant Candidate List 4 (CCL4), chemicals that are currently being considered for regulation under the Safe Drinking Water Act based on their potential to occur in public drinking water systems. Chemicals on the CCL are not currently subject to primary drinking water regulations. Diuron is a non-selective herbicide that is used by Northern on the canal road surfaces. Diuron is mobile and persistent in soil environments, and due to its persistence and mobility it is commonly detected in ground water (https://pdfs.semanticscholar.org/671d/752a39d29e0d55288abca0c28e3ba648880f.pdf). Microbial degradation is the primary process by which it is removed from aquatic environments (https://archive.epa.gov/pesticides/reregistration/web/pdf/diuron_red-2.pdf). Water sampling conducted 2010-2017 for Northern Water's Collaborative Compounds of Emerging Concern Monitoring Program showed trace concentrations of diuron (detection limit of 5 ng/L) in 2010 in Horsetooth Reservoir (1-meter depth at Soldier Canyon), with concentrations falling within the narrow range of 5.7 to 6.4 ng/L (0.000006 mg/L). Diuron has also been detected in Boulder Reservoir water during several sampling events during the 2010-2017 period, with trace concentrations ranging from 5.2 to 14.9 ng/L.

4.0 PEST MANAGEMENT OPTIONS EVALUATION

The Pesticide General Permit requires Decision-Makers to document the evaluation of their pest management options, including a combination of pest management options, to control the target pests. Six pest management options must be evaluated: No Action, Prevention, Mechanical or physical methods, Cultural Methods, Biological control agents, and Pesticides. These options must be evaluated with respect to their impact to water quality, impact to non-target organisms, feasibility, cost effectiveness, and any relevant previous Pest Management Measures.

In this section, pest management options within the canal prism are evaluated separately from pest management options outside of the canal prism. The canal prism includes the canal itself and land directly adjacent to the canal that drains into the canal (Figure 4.1).

Figure 4.1. Diagrams showing extent of Canal Prism (Saint Vrain Supply Canal, Aug 2011).



4.1 PEST MANAGEMENT WITHIN THE CANAL PRISM

4.1.1 NO ACTION

The presence of attached algae, aquatic plants and other weeds in the canals can significantly impact water transport and impedes the use goals for the water. These target pests must be controlled to maintain the function of the canals and allow Northern Water to deliver required quantities of water. The No Action option is not an option within Northern Water's pest management area.

4.1.2 PREVENTION

Water temperature, flow rates, water levels, substrate conditions, sunlight, and nutrients are all important factors that impact the growth of attached algae and aquatic plants in the canals. Purposeful management of these factors can reduce the capacity of the canal ecosystem to support nuisance levels of attached algae and aquatic plants. For example, the Hansen Feeder Canal and the Hansen Supply Canal have concrete lining which reduces/eliminates the growth of vascular aquatic plants. Some portions of the earth lined canals are filled with flagstone rip-rap after clay blanket replacement. Flagstone does not support aquatic plant growth, although it is a suitable substrate for attached algae.

The control of nutrient loading to the canals could potentially reduce attached algae and aquatic plant densities within the canals. The aquatic ecosystems in the region are sensitive to small changes in nutrient inputs. However, the nutrient concentrations in the canals are relatively low and the threshold levels of nutrient concentrations that result in nuisance levels of attached algae and aquatic plants are currently unknown. In addition, there is not a complete understanding of non-point sources of nutrients. Locations of nutrient sources, quantification of nutrient loadings, and threshold concentrations that result in nuisance algae and aquatic plant densities are all required in order to implement effective nutrient control measures. Ongoing C-BT Project water quality monitoring conducted by Northern Water is used to assess trends in nutrient concentrations and to assess potential site-specific cause and effect relationships.

4.1.3 MECHANICAL/PHYSICAL METHODS

Mechanical control involves the use of physical methods or mechanical equipment to control pest infestations. For attached algae and aquatic weeds, this could include pressure washing, abrasive scrubbing, weed removal by hand or machine, and dredging.

For the most part, hand pulling of terrestrial and aquatic weeds is not an option because of the large areas involved and the labor-intensive nature of this method.

A tractor mower is used to mow grasses and broadleaf weeds down to the high water line.

A backhoe or dragline is used to remove silt and sand from canal bottoms and disrupt some aquatic plant tubers.

Increased flow velocities in the earthen canals may cause certain attached algae species to detach or be sheared off. It is an option that could be explored for *Ulothrix* or other target attached algae in the earthen canal sections south of Carter Lake.

4.1.4 CULTURAL METHODS

Cultural control involves manipulation of the habitat to make it less suitable for the pest and reduce the development of the pest problems. For example, management decisions to line the canals with concrete lead to a reduction in problems associated with aquatic plants.

Canal draw-down is used during the irrigation off-season to kill aquatic plants/algae by exposing them to drying conditions and freezing temperatures. This also reduces the number of viable tubers in the soil in the earthen canals. However, Sago Pondweed and other aquatic plants can survive up to five months after dewatering so canal draw-down may not produce the expected results with respect to killing aquatic vascular plants (particularly if the winter does not experience intervals of severe cold). In addition, many sections of the Boulder Feeder Canal experience groundwater seepage such that the canal is never fully dewatered over the winter.

Complete canal draw-down of the Hansen Feeder Canal is only conducted for about two weeks every fall for routine maintenance. This generally works well as a method to help control the attached algae in this canal. However, depending on conditions, there may not always be enough time for complete desiccation of the attached algae.

Partial canal draw-down is used in the summer to kill algae by exposing the bands of attached algae to high temperatures and drying conditions. However, the use of canal drawdown in the summer can sometimes be difficult to coordinate with planned or anticipated water deliveries.

4.1.5 BIOLOGICAL CONTROL AGENTS

Biological control involves the use of a specific enemy population to control a pest. Northern Water tested the use of Grass Carp (*Ctenopharyngodon idella*) for aquatic plant control in a one-mile section of the Boulder Feeder Canal in 2008. Fish containment was a problem with a majority of the fish escaping within the first couple of days. With little or no fish left in the test section, effectiveness of the fish is unknown. Grass Carp may be an option to be considered in the future for aquatic weed control in Northern Water canals.

4.1.6 CHEMICAL HERBICIDES

Chemical herbicides are used by Northern Water when the other treatment options together do not keep attached algae and aquatic weeds below the nuisance threshold levels. Chemical herbicides are only applied if and when the action thresholds have been met. Chemical herbicides that Northern Water applies within the East Slope canals are listed on Tables 4.1 and 4.2 and discussed in more detail later in this section. Some of these herbicides are applied when the canals are flowing while others are only applied when the canals have been shut off and dewatered for the season or for maintenance. The West Slope canals are generally not treated for algae and aquatic plants.

Table 4.1. Flowing Canal Treatments: Herbicides and application rates used by Northern Water into flowing canals below the waterline within the East Slope canal prisms.

TRADE NAME	ACTIVE INGREDIENTS	TARGET PLANTS	APPLICATION RATE
GREEN CLEAN PRO	Sodium Carbonate Peroxyhydrate	Attached algae	Applied directly onto algae at 1 to 10 ppm with herbicide blower.
GREEN CLEAN LIQUID	Hydrogen Peroxide & Peroxyacetic Acid	Attached algae	Pumped into canal to achieve 10 ppm for 4 to 6 hrs; approx. 2.75 gallons per cfs = 10 ppm.
CASCADE	Dipotassium salt of Endothall	Vascular aquatic plants	3 to 4 ppm over 8 hours (if required) with peristaltic pump.
TETON	Mono (N,N-dimethylalkylamine) salt of Endothall	Attached algae; Elodea	0.1 ppm (over 24 hours) to 0.3 ppm (over 8 hours); for 0.3 ppm, 0.269 gallons of Teton product per cfs applied over 8 hrs.

Table 4.2. Dry Canal Treatments: Herbicides and application rates used by Northern Water in dewatered and dry canals, OR in the canal prism above the waterline within the East Slope canals.

TRADE NAME	ACTIVE INGREDIENTS	TARGET PLANTS	APPLICATION RATE
CLEARCAST	Imazamox	Vascular aquatic plants	8 oz per acre applied in the canal prism, between canal high water line and the edge of the canal roads, or in dewatered canals
GALLEON	Penoxsulam	Vascular aquatic plants	
KARMEX DF or DIURON 80 DF	Diuron	Non-selective	20-30 lb per acre applied with handgun around turnouts and water measuring devices (flumes) in fall of year to dewatered canals
OASIS	Topramezone	Vascular aquatic plants	
RENOVATE 3	Triclopyr	Terrestrial broadleaf weeds	1% mix applied with handgun once or twice a year where broadleaves are present between canal high water line and the edge of the canal roads; plus 0.25% nonionic surfactant
RODEO	Glyphosate	Cattails, grasses and broadleaf weeds	1% mix applied with handgun up to high water line plus 0.25% nonionic surfactant in dewatered canals
SONAR GENESIS	Fluridone	Vascular aquatic plants, terrestrial broadleaf weeds	Liquid applied with truck mounted sprayer; 1 ½ gallons per acre applied in the canal prism in the dewatered BFC.
SONAR Q	Fluridone	Vascular aquatic plants, terrestrial broadleaf weeds	Pellets applied with herbicide blower; 16 ppb applied in dewatered BFC during the off season
TETON	Mono (N,N-dimethylalkylamine) salt of Endothall	Vascular aquatic plants	Liquid applied with truck mounted sprayer in the dewatered BFC.
VIEWPOINT	Imazapyr; Aminocyclopyrachlor; Metasulfuron methyl	Terrestrial broadleaf weeds	4.3 oz per acre in dewatered canals

Algae and aquatic plant control is generally easier to achieve if herbicides are applied early in the vegetative growth stage to minimize the build-up of nuisance vegetation and to keep the situation under control. If a decision is made to wait for application, the higher vegetative density will require more herbicide. In addition, a large mass of dead and decaying algae and/or aquatic plants could result in significant adverse water quality impacts including the depletion of dissolved oxygen and the loading of total organic carbon to the reservoirs. Northern Water staff conduct weekly surveillance to assess the canals and confirm that the action threshold(s) have been met. Data and information that are used to determine that the action thresholds have been reached and that herbicide application is required include the following:

- Canal flow data: flows are less than expected for the given water level in the canal
- Canal water levels: canal water levels are higher than expected and may be reaching maximum levels with flow rates well below capacity
- Density of plants in the canals
- Length of algae filaments and/or length of aquatic plants
- Plugging of bar screens: bar screens must be cleaned several times a day
- Issues with flow measurement devices: flumes are not providing accurate readings due to the presence of algae
- Water demands: peak of the irrigation season with significant demands expected over the next two to three weeks

4.1.6.1 Copper Sulfate

As discussed in Section 3.4, the use of copper sulfate for algae control was discontinued by Northern Water in 2008. It is not considered to be an option for use any time in the future within any portion of Northern Water's pest management area due to prior and current 303(d) listings for copper impairment in downstream receiving waters. Northern Water had been using copper sulfate to control algae in the canals since around 1964. With the discontinued use of copper sulfate, Northern Water began looking at other potential algaecides in 2007.

4.1.6.2 Algae Control with Hydrogen Peroxide-based Products

Northern Water began using hydrogen peroxide-based products for algae control in 2007. Green Clean PRO (Sodium Carbonate Peroxyhydrate; https://biosafesystems.com/product/greencleanpro/) is the dry, granular product that Northern Water currently uses. Northern Water also currently uses a liquid hydrogen peroxide - based product called Green Clean Liquid (https://biosafesystems.com/product/greenclean-liquid-5/ ; http://www.biconet.com/treatment/infosheets/GreenCleanLiquidSpecimenLabelMSDS.pdf)

The mode of action of hydrogen peroxide-based products is oxidation. Green Clean PRO dissociates in water to form sodium carbonate and the oxidizer hydrogen peroxide (H_2O_2). The hydrogen peroxide in Green Clean PRO and Green Clean Liquid reacts on contact with organic matter (algae, detritus, etc) to form water and oxygen. These products have a low level of toxicity to fish, aquatic invertebrates, and other non-target organisms due to their short residual time as an oxidizer and relatively low application rates. These products have no general

water use restrictions at label rates and do not leave any persistent residue of concern for drinking water providers. For these reasons, hydrogen peroxide-based products are the algaecide of choice for Northern Water. However, Green Clean PRO results in a short-term increase in pH due to the presence of sodium carbonate, which can be an issue for drinking water treatment plants that take water directly off the canal if they do not have adequate warning of planned applications.

Since 2007, Northern Water has tested the use of the dry product over a range of application methods, frequencies, and dosages as part of a significant effort to achieve successful control of the attached algal groups found in the canals. These methods included a Gandy box that metered dry material into the canal. Other methods included applying a mixture of the dry product and water, using either the fixed point application method (using a hose that discharges below the water surface) or a hydro seeder (where the mixture is applied to the canal water surface with a spray nozzle while driving upstream on the canal road). None of these methods achieved a level of algae control that met Northern Water's requirements.

Northern Water began using an application method for the dry product in fall 2013 that has proven to be successful for algae control. The method uses a truck mounted application system (Figure 4.2) that includes a herbicide blower that allows the product to be directly applied onto bands of algae along the canal walls. The system uses a large hopper that can hold up to 500 pounds of dry product. The gravity flow of the product is regulated by a valve below the hopper. The herbicide blower pushes the product out of the PVC pipe and into the canal. Applications are made while traveling upstream to prevent accumulations of the product in the water column. Information supplied by the product manufacturer is used to determine the amount of product to be applied to achieve up to a 10 ppm hydrogen peroxide concentration.

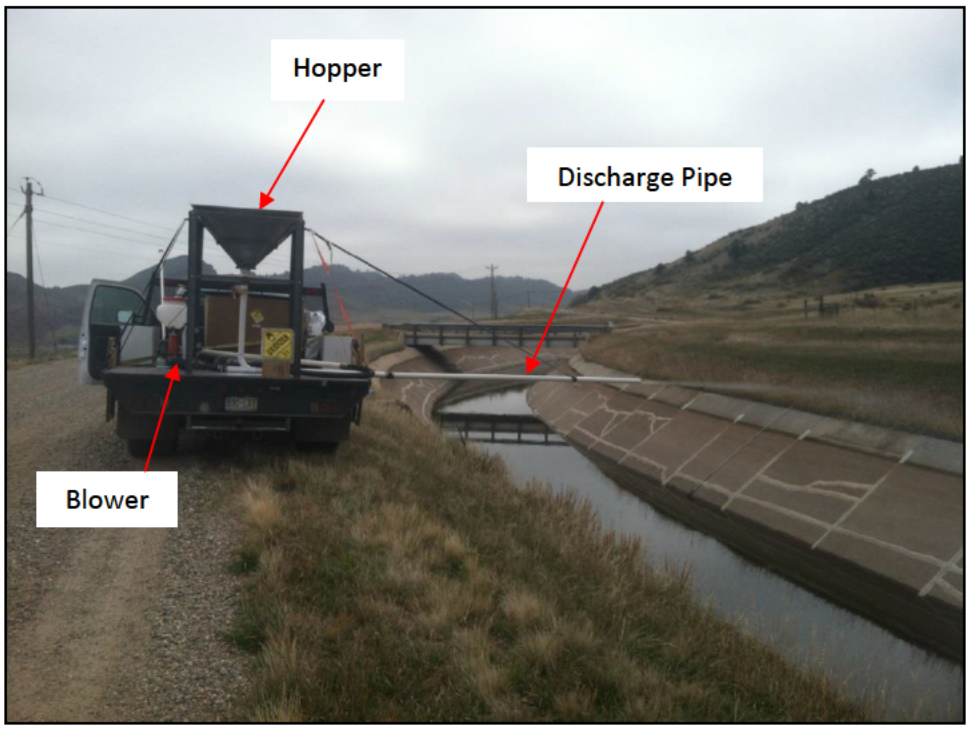


Figure 4.2 Application of dry hydrogen peroxide-based algaecide to HFC 930 section using truck mounted application system.

Northern Water has found that the key to successful control is achieving uniform coverage and applying the dry product pellets directly onto the attached algae. This method works best when taking advantage of a canal drawdown where the product can be directly applied to the exposed bands of attached algae. Northern Water's current preferred method for controlling attached algae in the concrete-lined canals is to use the dry product for conditions of low flows (with requests to the USBR that canal flows be reduced, if possible), and use Green Clean Liquid during times when canal flow cannot be reduced and flow velocities are high.

Northern Water began using the liquid hydrogen peroxide-based product Green Clean Liquid in 2012. Because Green Clean Liquid comes ready-to-apply as a liquid product, the manpower requirements are reduced and it provides for a more uniform, steady control of the applied dose. Green Clean Liquid is applied at between 2 and 3 gallons per cfs, with a targeted dose of 10 ppm that must be maintained for a minimum of 4 hours to be effective on filamentous algae. Northern Water purchased a Hach Hydrogen Peroxide Test Kit (Model HYP-1) to verify the dose in the canals during the applications. Containers of Green Clean Liquid and the diaphragm pump and hose used to apply the product are shown in Figures 4.3 and 4.4. Green Clean Liquid is more effective than the dry product at high canal velocities and water levels, but is more expensive.

Figure 4.3 Green Clean Liquid application equipment.

Figure 4.4 Green Clean Liquid discharge hose.

4.1.6.3 ALGAE & AQUATIC PLANT CONTROL WITH ENDOTHALL IN FLOWING CANALS

If the hydrogen peroxide-based products are not able to control the attached algae in flowing canals and the established action thresholds are met, Northern Water has selected the algaecide Teton (http://www.cdms.net/LDat/ld9JU005.pdf; active ingredient: Mono N,N-dimethylalkylamine salt of Endothall) as the last resort (to be used in flowing canals only if absolutely necessary). Teton can also be applied to flowing waters for the control of some vascular aquatic plants (particularly Common Elodea). Northern Water has selected Cascade (http://www.cdms.net/LDat/ld9JT008.pdf; active ingredient: Dipotassium salt of Endothall) for the control of other vascular aquatic plants (Sago Pondweed, Parrot Feather, and others) in flowing waters. Cascade does not control algae.

Teton and Cascade are contact herbicides and are applied after algae and aquatic plants appear and are actively growing. The product is pumped from a tank (100 to 300-gallon capacity tanks) using a peristaltic pump. Staff may dilute the Teton with water in the tank; the Cascade is fed without dilution. If they are both being used at the same time, Teton and Cascade are fed from separate, adjacent tanks. They are pumped from their tanks and released onto the water surface at a fixed location (Figure 4.5). The feed rate for each tank is verified at the beginning of each application.

Figure 4.5. Application of Teton & Cascade. on the Lower Boulder Canal

Summary of Past Summer (flowing canal) Applications of Teton & Cascade

Northern Water applied a mix of Teton and Cascade to the flowing Boulder Feeder Canal on two occasions in Summer 2011, with doses of 0.3 ppm Teton and 3.0 to 3.5 ppm Cascade applied over 8 hours. This was the first year that Northern Water applied Teton and Cascade in a flowing canal. The Teton and Cascade doses used by Northern Water were based on the dosage ranges on the product labels. For Teton, the label indicates that dosage rates of 0.05 to 0.3 ppm are generally effective for the control of algae. For Cascade, a dose of 3.0 to 5.0 ppm is listed for canals using an 8 hour application period. The doses applied in 2011 addressed the target algae and aquatic weeds. The second application was specifically targeted at a significant growth of Elodea at the south end of the Boulder Feeder Canal. The growth of Elodea was so large that it was difficult to achieve effective control even with the second application.

Since 2011, no applications of Teton or Cascade have been made to flowing canals within Northern Water's Pest Management Areas.

General Plan for use of Endothall Products in Flowing Canals

Northern Water will continue to use the hydrogen peroxide-based products, Green Clean PRO and Green Clean Liquid, as the primary control for attached algae. For *potential* applications of Cascade and Teton to flowing waters, Northern Water will not exceed the application rates specified on the product labels. Northern Water will use Teton doses ranging from 0.1 ppm over 24 hours to 0.3 ppm over 8 hours. Northern Water will also consider the application of maintenance doses of Cascade and Teton (approximately one half the maximum recommended dose) depending on the situation. As Northern Water gains more experience with the use of Teton and Cascade, staff may find that they can achieve desired results with lower doses.

The optimum frequency of Teton and/or Cascade applications is determined based on ongoing surveillance and the action thresholds, as well as the product label instructions for application intervals and growing season totals. After an initial application, repeat applications may only be required in specific locations (targeted spot application). Teton may be applied any time of the year to the Hansen Feeder Canal depending on the presence of significant algae problems (since this canal is used year-round).

Endothall, the active ingredient in both Teton and Cascade, is toxic to fish and wildlife and non-target plants. Fish are very sensitive to endothall. There is a regulated drinking water Maximum Contaminant Level of 0.1 mg/L for endothall so the drinking water providers that treat water from Northern Water canals prefer for Northern Water to significantly limit the use of this product.

Water Quality Sampling for Endothall

When Northern Water applies Teton or Cascade to any of its flowing canals, water quality samples will be collected and submitted for laboratory analysis of endothall. The sampling will be conducted at several locations downstream of the application site in order to:

- Verify applied concentrations
- Determine the canal length that is exposed to the applied endothall dose as a result of a typical 8 hour application period (track passage and concentrations of plume as it moves down the canal)
- Determine endothall concentrations immediately upstream of any diversion that goes directly or indirectly to a drinking water treatment plant (prior to reopening intakes)
- Gain an understanding of endothall transport, fate and persistence in the aqueous environment (i.e., in downstream reservoirs or other receiving waters) at various times (up to two weeks) after application

In addition to the water quality sampling, tracer studies on the canals may be conducted to obtain a better understanding of travel times and the behavior of the endothall plume under various canal flow rates. A more detailed plan for endothall sampling and related tracer studies has been developed and is documented in a separate technical memorandum. Northern Water will notify all potentially impacted downstream domestic water treatment plants of the results of the monitoring and tracer studies.

Notification of Downstream Water Treatment Plants Regarding Endothall Applications

Northern Water will notify all potentially impacted downstream drinking water treatment plants three times prior to each endothall application to flowing canals: 1 week prior, 3 days prior and 1 day prior to application. Table 4. 3 lists the drinking water treatment plants that will be notified depending on the specific application location.

The treatment plants taking water directly from a canal where endothall will be applied will be asked to shut off their intakes. The length of time that the intakes must be off depends on the application period and dose selected by Northern Water, and will be a case by case determination.

Table 4.3. List of Water Treatment Plants to be notified prior to endothall (Teton or Cascade) applications.

Canal	Water Treatment Plant	Contact Name	Phone	Email
Hansen Supply Canal	City of Greeley Bellvue WTP	Andrew Kabot	970-482-2446	andrew.kabot@greeleygov.com
Hansen Feeder Canal	City of Loveland WTP	Tim Bohling	970-667-8742	Tim.Bohling@cityofloveland.org
	Emissaries of Divine Light (Sunrise Ranch)	Ned Koss	970-679-4200	nkoss@emnet.org
	Eden Valley Institute	Darrel Bates	970-231-7739	btsdrrll@hotmail.com
	City of Fort Collins Water Treatment Facility (Horsetooth Res.)	Ken Morrison	970-221-6690	kmorrison@fcgov.com
	Tri-Districts Soldier Canyon Filter Plant (Horsetooth Reservoir)	Chris Harris	970-482-3143	charris@soldiercanyon.com
Saint Vrain Supply Canal	City of Longmont Nelson-Flanders WTP & Wade Gaddis WTP (turnout above Lyons)	Wes Lorwie	303-776-6050	Wes.Lowrie@longmontcolorado.gov
Boulder Feeder Canal	Left Hand Water District (turnout at Left Hand Creek)	Jason Whitmore	303-530-4200	jwhitmore@lefthandwater.org
	City of Boulder – Boulder Reservoir WTP	Mike Emarine	303-598-8668	Emarinem@bouldercolorado.gov

4.1.6.4 HERBICIDE APPLICATIONS TO DEWATERED CANALS

Northern Water has historically applied herbicides after the canals have been dewatered for the season or dewatered for maintenance (outlined previously on Table 4.2). This minimizes the direct introduction of chemicals into flowing water, although there may still be a pesticide residue present on the canal walls and floor when water begins flowing again.

Rodeo, an aquatic glyphosate herbicide, is used for bare ground application on cattails, grasses and broadleaves on the floor and sides of the dewatered canals. Rodeo is applied at the dose listed on the product label. There is a primary drinking water Maximum Contaminant Level of 0.70 mg/L for glyphosate.

Karmex DF is used around the turnouts, headgates, Parshall flumes, and lateral ditches for increasing water capacity. Karmex DF is a non-selective herbicide and kills all plants, which is also helpful in these areas because it allows staff to see the ground conditions and safety risks such as the presence of rattlesnakes. Karmex DF is applied in the fall to allow winter moisture to fix it into the soil. Diuron, the active ingredient of Karmex DF, is on the U.S. EPA's Fourth Contaminant Candidate List (CCL4) currently being considered for regulation under the Safe Drinking Water Act based on its potential to occur in public drinking water systems.

2011 – 2014 Fall Applications of Teton to Aquatic Weeds in Dewatered Boulder Feeder Canal

Northern Water tested a fall treatment of Teton in 2011 to aggressively address the problematic aquatic vascular weeds in the Boulder Feeder Canal, particularly Elodea (Figure 4.6). Fall treatment occurred after the Boulder Feeder Canal was dewatered for the season and after the earthen canal banks had adequately released their stored water. A Teton dose of 5% was applied in November 2011 to specific ponded areas within the canal, upstream of the "Star Ditch Turnout" where there is an overshot gate. The gate was raised to impound any upstream water in the canal and prevent it from flowing into Boulder Reservoir. This method of treatment is approved on the product label and was found by Northern Water to be fairly effective. Successful fall treatments minimize or eliminate the need for aquatic plant treatment when the canal is flowing again during the summer irrigation season. This is the objective of the fall treatment.

Figure 4.6 *Elodea* in BFC before the Fall 2012 Teton treatment.

Teton is a contact herbicide and does its job after it directly contacts the aquatic plant vegetative surfaces, so there is no need for it to persist in the environment to be effective. By the time the canal is put back into service in the spring, the endothall has 5 months to degrade. The degradation rate for the endothall decreases at lower water temperatures, and water samples were collected from the ponded areas on several dates after application to gain a better understanding of the persistence and degradation of endothall in aqueous environments under cold temperature conditions. The laboratory results showed that by November 29 (20 days after the 2011 application), endothall was not detected in any of the samples.

Fall applications of Teton to the Boulder Feeder Canal were repeated in 2012, 2013 and 2014 based on the success of the Fall 2011 application.

2015 to 2020: Herbicide Rotations to Dewatered Boulder Feeder Canal

In Summer 2015, Northern Water began to notice a significant increase in aquatic and terrestrial weeds in the Boulder Feeder Canal (see photos in Figures 4.7 to 4.9). The Fall 2014 application of Teton for aquatic weed control seemed less effective than in previous years. As a result, alternative aquatic herbicides and combinations of herbicides were researched by Northern Water. SePRO Corp. staff worked with Northern Water to recommend a rotation of systemic SePRO herbicides (Sonar Genesis, Sonar Q, Clearcast, Galleon, and Oasis) to more effectively treat the aquatic weeds (http://www.sepro.com/). The mix of herbicides applied since 2015 to the Boulder Feeder Canal after the canal is dewatered are summarized in Table 4.4.

Table 4.4. Rotation schedule for herbicide applications to aquatic weeds in dewatered Boulder Feeder Canal.

	Sonar Genesis or Sonar Q (Fluridone)	Clearcast (Imazamox)	Galleon SC (Penoxsulam)	Oasis (Topramezone)	Teton (Endothall)	Reward (Diquat Dibromide)
Fall 2015	X	X				
Fall 2016	X	X	X		X	
Fall 2017	X	X		X		
Fall 2018	X	X				
Fall 2019	X					
Fall 2020	X	X		X		X

Rotation of a mix of herbicides between years helps to reduce adaptation of weeds to the herbicide. The specific mix of chemicals are applied by Northern Water in the fall to the dewatered canal and allowed to set into the canal sediments over the fall and winter, such that the herbicides are then available to be taken up by the aquatic plants when they start growing again in the spring.

Northern Water met with City of Boulder and Left Hand Water District personnel in Fall 2015 to discuss the aquatic and terrestrial weed problems in the Boulder Feeder canal and the change to a herbicide rotation. Northern Water continues to communicate with the City of Boulder and Left Hand Water District to inform them of the planned Fall applications to the dewatered canal and the composition of the next rotation. In Spring 2020, the City of Boulder and Left Hand Water District began receiving their C-BT and Windy Gap Project water through the new SWSP II Pipeline instead of from the Boulder Feeder Canal, although the Boulder Feeder Canal remains a back-up delivery option for these entities.

Northern Water has added the active ingredients in the SePRO herbicide products (Fluoridone, Penoxsulam, Imazamox, and Topramezone) to their Contaminants of Emerging Concern Monitoring Program. This allows for

an assessment of the persistence of these chemicals (at trace levels) within the canals, including the potential low-level release of these chemicals from the sediments.

Figure 4.7. Aquatic plants in Boulder Feeder Canal prior to Fall 2015 herbicide application to dewatered canal.

Figure 4.8. Aquatic plants in Boulder Feeder Canal prior to Fall 2015 herbicide application to dewatered canal.

Figure 4.9. Aquatic plants and grasses in Boulder Feeder Canal prior to Fall 2015 herbicide application to dewatered canal.

4.1.6.5 Herbicide Applications to Weeds between Canal High Water Level & Edge of Canal Roads

Northern Water has historically used aquatic labeled 2,4-D Amine as the herbicide of choice to control broadleaf weeds between the high-water mark and the canal road edge. There is a primary drinking water Maximum Contaminant Level of 0.07 mg/L for 2,4-D and, because of this, the drinking water providers are concerned with the use of this chemical in and around the flowing canals. Trace levels of 2,4-D have been measured in samples collected from Horsetooth Reservoir, Carter Lake, Boulder Reservoir, Hansen Feeder Canal, Saint Vrain Supply Canal, and the Boulder Feeder Canal, although the specific sources of 2,4-D in each case are unknown.

In 2013, Northern Water tested the aquatic labeled herbicide Renovate 3 to use instead of 2,4-D for broadleaf weed control along the canals (http://www.sepro.com/documents/renovate_label.pdf). The active ingredient in Renovate 3 is triclopyr, which has been shown to degrade relatively quickly in water and soil, and does not have associated water quality standards (for more information see http://npic.orst.edu/factsheets/triclopyrgen.html). Renovate 3 has been used by Northern Water since 2014 along the canals. The Bureau of Reclamation approved the use of Renovate 3 along the Hansen Feeder Canal in 2014.

4.1.6.6 Measures to Prevent or Reduce the Risks to Non-Target Organisms

Northern Water O&M staff calibrate the herbicide application equipment on an annual basis and conduct routine maintenance and daily inspection of the application equipment when in use. They regularly monitor pesticide containers and mixing tanks for leaks. They strictly adhere to the product labels for application rates

and use restrictions. These practices help to prevent or reduce the risks to non-target organisms and minimize the potential for spills, leaks, or other unintended discharges of herbicides to waters of Colorado and the U.S.

4.2 TERRESTRIAL WEEDS OUTSIDE THE CANAL PRISM

Application areas discussed in this section include the canal roads, dam and dike faces, dam roads, and all other areas outside of the canal prism.

4.2.1 NO ACTION

The No Action option is not an option for the Northern Water pest management area. The control of terrestrial weeds is an ongoing process that requires some continuous level of action to ensure that the weed problem remains at a manageable level. In the case of weeds on the State or County noxious weeds lists, their control or eradication may be required by law.

4.2.2 PREVENTION

It is almost impossible to prevent the introduction and growth of the invasive weed species that are prevalent in Northern Colorado. In many cases, there are extensive areas of weeds on adjacent and nearby sites that are beyond Northern Water's control and provide a continual source of seed.

4.2.3 MECHANICAL/PHYSICAL METHODS

Mechanical control involves the use of physical methods or mechanical equipment to control pest infestations. For terrestrial weeds, this could include mowing, tilling, clipping, hand-digging, pulling, or other activities that involve the physical removal of a pest species.

Mowing with a tractor-mounted mower is used along the East Slope canals and rights-of-way to control broadleaves and help the grasses to out-compete the broadleaves. Mowing is started when the grasses are approximately one foot tall.

On the West Slope, mowing has been used to some extent, but its use as a weed control option is limited. Most rights of way are bordered with sagebrush and other woody plants making mowing difficult. Other areas where mowing has been used are adjacent to Windy Gap Reservoir, but the ground there is so uneven and scattered with willow bushes and boggy areas that this strategy has been discontinued. Some hand pulling is used, especially on knapweed and henbane populations when these populations are small and relatively isolated.

Road grading as part of routine road maintenance can be effective for controlling weeds on the road bed.

4.2.4 CULTURAL METHODS

Cultural control involves manipulation of the habitat to make it less suitable for the pest and reduce the development of the pest problems. Cultural control activities include prescribed burning and cultivation of more desirable competitive vegetation to prevent the establishment of, or to replace, a weedy species in an area. Burning is not routinely conducted by Northern Water.

Good brome grass cover such as smooth brome (*Bromus inermis*) is promoted on the downstream sides of the dams and other areas, including ditch banks and right-of-ways.

Areas disturbed during maintenance projects (concrete replacement, clay linings, etc) are reseeded. Reseeding is done with a hydroseeder.

Increasing road base to 3 to 4 inches may help control weeds on canal roads.

4.2.5 BIOLOGICAL CONTROL AGENTS

The introduction of living organisms, such as grazing by domestic livestock, can control populations of a pest species. The City of Boulder uses goats to control weeds around Boulder Reservoir including the dam faces.

4.2.6 CHEMICAL HERBICIDES

Northern Water staff conduct constant surveillance for terrestrial weeds as part of their routine maintenance activities along the canal roads, dams, and other areas outside of the canal prism. Chemical herbicides are applied when the action thresholds are met. For the noxious broadleaf weeds, there is a zero tolerance so herbicide applications begin as soon as these weeds begin emerging in the spring.

EAST SLOPE. The herbicides and rates used on the East Slope outside of the canals are shown on Table 4.5. The rates shown in Table 4.5 are generally the rates reported on the product labels. From year-to-year, the specific chemicals and application rates may change depending on a number of factors, including weed species, densities of weeds, native plants, and climatic and physical factors (soil types, temperature, rainfall). Different pesticides are used rotationally or together for the same target weeds. In the interest of efficiency and to avoid constantly changing the tank mix, selection of the chemical and application rate is generally based on the requirement for controlling the pest species of greatest concern. The frequency of application depends on the effectiveness of the previous application, the findings of ongoing surveillance, and the availability of staff to conduct more than one application at any given location.

Of the herbicides and active ingredients listed on Table 4.5, both 2,4-D and glyphosate have primary drinking water Maximum Contaminant Levels (0.07 mg/L and 0.70 mg/L, respectively) that apply to their concentrations in treated drinking water. Diuron is on the U.S. EPA's Fourth Contaminant Candidate List currently being considered for regulation under the Safe Drinking Water Act based on its potential to occur in public drinking water systems. Colorado adopted an interim water quality standard of 0.21 mg/L for dicamba to protect raw drinking water supplies.

Table 4.5. Herbicides and Rates Used outside of the Canal Prism: EAST SLOPE Applications.

LOCATION	TRADE NAME	ACTIVE INGREDIENT	TARGET PLANTS	APPLICATION RATE	APPLICATION NOTES
Canal Roads	ROUNDUP PRO / RODEO	Glyphosate	Non-selective	1% mix with handgun; up to 7.5 pints/ac broadcast	Applied with handgun, or broadcast with spray boom.
	PLATEAU	Imazapic	Select grasses & broadleaf weeds	5% mix for bare ground control	
	KROVAR 1 DF or BROMACIL/ DIURON 40/40	Diuron/ Bromacil	Non-selective	8- to 12-lb. per acre for longer control; applied in the fall	Applied by broadcast spraying with large orifice spray nozzles.
Offside Roadside & Offside Canals	CORNBELT 2,4-D AMINE, CURTAIL or DMA IVM	2,4-D Amine	Noxious weeds (Canada thistle, Common mullein, Dalmatian toadflax, Leafy spurge)	1% mix for handgun; 1 to 2 qt/acre broadcast (can be used with Vanquish or Confront)	Broadcast spraying or handgun/spot sprayer.
	CONFRONT	Triclopyr & Clopyralid		1 qt/acre (with 1 qt/ac 2,4-D)	Broadcast spraying or handgun/spot sprayer.
	VANQUISH/ CRUISE CONTROL	Dicamba		1% mix handgun; 1 qt/ acre broadcast (with 1 qt/ac 2,4-D)	Broadcast spraying or handgun/spot sprayer.
	CLEARCAST	Imazamox	Aquatic weeds	8 oz per acre	
Guardrails along Dam Road	CORNBELT 2,4-D AMINE, CURTAIL or DMA IVM	2,4-D Amine	Brush species (Rabbit brush) and stumps of freshly cut trees	4 lb/acre for brush.	Applied with a truck-mounted sprayer or hand sprayer.
Down-stream Side of Dam	SPIKE 20P	Tebuthiuron	Willow, Chokecherry, Mtn Mahogany, pine trees, Rabbit brush, Serviceberry	Up to 10 lbs per acre	Applied using a blower or applied by hand.
	RENOVATE 3	Triclopyr	Willow, Chokecherry, Mtn Mahogany, pine trees, Rabbit brush, Serviceberry	1% mix for handgun or 2 qts/acre for broadcast.	Use if near water; Applied with a truck-mounted sprayer or hand sprayer.
	CORNBELT 2,4-D AMINE, CURTAIL or DMA IVM	2,4-D Amine	Brush species (Rabbit brush) and stumps of freshly cut trees; broadleaf weeds.	1% mix handgun or 2 qts/acre for broadcast. Tank mixture of 2,4-D plus Vanquish if away from water.	Applied using truck-mounted sprayer or hand sprayer.
	ROUNDUP PRO or MAD DOG	Glyphosate	Non-selective; Brush species; stumps of freshly cut trees.	50% mix for cut trees and 1% mix for brush species	Applied using truck mounted sprayer or hand sprayer.
	RODEO	Glyphosate	Riparian species (Cattails, willows)	1% mix using handgun; up to 7.5 pints/acre for broadcast spraying.	Applied using truck mounted sprayer or hand sprayer.
Riparian or Upstream Side of Dam	RENOVATE 3	Triclopyr	Noxious weeds (Canada thistle, Common mullein, Dalmatian toadflax, Leafy spurge); Rabbit brush; willow.	1% mix for handgun, or 2 qt/acre for broadcast	Applied with a truck-mounted sprayer or hand sprayer.
	CORNBELT 2,4-D AMINE or DMA IVM 2,4-D AMINE	2,4-D Amine	Noxious weeds (Canada thistle, Common mullein, toadflax, Leafy spurge); Rabbit brush; willow.	1% mix for handgun, or 2 qt/acre for broadcast	Applied with a truck-mounted sprayer or hand sprayer.
	RODEO	Glyphosate	Riparian species (Cattails, willows)	1% mix using a handgun; up to 7.5 pints/ac for broadcast .	Applied with a truck-mounted sprayer or hand sprayer.

Measures to prevent or reduce the risks to non-target organisms

Northern Water O&M staff calibrate the herbicide application equipment on an annual basis, and conduct routine maintenance and daily inspection of the application equipment when in use. O&M staff regularly monitor pesticide containers and mixing tanks for leaks. They strictly adhere to the product labels for application rates and use restrictions. They generally spray first thing in the morning when the winds are calm and the temperatures are cooler. They avoid applying herbicides in areas near homes and gardens to avoid impacting non-target vegetation in these areas. As much as possible, herbicide application is done with the handgun or hand sprayer applicator as spot spraying, i.e., only applying at the location of target weeds in order to avoid over use of chemicals. These practices help to prevent or reduce the risks to non-target organisms and minimize the potential for spills, leaks, or other unintended discharges of herbicides to waters of Colorado and the U.S.

West Slope

The herbicides used on the West Slope are listed in Table 4.6. The tank mixes used by West Slope staff are consistent with the product labels. In order to minimize pesticide application, the weakest recommended tank mixes are used and have proven effective in most cases.

Table 4.6. Herbicides and Rates Used outside of the Canals – WEST SLOPE Applications.

TRADE NAME	ACTIVE INGREDIENTS	WHERE APPLIED	TARGET WEEDS	APPLICATION TANK MIX	APPLICATION NOTES
Amine 4 2,4-D Weed Killer	2,4-D Amine	Canal roads, dam & dike faces, pump plant areas	Broadleaf weeds	2.5 gallons per 300 gal tank;	Usually mixed with other herbicides unless near water; phasing out useage.
Escort	Metsulfuron methyl	Roads & yards	Broadleaf weeds and woody plants	8 ounces per 300 gallon tank;	Always used together with other herbicides; not used around water
Krovar 1 DF	Diuron/Bromacil	Road or yard surfaces where complete elimination is desired; Farr yard areas	Non-selective	10 pounds per 100 gallons;	Applied every other year; applications made when no water is present in canal adjacent to road being treated
Milestone	Aminopyralid	All areas	Broadleaf weeds	20 ounces per 300 gal tank;	can use near water
Rodeo-Glyphos Aquatic	Glyphosate	Road edges, edge of water	Non-selective	2.5 gallons per 300 gal tank;	can use near water
Vanquish	Dicamba	Lawn at Farr, roads & pump plant areas	Broadleaf weeds and brush	3 quarts per 300 gallon tank;	Used with Escort for areas away from water
Surfactant	Alkylphenol ethoxylate, alcohol ethoxylate, and tall oil fatty acid	All areas	N/A	1 quart (or less) per 100 gallons	Used with all tank mixes except Krovar.

The West Slope application strategy involves scouting and identifying target weed populations as soon as snow and mud on roadways allows, usually the beginning of May. Spraying does not start until the middle of June. Earlier applications have been tested but were deemed to be largely a waste of time and chemicals. Sufficient emergence of weed species does not occur until the latter part of June. Once spraying starts, the crew sprays at some location every day, if practical, until September. The weed spraying crew is usually dedicated to this one task for the majority of the summer. The normal agenda is Willow Creek canals, Granby pump canal, Granby dikes and dam, Farr lawn and surroundings, and then all other facilities as scouting and conditions allow. Canals are usually revisited at least once during the summer. Windy Gap Dam areas are sprayed after July when flows recede as most of these areas are reached by crossing the river below the dam. All personnel at Farr keep the spray crew apprised of any weeds sighted during their travels around the project area.

A flat bed, dual rear wheel, four wheel drive truck mounted with a specially designed and manufactured spray rig is used for all West Slope applications except sidewalk spraying at Farr plant. This sprayer was designed and built at Northern Water's East Slope facility in Berthoud. It features a seat with seat belt on both passenger and driver sides, in-cab boom sprayer controls to facilitate solo right of way spraying, and a 300' hose reel with hand gun applicator. The circular type pump pressures the spray system to 90 psi and holds this pressure even when using the boom and hand gun. The sprayer tank is filled at Farr plant with an overhead filler hose made just for this spray rig. It fills the 300 gallon tank in ten to twelve minutes.

Most herbicide application is done with the handgun applicator as spot spraying, i.e., only applying at the location of target weeds in order to avoid over use of chemicals. Economic and environmental concerns are best addressed with this method.

Herbicide applications near water are of great concern to Northern Water and special care is always used when spraying around water. Milestone, Aquatic Rodeo and Aquatic 2-4 D are approved for use near water and for aquatic applications. However, there is a primary drinking water Maximum Contaminant Level of 0.07 mg/L for 2,4-D and 0.70 mg/L for glyphosate and, because of this, drinking water providers are concerned with the use of these chemicals in and around water. Caution is exercised when using these herbicides along streams and ditches with water present. Spraying across water is avoided. When spraying along flowing water, an attempt is made to move opposite the direction of flow to avoid concentration of herbicides. If possible, canal prisms are treated when water is not present and will not be present for a few days.

When using mixes with Escort, water is avoided. All Diuron and Krovar applications are made when no water is present in the canal adjacent to the road being treated.

5.0 RESPONSE PROCEDURES AND CORRECTIVE ACTION

5.1 SPILL PREVENTION MEASURES AND SPILL RESPONSE PROCEDURES

This section describes the spill prevention measures and the spill response procedures related to Northern Water's use of the chemical herbicides identified in Tables 5.1 and 5.2. For general information on spill prevention and response, see http://pesticidestewardship.org/spill/Pages/default.aspx.

The use of herbicides is accompanied by an inherent risk of leaks and spills to the environment. Northern Water activities that pose a potential risk for leaks and spills and unintended discharges to the environment include:

- **Receiving of pesticide deliveries.**
- **Pesticide Storage Areas** at the Berthoud Headquarters and Farr Facility.
- **Transfer** of containers of pesticide concentrate from storage to vehicles and to mixing areas.
- **Loading/Mixing:** Pesticide loading/mixing activities on the West Slope occur at the Farr Facility; on the East Slope, these activities are conducted at the application sites.
- **Transport** of containers of pesticide concentrate or pesticide tank mixes to application sites using Northern Water vehicles.
- **Application:** Failure of pesticide tanks and application equipment (hose failures, leaking tanks, valve failures, pump failures, etc) can occur during herbicide application.
- **Equipment Cleaning** areas at the Berthoud Headquarters and Farr Facility.
- **Disposal** of rinsate and empty containers.

With regard to the spill prevention measures and spill response procedures outlined in this section, Northern Water will:

- Take steps to improve spill prone activities and areas as necessary.
- Ensure that the policies and procedures are adhered to.
- Respond to spills in an appropriate manner consistent with acceptable guidelines.
- Ensure that appropriate personnel are properly trained in spill prevention, emergency response, and containment of spills.
- Budget sufficient funds for spill prevention and response.
- Ensure that sufficient quantities and types of appropriate spill control materials are acquired to contain any spill that can be reasonably anticipated.
- Identify an outside contractor that can assist in the clean-up in the event of a large spill.

Table 5.1. Herbicides used on EAST Slope by Northern Water: Reportable Quantities & Typical Max Quantities taken to Field

(table ordered alphabetically by Active Ingredient name)

Herbicide Manufacturer	Herbicide Trade Name	Active Ingredients and % by weight in product	Active Ingredient CAS Number	EPA Reg. Number	40 CFR 302.4 CERCLA Hazardous Substances Reportable Quantity (pounds active ingredient)	Typical Max Quantity of Product taken to the field for application	Typical Max Amount of Active Ingredient(s) taken to the field
Dow Agro Sciences	DMA IVM	46 3% Dimethlyamine salt of 2,4-D ; 38.4% 2,4-Dichlorophenoxyacetic acid	2008-39-1	62719-3	2,4-D: 100 lbs	100 lbs (10 gal)	38 lbs 2,4-D
Cornbelt	Cornbelt 4lb Amine	46 3% Dimethlyamine salt of 2,4-D ; 38.4% 2,4-Dichlorophenoxyacetic acid	2008-39-1	111773-1A-1	2,4-D: 100 lbs	100 lbs (10 gal)	38 lbs 2,4-D
Dow Agro Sciences	Curtail	39 0 % Triisopropanolamine salt of 2,4- D ; 20 9% 2,4-Dichloraphenoxyacetic acid ; 5.1% Clopyralid Monoethan-olamine salt	2,4-D: 94-75-7 Clopyralid: 57754-85-5	62719-48	2,4-D: 100 lbs	100 lbs (10 gal)	20 lbs 2,4-D
Alligare	Cruise Control	Dicamba (40%)	1918-00-9	42750-40-81927	Dicamba: 1,000 lbs	100 lbs (10 gal)	40 lbs Dicamba
Nufarm	Vanquish	Dicamba (38.5%)	1918-00-9	228-397	Dicamba: 1,000 lbs	104 lbs Vanquish (10 gal)	40 lbs Dicamba
Syngenta	Reward	Diquat Dibromide (37 3%)	85-00-7	100-1091	Diquat: 1,000 lbs	100 lbs (10 gal)	38 lbs Diquat
Dupont	Karmex DF	Diuron (80%)	330-54-1	352-692	Diuron: 100 lbs	200 lbs Karmex DF	160 lbs Diuron
Alligare	Diuron 80 DF	Diuron (80%)	330-54-1	81927-12	Diuron: 100 lbs	200 lbs	160 lbs Diuron
Dupont	Krovar 1 DF	Diuron (40%) Bromacil (40%)	Diuron: 330-54-1 Bromacil: 314-40-9	352-505	Diuron: 100 lbs	200 lbs Krovar 1 DF	80 lbs each Diuron & Bromacil
Alligare	Bromacil/ Diuron 40/40	Diuron (40%) Bromacil (40%)	Diuron-330-54-1 Bromacil-314-40-9	81927-3	Diuron: 100 lbs	200 lbs	80 lbs each Diuron & Bromacil
United Phosphorus Inc.	Teton	Mono (N,N-diethylalklamine) salt of Endothall (53%) or 23 36% Endothall	66330-88-9 mono salt of endothall	70506-175	Endothall: 1,000 lbs	2,175 lbs (250 gal)	508 lbs Endothall
United Phosphorus Inc.	Cascade	Dipotassium salt of Endothall (40 3%) or 28.6% Endothall	2164-07-0 dipotassium endothall salt	70506-176	Endothall: 1,000 lbs	2,675 lbs (250 gal)	765 lbs Endothall
SePRO	Sonar Genesis	Fluridone (6.3%)	59756-60-4	67690-54	N/A	100 lbs (10 gal)	6 lbs Fluridone
SePRO	Sonar Q	Fluridone (5%)	59756-60-4	67690-3	N/A		
Dow Agro Sciences	Rodeo	Glyphosate (53 8%)	38641-94-0	62719-324	N/A	100 lbs (10 gal)	53.8 lbs Glyphosate
Monstanto	Roundup Pro	Glyphosate (41 0%)	38641-94-0	524-475	N/A	100 lbs (10 gal)	40 lbs Glyphosate
Loveland Products Inc.	Mad Dog	Glyphosate (41 0%)	38641-94-0	34704-889	N/A	100 lbs (10 gal)	40 lbs Glyphosate
Bio Safe Systems	GreenClean® Liquid	Hydrogen Dioxide (27.1%) Peroxyacetic acid (2%) Acetic Acid (<5%)	Hydrogen Dioxide 7722-84-1 Peroxyacetic acid 79-21-0 Acetic Acid 64-19-7	70299-12	Acetic acid: 5,000 lbs	6600 lbs (660 gal)	1,789 lbs Hydrogen Dioxide
DuPont	Viewpoint	Imazapyr (31.6%), Aminocyclopyrachlor (22.8%) Metsulfuron methyl (7.3%)	81510-83-0, 858956-08-8, 74223-64-6	352-847	N/A	50 lbs Viewpoint	15.8 lbs Imazapyr 11.4 lbs Amino. 3.7 lbs M. methyl
SePRO	Clearcast	Imazamox, Ammonium salt of (12.1%)	247057-22-3	241-437-67690	N/A	100 lbs (10 gal)	12 lbs free acid
SePRO	Galleon	Penoxsulam (21.7%)	219714-96-2	67690-47	N/A	100 lbs (10 gal)	22 lbs penoxsulam
Bio Safe Systems	GreenClean® PRO	Sodium Carbonate Peroxyhydrate (85%)	15630-89-4	70299-19	N/A	2,000 lbs product	1,700 lbs
Applied Biochemist	Phycomycin	Sodium Carbonate Peroxyhydrate (85%)	15630-89-4	68660-9-8959	N/A	2,000 lbs Phycomycin	1,700 lbs
Dow Agro Sciences	Spike 20 P	Tebuthiuron (20%)	34014-18-1	62719-121	N/A	50 lbs Spike 20 P	10 lbs Tebuthiuron
SePRO	Oasis	Topramenzone (29.7%)	210631-68-8	7969-339-67690	N/A	100 lbs (10 gal)	30 lbs
Dow Agro Sciences	Redeem R&P	Triclopyr, TEA salt (33%) Clopyralid TEA (12.1%)	57213-69-1 119308-91-7	62719-337	N/A	100 lbs (10 gal)	31.3 lbs 11.5 lbs
Sepro	Renovate 3	Triclopyr Triethylamine Salt (44.4 %; Triclopyr = 31.8%)	57213-69-1	62719-37-67690	N/A	50 lbs (5 gal)	16 lbs Triclopyr

Table 5.2. Herbicides used on WEST Slope by Northern Water: Reportable Quantities & Typical Maximum Quantities taken to the Field

(table ordered alphabetically by Active Ingredient name)

Herbicide Manufacturer	Herbicide Trade Name	Active Ingredients and % by weight in product	Active Ingredient CAS Number	EPA Reg. Number	40 CFR 302.4 CERCLA Hazardous Substances Reportable Quantity (pounds active ingredient)	Typical Max Quantity of Product taken to the field for application	Typical Max Amount of Active Ingredient(s) taken to the field
Dow Agro Sciences	DMA IVM	46.3% Dimethlyamine salt of 2,4-D (38.4% 2,4-Dichlorophenoxyacetic acid)	2008-39-1	62719-3	2,4-D: 100 lbs	5 gals x 9 8 lb/gal = 49 lbs DMA IVM	19 lbs 2,4-D
Cornbelt	Cornbelt 4lb Amine	46.3% Dimethlyamine salt of 2,4-D (38.4% 2,4-Dichlorophenoxyacetic acid)	2008-39-1	111773-1A-1	2,4-D: 100 lbs	5 gals x 9 8 lb/gal = 49 lbs Cornbelt 4lb Amine	19 lbs 2,4-D
Dow Agro Sciences	Milestone	Aminopyralid (40.6%)	566191-89-7	62719-519	N/A	2 5 gals x 9.5 lbs/gal = 23 8 lbs Milestone	9.6 lbs Aminopyralid
Nufarm	Vanquish	Dicamba (38 5%)	1918-00-9	228-397	Dicamba: 1,000 lbs	2 5 gals x 10.4 lbs/gal = 26 lbs Vanquish	10 lbs Dicamba
Dupont	Krovar 1 DF	Diuron (40%) Bromacil (40%)	Diuron-330-54-1 Bromacil-314-40-9	352-505	Diuron: 100 lbs	30 lbs Krovar 1 DF	12 lbs each Diuron & Bromacil
Alligare	Bromacil/ Diuron 40/40	Diuron (40%) Bromacil (40%)	Diuron-330-54-1 Bromacil-314-40-9	81927-3	Diuron: 100 lbs	30 lbs	12 lbs each Diuron & Bromacil
Dow Agro Sciences	Rodeo	Glyphosate (53 8%)	38641-94-0	62719-324	N/A	5 gals x 10 lb/gal = 50 lbs Rodeo	27 lbs Glyphosate
Dupont	Escort	Metsulfuron methyl (60%)	74223-64-6	352-439	N/A	0.5 lbs Escort	0 3 lbs Metsulfuron methyl

5.1.1 SPILL PREVENTION MEASURES

Pesticide receiving, storage, transfer, loading, mixing, transport, application, and cleaning activities are conducted by Northern Water in a manner to minimize the risk of spills to Waters of the U.S. and Colorado. Specific practices used by Northern Water related to these activities are outlined below:

- **Receiving of pesticide deliveries:** Pesticide shipments are delivered to the appropriate location and accepted by the appropriate person(s) who will then ensure that it is placed in storage.
- **Storage:** All pesticide products are stored in secured locations in original containers prior to use. A locked, pre-engineered, free-standing chemical storage building with spill containment, shelving, and ventilation is present at the Berthoud Headquarters for storage of all pesticides. Storage areas are routinely inspected for leaks and damaged containers.
- **Transfer** of containers of pesticide concentrate from storage to vehicles and/or to mixing areas: Northern Water staff use patience and diligence during transfer of pesticide containers in order to prevent spills.
- **Transport:** Pesticide containers and mix tanks are properly secured in the trucks prior to transport to the application sites. It is realized that vehicle accidents are often caused by others and staff must be prepared for that possibility. All vehicles used by Northern Water for herbicide applications contain a HAZMAT Spill Kit.
- **Loading/Mixing at the Application Site:** Prior to loading/mixing activities outside in the field, staff conduct a visual inspection for nearby drainages and drainage paths. Mixing is conducted in areas where a spill or overflow will not drain directly into the canal or other waterway. Staff check to make sure that the grade of the mixing area is sloped away from the canal and other waterways. Diking tubes and sorbent materials are on hand to quickly contain a spill. Pesticide containers and mixing tanks are carefully inspected and monitored for leaks.
- **Application:** Northern Water staff calibrate the herbicide application equipment on an annual basis, and conduct routine maintenance and daily inspection of the application equipment when in use. Staff conduct daily (or more frequent) inspection of pesticide containers, mixing tanks, pumps, hoses and valves for cracks and leaks. Sprayers, nozzles, and hoses undergo daily inspection for signs of uneven wear to prevent equipment failure. Chemical feed pumps are checked and verified prior to each application to ensure that the correct amount of product is being applied.
- **Equipment Cleaning**: Equipment used for herbicide mixing and/or application are cleaned according to manufacturer recommendations. Rinse waters generated at the Berthoud facility are diluted and discharged to the sanitary sewer system.
- **Disposal:** Empty pesticide containers are immediately triple rinsed, and the container rinsewater is drained into the mixing tank for application. The rinsed containers are then punctured and disposed of in a sanitary landfill. If a spill were to occur, contaminated soils, water, sorbents, clothing, and unusable recovered spilled pesticide will be disposed of in accordance with applicable regulations.

5.1.2 SPILL RESPONSE PROCEDURES

Procedures for expeditiously controlling, containing, and cleaning up pesticide leaks, spills, and non-permitted releases to Waters of the United States and Colorado are outlined below (modified from http://pesticidestewardship.org/spill/Pages/default.aspx):

1). **Call 911 to obtain immediate medical assistance for injured or contaminated persons.** Consult the pesticide Material Safety Data Sheet (MSDS) for appropriate first aid measures (a notebook of MSDS's for all herbicides used by Northern Water is kept in each vehicle as part of the vehicle HAZMAT Spill Kit). Call the Rocky Mountain Poison Center (1-800-222-1222; 24 hrs) for more information on first aid measures related to eye contact, skin contact, inhalation, and/or ingestion of the spilled pesticide.

2). **Wear appropriate Personal Protective Equipment (PPE)**, as specified on the pesticide MSDS, when working to control, contain and clean up the spilled product. Appropriate PPE for Northern staff is contained in the vehicle HAZMAT Spill Kit (chemical resistant gloves, chemical resistant suits, rubber boots, goggles).

3). **Control the Spill** to minimize the quantity released to the environment:

a) Shut down equipment and operations.
b) Turn off pumps, spraying devices, vehicle, etc.; close valves.
c) Redirect leak into an empty container and ensure that it doesn't overflow.

4). **Contain the Spill**

a) Diking tubes, sorbent pillows, shovel, plastic sheet/tarp and other equipment to help contain the spill are contained in the vehicle HAZMAT Spill Kit.
b) Prevent the pesticide from entering canals, ditches, streams, rivers, storm drains, or other waterways. Block any drainage path or entrance to waterways.
c) Block the spill from spreading by encircling it with a trench, dike of sand or soil, absorbent diking tubes, or rags.
d) Absorb liquid spills with suitable inert absorbent material (absorbent pads/pillows, sand, dirt), as outlined on MSDS.
e) Cover dry spills with plastic or a tarp (with weights on top) to prevent wind from moving the product.

5). **Notify your supervisor and Northern Water Management**

a) East Slope: Call Lu Pena at 970-635-3326 (cell).
West Slope: Call Craig Friar at 970-685-1710 (cell).

Identify the chemical spilled, the estimated amount, the spill location, actions to control and contain the spill, and if 911 has been called.

b) Supervisor to immediately notify Jerry Gibbens (or, in Jerry's absence, his designate).

6) **Significant Spills.** A spill is significant if:

- you cannot control and contain it
- OR it involves an amount greater than the reportable quantity (Tables 5.1 and 5.2 for 40 CFR 302.4 CERCLA Hazardous Substances Reportable Quantities)
- OR it has discharged into waters of the State or U.S. (downstream rivers, streams, and reservoirs).

Significant spills may require the following additional actions:

a) **If you cannot control and contain the spill**: Call 911 and request the Hazardous Material Response Team. Identify the chemical spilled, the estimated amount, and the spill location.

b) **If an uncontrolled spill enters the canal:** Northern Water Management will make decisions regarding the necessity for reducing/stopping canal flows to facilitate spill containment and clean-up, and will ensure that these decisions are implemented immediately.

7). **Spill Cleanup**

a) Consult the MSDS for proper cleanup and disposal procedures; depending on the size of the spill, an outside contractor may be required.
b) Equipment used to clean up small spills are contained in the vehicle HAZMAT Spill Kit (broom, dust pan, shovel, five gallon plastic buckets, container labels, etc).

c) **Dry Spills** (granular formulations)
- Use a broom, dust pan, and/or shovel to sweep up the spill.
- Place the spillage in a five gallon plastic bucket.
- Secure and label the container for later disposal.
- If possible, apply the recovered spilled product for pest control.

d) **Liquid Spills**
- Gather the sorbents and place in five gallon plastic buckets.
- Contaminated soil should be placed in five gallon plastic buckets.

e) **Dispose of contaminated materials** (soils, water, sorbents, clothing, and unusable recovered spilled pesticide) in accordance with applicable State regulations.

8) **Report to State and Federal regulatory authorities.** As required, Northern Water Management will report the spill to State and Federal regulatory authorities. If it is not known if a release needs to be reported, the Colorado Department of Public Health and Environment (CDPH&E) recommends that releases be reported immediately even if the quantity of the release has not yet been determined. Report if there is any potential for harm to human health or the environment, or if the spill occurs in an area frequented by the public.

The following situations must be reported (calls to be made by Jerry Gibbens, or in his absence, his designate):

- **Spills of a CERCLA hazardous substance to the environment at or above the reportable quantity** (see Tables 5.1 and 5.2, or see http://www.epa.gov/epcra/consolidated-list-lists) must be reported to the **National Response Center** within 24 hours at 1-800-424-8802 (24-hour). Based on the typical maximum quantities that Northern Water takes to the field for application (as shown in Tables 5.1 and 5.2), reportable spills could potentially occur for diuron (Karmex DF or Diuron 80 DF) and endothall (particularly if both Teton and Cascade are being applied at the same time).

- The Clean Water Act requires that facilities with an NPDES permit report to the National Response Center (1-800-424-8802) within 24 hours of becoming aware of any spills that cause an exceedance of the effluent limits of the permit (spills that result in discharges to water).

- **CDPH&E Colorado Environmental Release and Incident Reporting Line.** Spills that result in a *non-permitted discharge to waters of the state of Colorado* (which include surface water, ground water and dry gullies and storm sewers leading to surface water) must be immediately reported to the CDPH&E Colorado Environmental Release and Incident Reporting Line at 1-877-518-5608 (24-hour).

9) **Notify downstream domestic water treatment plants.** If a spill results in a discharge to water, Operations staff will contact downstream domestic water treatment plants and notify them of the spill (see Table 4.3 for contact list). This is a call to inform the treatment plants of the incident, and to indicate if intakes should be shut off.

10) **Document Reportable Spills.** Reportable spills, leaks or unpermitted discharges (as reported under item (8) above) that occur while covered under the Pesticide General Permit must be documented. The documentation provides a written record of what was reported orally to the National Response Center. The documentation also must include information about corrective actions and any measures to prevent recurrence of such a spill or leak, and whether PDMP modifications are required. Gage Lee will be responsible for documenting the reportable

spill/leak, with input from other staff directly involved in the incident. The reportable spill/leak will be documented within 30 days of the incident.

11) **Take corrective actions.** Corrective actions will be taken to prevent the recurrence of the spill/leak. All corrective actions will be documented by Gage Lee within 30 days and include the items outlined in Section 5.3.

12) **Adverse Incident.** If the spill or leak results in an Adverse Incident, also follow the response and notification procedures outlined in Section 5.2.

5.1.3 VEHICLE HAZMAT SPILL KITS

All vehicles used by Northern Water for herbicide applications contain a HAZMAT Spill Kit.

5.2 ADVERSE INCIDENT RESPONSE PROCEDURES

An Adverse Incident is an unusual or unexpected incident that occurs as a result of exposure to a pesticide application and pesticide residue. Adverse incidents include effects that occur within Waters of Colorado or Waters of the U.S. on non-target plants, fish or wildlife. Waters of the U.S. and Colorado in Northern Water's pest management area were listed in Table 3.5 and include the downstream rivers, streams, and reservoirs; they do not specifically include the canals. Possible effects include:

- Distressed or dead juvenile and small fishes
- Washed up or floating fish
- Fish swimming abnormally or erratically
- Fish lying lethargically at water surface or in shallow water
- Fish that are listless or nonresponsive to disturbance
- Stunting, wilting, or desiccation of non-target submerged or emergent aquatic plants
- Other dead or visibly distressed non-target aquatic organisms (amphibians, turtles, invertebrates, etc)

Adverse incidents also include adverse effects to humans or domesticated animals from direct contact with or as a secondary effect from a discharge to waters of Colorado or waters of the U.S. Such effects may include skin rashes, vomiting, lethargy, etc.

5.2.1 PROCEDURES FOR RESPONDING TO ADVERSE INCIDENTS RESULTING FROM PESTICIDE APPLICATIONS

1) **Call 911 to obtain immediate medical assistance for injured or contaminated persons.** Consult the pesticide MSDS for appropriate first aid measures. Call the Rocky Mountain Poison Center (1-800-222-1222; 24 hrs) for more information on first aid measures related to eye contact, skin contact, inhalation, and/or ingestion of the spilled pesticide.

2) **Report the incident immediately:** Report the incident to Northern Water management, the EPA, and the Colorado Water Quality Control Division as outlined below in Section 5.2.2.

3) **Stop any further contamination or hazard:** If currently applying a herbicide, stop the application. Follow the spill response procedures outlined in Section 5.1.2.

4) **Collect information/data to determine the extent and magnitude of the problem:** Contact Northern Water Field Services Dept. and Water Quality Dept. staff for help in implementing this task. Estimate and record the appearance of the affected waters (sheen, color, clarity, etc); the species of organisms and the number of organisms affected; the approximate size of dead or distressed organisms; and the total stream distance affected or reservoir area affected. Collect water samples: 1) in the canal downstream of the application site, 2) within the receiving water body upstream of the canal, 3) within the receiving water body in a fully mixed section

immediately downstream of where the canal discharges, and 4) within the receiving water body along the length of the impacted area. Submit the water samples for laboratory analysis of concentrations of the discharged pesticide.

5) **Determine the cause of the incident**: Determine what caused the incident (equipment failure, spill or leak, dose incorrectly determined, dose incorrectly applied, etc.).

6) **Take corrective actions**: Corrective actions will be taken to prevent the recurrence of the incident. All corrective actions must be documented in the Adverse Incident Report.

7) **Document the adverse incident**: Within 30 days of a reportable adverse incident, a written **Adverse Incident Report** will be prepared by Northern Water and submitted to the EPA Regional Office and the Colorado Water Quality Control Division (contacts listed in Section 5.2.2). The written report will use the EPA template found at http://www.epa.gov/npdes/pubs/pgp_apph.pdf. The written report will be prepared by Gage Lee with input and assistance from Northern Water's Water Quality Dept. and Field Services Dept.

5.2.2 Procedures for Internal and External Notification of Adverse Incidents

If an adverse incident occurs, the following entities must be notified:

1) **Notify your supervisor and Northern Water Management**

   a) East Slope: Call Lu Pena at 970-635-3326 (cell) and describe the incident.

      West Slope: Call Craig Friar at 970-685-1710 (cell) and describe the incident.

   b) Supervisor to immediately notify Jerry Gibbens, or in Jerry's absence, his designate.

2) **EPA Incident Reporting -- EPA Region 8 must be contacted within 24 hours** by Jerry Gibbens, or in his absence, his designate:

   Call 303-312-6312 and ask for the EPA Region 8 Adverse Incident Reporting Contact. Provide the contact with the following information:

   - Caller's name and telephone number.
   - Northern Water's address (220 Water Ave, Berthoud, CO 80513).
   - Name and phone number of a contact person if different than the Caller.
   - How and when Northern Water became aware of the adverse incident.
   - Location of the adverse incident.

- Description of the adverse incident and the pesticide product(s), including the EPA pesticide registration number(s).
- Description of any steps that Northern Water has taken or will take to correct, repair, remedy, clean up, or otherwise address any adverse effects.

For Northern Water's records, document the date and time that EPA was notified, the name and title of the person notified at EPA, and a description of instructions received by EPA.

3). **Colorado Water Quality Control Division**

The CDPH&E Colorado Environmental Release and Incident Reporting Line must be contacted within 24 hours at 1-877-518-5608 (24-hour). The call will be made by Jerry Gibbens, or in his absence, his designate. The following information will be provided to the State:

- Caller's name and telephone number.
- Northern Water's address.
- Name and phone number of a contact person if different than the Caller.
- How and when Northern Water became aware of the adverse incident.
- Location of the adverse incident.
- Description of the adverse incident and the pesticide product(s), including the EPA pesticide registration number(s).
- Description of any steps that Northern Water has taken or will take to correct, repair, remedy, clean up, or otherwise address any adverse effects.

For Northern Water's records, document the date and time that the State was notified, the name and title of the person notified at the State, and a description of instructions received by the State. The written Adverse Incident Report will be submitted within 30 days to the Water Quality Control Division at the following address:

Compliance Assurance Section – Industrial Compliance Program
Water Quality Control Division
Colorado Dept. of Public Health and Environment
WQCD-WQP-B2
4300 Cherry Creek Drive South
Denver, CO 80246-1530

During normal business hours, the Compliance Assurance Section – Industrial Compliance Program may be contacted at 303-692-3500.

5.3 CORRECTIVE ACTION

Corrective actions are follow-up actions that must be taken to assess and correct problems. Situations that may trigger corrective action include: 1) a spill, leak, or unauthorized discharge associated with the application of pesticides, 2) existing Pest Management Measures are not adequate to meet applicable water quality standards, 3) monitoring activities indicate failure to meet applicable technology-based effluent limitations, or 4) the occurrence of an adverse incident.

Corrective actions must be documented. The documentation must include the following:

- Identification of the condition triggering the need for corrective action review, including any ambient water quality monitoring that assisted in determining that discharges did not meet water quality standards
- Brief description of the situation
- Date the problem was identified
- Brief description of how the problem was identified, how Northern Water learned of the situation, and date that Northern Water learned of the situation
- Summary of corrective action taken or to be taken, including date initiated and date completed or expected to be completed
- Any measures to prevent recurrence of the incident, including notice of whether PDMP modifications are required as a result of the incident.

6.0 RECORDKEEPING, MONITORING, AND REPORTING

6.1 RECORDKEEPING

As part of its Integrated Pest Management Program, Northern Water keeps records of its pesticide applications with the information outlined in the form shown in Figure 6.1. The recorded information includes date/time of application, location of application, type of application area (canal prism, road, etc), target weeds, name of each pesticide product used and EPA registration number, quantity of each pesticide product applied, weather conditions, application method (handgun, boom, etc.), and applicator name or names, license numbers and dates of expiration. This information was previously recorded on the paper form shown in Figure 6.1, but since 2016 the same information is recorded directly into an asset management system using laptop computers or tablets. The previous paper forms and the information now directly entered into the asset management system software are kept indefinitely by Northern Water to be reviewed by the Colorado Department of Agriculture or the CDPHE at their request. This recordkeeping information meets the recordkeeping requirements of the Pesticide General Permit.

The Pesticide General Permit also requires Northern Water to retain the following records:

- Copy of any correspondence exchanged between Northern Water and EPA and/or State.
- Documentation of equipment calibration.
- Whether or not visual monitoring was conducted during application and post-application, and whether or not the monitoring identified any possible adverse incidents.
- A copy of any Adverse Incident Reports (see Section 5.2.1).
- A copy of any spill or leak or other unpermitted discharge documentation.

NORTHERN COLORADO WATER CONSERVANCY DISTRICT
WEED SPRAYING FORM

Feature_____ Page____of____

Date: | Time Start: | Finish:

Location and Address of Area Sprayed: Larimer Co. ☐ Boulder Co. ☐ Grand ☐ . Other ☐_____

Office Address: 220 Water Ave., Berthoud, CO 80513

Target Weed(s): ☐ Canada Thistle ☐ Musk Thistle ☐ Leafy Spurge ☐ Mullein ☐ Bindweed ☐ Willow ☐ Wild Plum ☐ Cottonwood ☐ Sand Bur ☐ Foxtail ☐ Blue Mustard ☐ Houndstongue ☐ Black Henbane ☐ Yellow Toad Flax ☐ Other Broad Leafs ☐

Chemical Name:	Qty. of Chemicals	Gals. of Water	Amount of Sticker	Total Mix	Estimated Area
Totals					

Start. Gals. in Tank: | Amt. Left in Tank: | Amount Used:

Type of Application:	Hand Gun	Side Boom	Back Boom	Other
	☐	☐	☐	☐

How Applied If Other: _____

Wind Speed & Temp:

Type of Site Treated:	R.O.W.	Canal	Dam	Yard	Road
	☐	☐	☐	☐	☐

Pesticide Used	Trade Name	Common Name	Manufacturer	EPA Reg. No.	
_____1	Amine 4	24 D	Platoon	34704-120	
_____2	Clearigate	Copper Chelate	Applied Biochemists	42291-GA-1	
_____3	Copper Sulfate	Copper Sulfate	Tennessee Chem. Co.	1109-20	
_____4	Diquat	Diquat Dibromide	Zeneca	10182-353	
_____5	Karmex	Diuron	Dupont	352-247	
_____6	Krenite S	Fosamine	Dupont	352-395	
_____7	Krovar IDF	Bromacil/Diuron	DuPont	352-505	
_____8	Rodeo	Glyphosate	Monsanto	524-343	
_____9	Roundup	Glyphosate	Monsanto	524-308-AA	
_____10	Premier 90	Polyalkeneoxide	Loveland	International	
_____11	Spike 20P	Tebuthiuron	Dow Elanco	62719-121	
_____12	Sticker access penetrator	100% Limonene	Van Diest Chem. Co.	N/A	
_____13	Vanquish	Dicamba	River Dale	397	
_____14	Weed Pro	24D	Van Diest Chem. Co.	264-2-10107	

Applicator:	Applicator:
Title:	Title:
Certification Number:	Certification Number:
Expiration Date:	Expiration Date:
Spray Rig #:	Spray Rig Time:

Comments: _____

Figure 6.1 . Northern Water's pesticide recordkeeping form. (Information now entered directly into asset management system software instead of recording on paper form.)

- A copy of any corrective action documentation (see Section 5.3).

As of this updated PDMP, no incidents have occurred that have required Northern Water to prepare an Adverse Incident Report, reports of unpermitted discharges, or corrective action documentation.

6.2 EQUIPMENT CALIBRATION AND MAINTENANCE

In order to meet the technology-based effluent limitations of the Pesticide General Permit, pesticide application equipment must be maintained in proper operating condition. The Pesticide General Permit requires the cleaning, calibration and repair of application equipment on a regular basis to ensure effective pesticide application. Northern Water's equipment calibration and maintenance procedures are outlined below.

6.2.1 EAST SLOPE

Northern Water's East Slope operation and maintenance department has two 300-gallon truck mounted skid type herbicide sprayers. Both truck mounted sprayers are powered by gas motors that drive a Hypro centrifugal pump. The centrifugal pump provides water to both the boom system (for broadcast spraying) and the handgun system (for spot spraying). These two systems can be used together or independently of each other.

One of the truck mounted sprayers has a herbicide injector system manufactured by Dosatron. This system uses the vacuum created by the movement of the water to draw herbicide out of one of three containers on the back of the sprayer. Each container is connected to a Dosatron injector pump. Each pump has a dial that can be used to provide between 0.5% to 1.5% herbicide mix. This spray unit is mainly used for spot spraying using a handgun at a 1% mix. This 1% mix is achieved by dialing the injector unit to 1% on the dial.

To ensure that the pump is working correctly, the water output in the main water tank should match the output in the herbicide tank. For example, if 100 gallons is used from the main water tank then 1 gallon should be gone from the herbicide tank.

Handgun Calibration

Handgun calibration is done by marking off an area 18.5 feet by 18.5 feet. This is 1/128 acre or 340 square feet. This area is sprayed with a handgun and the time it takes to spray it is recorded. If it takes 20 seconds to spray this area, spray into a bucket for 20 seconds and measure how much water was sprayed. For example:

20 seconds to spray 18.5 ft x 18.5 ft area.
31 oz of water was measured in 20 seconds.
18.5 ft x 18.5 ft x 1 acre/43,560 ft^2 = 0.0078 acres = 1/128 acre
Ounces applied per acre: 31 oz/0.0078 acres = 3,968 oz/acre
Gallons applied per acre: 3,968 oz/acre x 1 gal/128 oz = 31 gallons/acre

Broadcast Spraying Calibration

Broadcast spraying is used for larger populations of noxious weeds and for canal roads. Canal roads are typically sprayed in the fall using the herbicide Krovar 1 DF. This is done with a boom that uses large orifice "flood jet" type tips. These types of tips produce a large water droplet that reduces "drift" and reduces clogging of tips by wettable powders such as Krovar 1 DF.

Calibration is done by laying out an 88 foot long course in the O & M yard. With a full tank of water, the truck-mounted sprayer is driven through the 88 foot course at a maintained speed using the truck's tachometer. Our desired speed of 5 mph is achieved by 2000 RPM's in 1st gear. Covering the 88 foot course in 12 seconds equals 5 mph, (5 mph = 440 feet in 1 minute). The next step is to collect the sprayer water output and measure the width of the spray pattern. The spray pattern is measured by setting the pump to the desired pressure and turning on the spray boom or booms. The width of the spray pattern is then measured. At 75 PSI our "road boom" produces a 10 foot wide pattern. Collection of sprayer output is done by setting the pump pressure and capturing all the water from all nozzles for 1 minute. At 75 PSI our "road boom" produces 1.5 gallons per minute. For example, using the above information:

75 PSI = 1.5 gallon / minute
10 foot wide pattern = 4,356 linear ft make 1 acre (43,560 square feet per acre/10)
4,356ft/ 440ft (feet covered in 1 minute) = 9.9 minutes to cover 1 acre
9.9 minutes x 1.5 gallons/minute = 14.85 gallons/ acre

The output at 75 PSI would be 14.85 gallons/acre.

Verification of Greylor Peristaltic Pumps for Cascade and Teton Application

Northern Water pumps Teton and Cascade into the canals from mix tanks using a Greylor peristaltic pump. The feed rate for each pump and tank is verified at the beginning of each application by capturing the flow from the mix tank into a graduated cylinder or a measuring cup over a specific period of time to calculate the actual feed. At the end of the application period (8 hour application period or as otherwise selected), the mix tank should be empty. This is another check that the pump was feeding the product at the correct rate.

Green Clean Liquid Application Verification

Green Clean Liquid is applied using a 12 volt diaphragm pump that pulls the herbicide directly out of the 330 gallon container. A chemical resistant hose attaches to the pump and a valve on the end of the hose feeds the Green Clean Liquid into the canal (See Figures 4.3 and 4.4). The valve on the end of the hose regulates the flow of herbicide into the canal. The herbicide coming out of the hose is captured and measured to determine the correct rate of applied Green Clean Liquid. Target application rate for Green Clean Liquid is 2.75 to 3 gallons per cfs of flowing water for 10 ppm hydrogen peroxide. The application is made over a 4 to 6 hour period. For example:

Canal flow= 100 cfs
100 cfs X 3 gallons Green Clean Liquid = 300 gallons
300 gallons / 4 hours application =75 gallons /hour
75 gallons/ 60 minutes=1.25 gallons /minute
1.25 gallons/minute x 128 oz per gallon =160 ounces /minute

Application Verification of Dry Hydrogen Peroxide-based Products

In 2013, Northern Water began applying hydrogen peroxide-based products in the dry form using a specialized herbicide blower (see Figure 4.2). The application rate is determined using information supplied by the manufacturer (i.e., BioSafe Systems https://biosafesystems.com/product/greencleanpro/ ; Applied Biochemists http://www.archwaterworks.com/Docs/Surface/Labels/Phycomycin.pdf), where 306.9 lbs of product is applied per million gallons of water in order to achieve the maximum dose of 10.2 ppm. For Northern Water, the maximum target application is the maximum hydrogen peroxide dose of 10.2 ppm applied over a 4 hour period. Converting the canal flow in cfs over a 4 hour time period to a volume, the table below outlines the total pounds of product to be applied over the 4 hours to achieve the maximum dose of 10.2 ppm:

Canal Flow (cfs)	Equivalent Volume over 4 hours (million gallons)	Total Pounds of product to apply over 4 hours to achieve maximum 10.2 ppm dose
100	10.77	3,306
200	21.54	6,612
300	32.32	9,918
400	43.09	13,224

This table can be used to determine the application rate for any canal flow. For example, for a canal flow of 150 cfs, the total pounds of applied product is calculated as:

3,306 lbs product/100cfs = 33.06 lbs per cfs
33.06 lbs/cfs x 150 cfs = 4,959 lbs for 10.2 ppm treatment at 150 cfs flow

6.2.2 WEST SLOPE

A flat bed dual rear wheel four wheel drive truck mounted with a specially designed and manufactured spray rig is used for all applications except sidewalk spraying at Farr plant. This sprayer was designed and built at Northern Water's East Slope facility in Berthoud. It features a seat with seat belt on both passenger and driver sides, in-cab boom sprayer controls to facilitate solo right of way spraying, and a 300' hose reel with hand gun applicator. The circular type pump pressures the spray system to 90 psi. and holds this pressure even when using boom and hand gun. The sprayer tank is filled at Farr plant with an overhead filler hose made just for this spray rig. It fills the 300 gallon tank in ten to twelve minutes.

Most herbicide application is done with the handgun applicator as spot spraying, i.e., only applying at the location of target weeds in order to avoid over use of chemicals. Calibration of the handgun is done at the beginning of the spray season and at least once during the spray season. The method of calibration is to mark off an area 18.5' by 18.5' and then time the spraying of this area to a proper coverage. Next, capture the spray fluid in a container for the same amount of time. Measure this fluid in ounces and the number of ounces will be the same as gallons per acre. This method has always yielded a gallons per acre portion of 50 to 80 gallons per acre. Since the actual application is difficult to determine in acres a mix of slightly more diluted herbicide is used and the effects monitored. Adjustments in mixing formulae are then made. Generally less herbicide than is recommended is effective.

When boom applications are made, the boom nozzles are inspected and cleaned. This is done every couple of days to insure proper spray rates. With the herbicides used, there is usually not a nozzle blockage problem. However, dry flowables (Diuron or Krovar) may cause some problems so frequent inspection and cleaning are conducted. The method of calibration for boom spraying is to mark off an area of 435' by 10' (this is one tenth of an acre). The spray rig has a boom spray width of 10'. The method includes: 1) travel the 435 ft length at 3 miles per hour, 2) time this distance, 3) collect spray from all nozzles for this same amount of time, 4) multiply this amount in gallons by 10 for gallons per acre. In our experience, this is the speed that most closely approximates the field application speeds needed for most effective coverage of rough ground. On roadways, a quicker speed may be used but 3 miles per hour produces a good result without an over application. Most roadway boom applications are made with bare ground results intended and the slower speed of 3 mph is most effective especially for roadside ditch applications. Boom spray calibrations usually yield a rate of 80 to 100 gallons per acre.

There are two moveable side nozzles on the spray rig that have a spray width of approximately 8' each. By timing a travel distance of 545' and collecting spray for this amount of time we determine that each nozzle yields approximately 30 gallons per acre. Again, travel speed is 3 mph. These side nozzles are mostly used to spray roadside ditches

6.3 VISUAL MONITORING

Visual monitoring is conducted by Northern Water both during and after pesticide application.

Visual monitoring during and after application is conducted to identify unintended effects related to Northern Water's use of pesticides, including:

- Instances of detrimental impact to non-target organisms
- Disruption or degradation of wildlife habitat
- Prevention of designated uses of a water body (recreational or drinking water supply)

Visual monitoring during and after application consists of spot checks for observable adverse incidents such as fish kills or distressed fish or macro-invertebrates (see Section 5.2).

Visual monitoring after application is also conducted to assess the efficacy of the pesticide application such that appropriate changes in application rates or frequency can be made. Northern Water conducts pre- and post-application surveillance as part of their routine operations.

6.4 ANNUAL REPORTS

Pesticide applications covered by the Colorado General Permit: Northern Water-owned portions of the C-BT system. The State of Colorado requires the submittal of an Annual Report that is due by February 1 each year and reports on herbicide applications made in the previous calendar year (January - December). Northern Water is responsible for preparing and submitting the Annual Report to the Colorado Department of Public Health and Environment. The Colorado Pesticides Annual Report template is provided at https://www.colorado.gov/pacific/cdphe/wq-pesticides-permits.

Pesticide applications covered by the EPA General Permit: federally-owned C-BT facilities listed on Table 1.1. The U.S. Bureau of Reclamation is responsible for preparing and submitting the Annual Report to the EPA for herbicide applications to federally-owned portions of the C-BT system. The Annual Report must be submitted no later than February 15 for all pesticide activities covered under the permit occurring during the previous calendar year. Northern Water provides information to Reclamation on the pesticide applications that Northern Water made to federally-owned portions of the C-BT system during the period of the annual report. The EPA Annual Report template is provided at http://www.epa.gov/npdes/pubs/pgp_appg.pdf.

6.5 UPDATE OF THE PDMP

This PDMP is a dynamic document that must reflect the actual on-the-ground practices used by Northern Water. Failure to keep the PDMP up-to-date is a recordkeeping violation of the General Permit. Northern Water must update their PDMP when a change in pest control activities significantly changes the type or quantity of

discharged pollutants, or whenever necessary to address conditions that triggered corrective actions (unauthorized spills/leaks, adverse incidents, inadequate Pest Management Measures). Changes to the PDMP must be made no later than 90 days after any change in pesticide application activities.

Northern Water's PDMP will be updated to reflect the following:

- Changes in the pest management strategies, including changes in the specific chemical herbicides used and/or their application rates
- Changes in the pest problem description: type, species, locations, or densities of target pests
- Implementation of new control measures to minimize the discharge of pesticides to waters of the U.S.
- Modifications to the Actions Thresholds
- Changes to spill and adverse incident response procedures, including notification contact information (names and phone numbers)
- Changes in maintenance and calibration procedures
- Changes in personnel and contact names (update Table 2.1 and Table 4.3)
- Changes in the Colorado 303(d) List of Impaired Waters or Monitoring & Evaluation List that impact the application of herbicides that contain specific active ingredients.
- Changes in maps showing locations of target pests.

Northern Water's PDMP was originally completed on February 1, 2012. Updates to the original PDMP are summarized below.

April 2013 Update: The PDMP was updated in April 2013 to reflect changes in personnel and contact names (Table 2.1 and Table 4.3) and the use of the hydrogen peroxide product Green Clean Liquid. The April 2013 revisions also reflected the fact that the U.S. Bureau of Reclamation is the designated "Decision Maker" (as defined in the Pesticide General Permit) for all of the federally-owned components of the CBT System. Note that the February 2012 version of the PDMP had (incorrectly) indicated that Northern Water was the "Decision Maker" for the federally-owned components of the CBT System.

January 2014 Update: The PDMP was updated in 2014 to reflect changes in contact names (Table 4.2) and in Northern Water's operations. The 2014 operations update included a description of Northern Water's new application method for Phycomycin that was developed in 2013 (truck mounted application system that uses a herbicide blower to apply dry hydrogen peroxide-based products directly to the canal). The 2014 update also discussed the use of the broadleaf herbicide Renovate 3 (active ingredient = Triclopyr). In 2013, Northern Water began using Renovate 3 for terrestrial weeds within the canal prism as an alternative to the use of 2,4-D based products in order to address concerns expressed by the City of Boulder and other water treatment providers. Renovate 3 was added to Tables 4.2, 4.5 and 5.1.

The January 2014 update also includes an updated summary of the periphyton (attached algae) data collected by Northern Water for the East Slope canals through 2013, including an update of Figure 3.1 and Table 3.1.

February 2016 Update: The PDMP was updated in February 2016 to reflect changes in Northern Water's operations and other items as noted below:

- Northern Water changed the fall herbicide applications to the dewatered Boulder Feeder Canal. The fall application of the contact herbicide Teton (active ingredient: endothall) was replaced in 2015 by a multi-year rotation of several SePRO systemic herbicides, beginning with Sonar Genesis (active ingredient: Fluridone) and Clearcast (active ingredient: Imazamox) in November 2015.
- Northern Water began using the herbicide Confront instead of Redeem R &P on the canal roads because Redeem R & P is no longer available. The active ingredients for both herbicides are the same (Triclopyr and Clopyralid).
- Tables 4.1, 4.2 and 5.1 were updated to reflect changes in herbicide products.
- Periphyton (attached algae) data collected by Northern Water for the East Slope canals was summarized through 2015, including an update of Table 3.1.
- Table 4.3, list of Water Treatment Plant contact names, was updated.
- Section 6.4 was updated to reflect the fact that the CDPHE now requires the submittal of an annual report each February 1 to summarize applications in the previous calendar year (January -December).
- Section 3.4 was updated to reflect expected changes to the Section 303(d) List of Impaired Waters to be adopted by the Colorado Water Quality Control Commission in 2016.

May 2020 Update: The PDMP was updated in May 2020 to reflect Northern Water's most recent herbicide application operations, procedures, and chemical products, and other items as noted below:

- Table 2.1, list of individuals that comprise Northern Water's Pesticide Discharge Management Team, was updated to reflect staff changes.
- Tables 4.1, 4.2 and 5.1 were updated to reflect the changes in herbicide products. Note that the dry hydrogen peroxide-based algaecide Green Clean Pro is being used instead of Phycomycin.
- Periphyton (attached algae) data collected by Northern Water for the East Slope canals were reviewed and summarized through 2019, including an update of Table 3.1 and Figure 3.1.
- Table 4.3, list of Water Treatment Plant contact names, was updated.
- Section 3.4 was updated to reflect the relevant copper listings on the 2020 Section 303(d) List of Impaired Waters adopted by the Colorado Water Quality Control Commission.
- All web links (included throughout this PDMP to provide additional supporting information) were checked to make sure they are still valid.

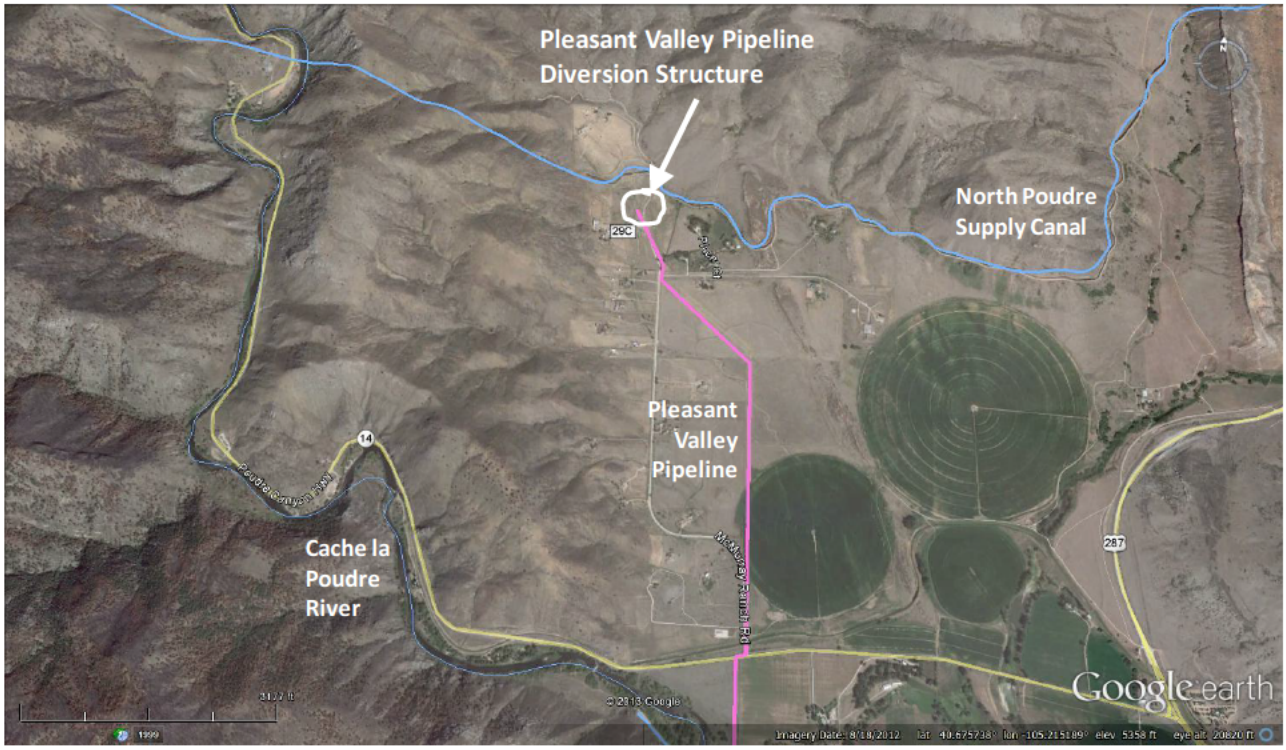
7.0 SIGNATURE PAGE

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the application of pesticides, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

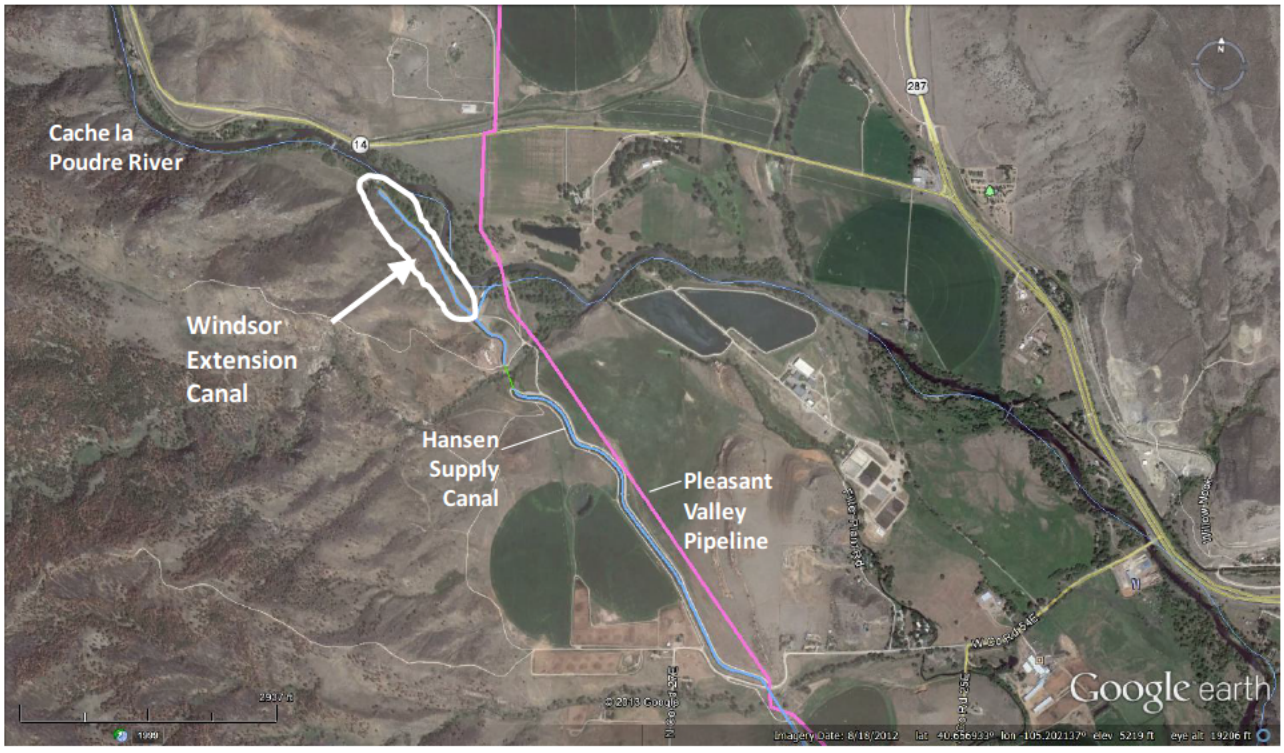
ATTACHMENT A

Maps of herbicide application areas
for
Northern Water-owned facilities

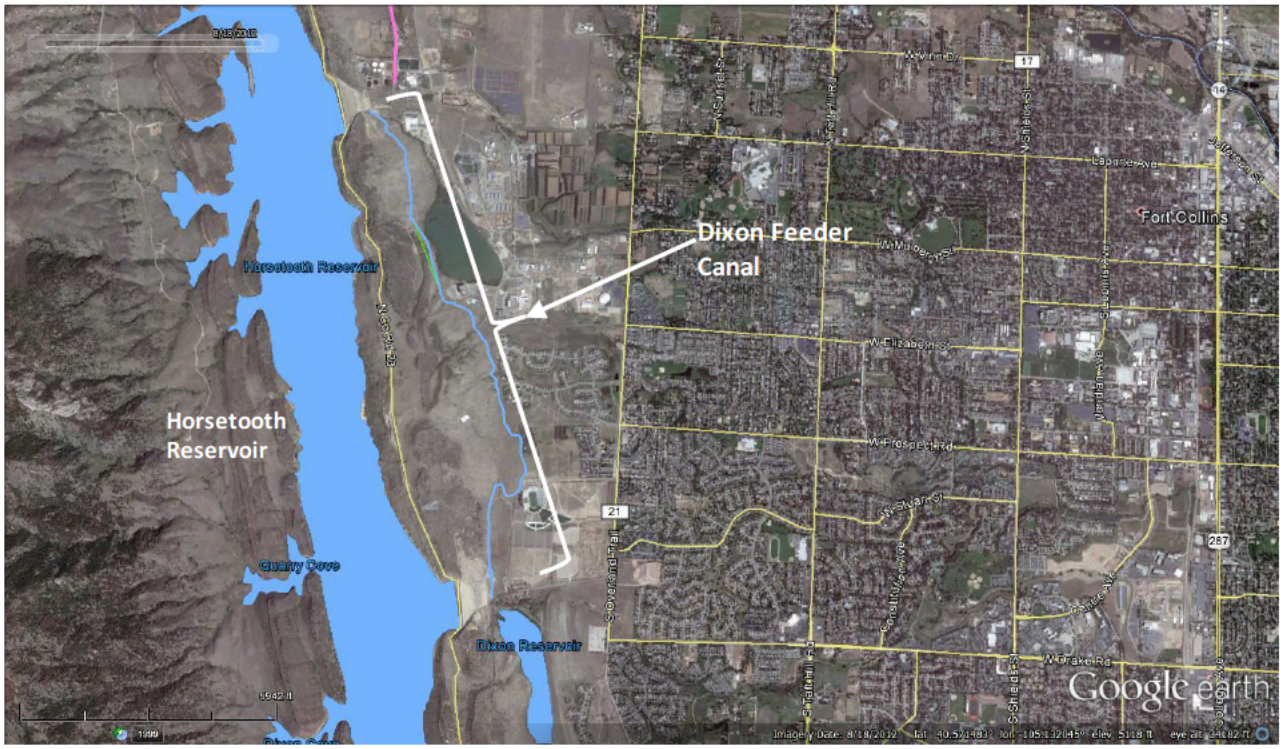
Area 1: Pleasant Valley Pipeline Diversion Structure



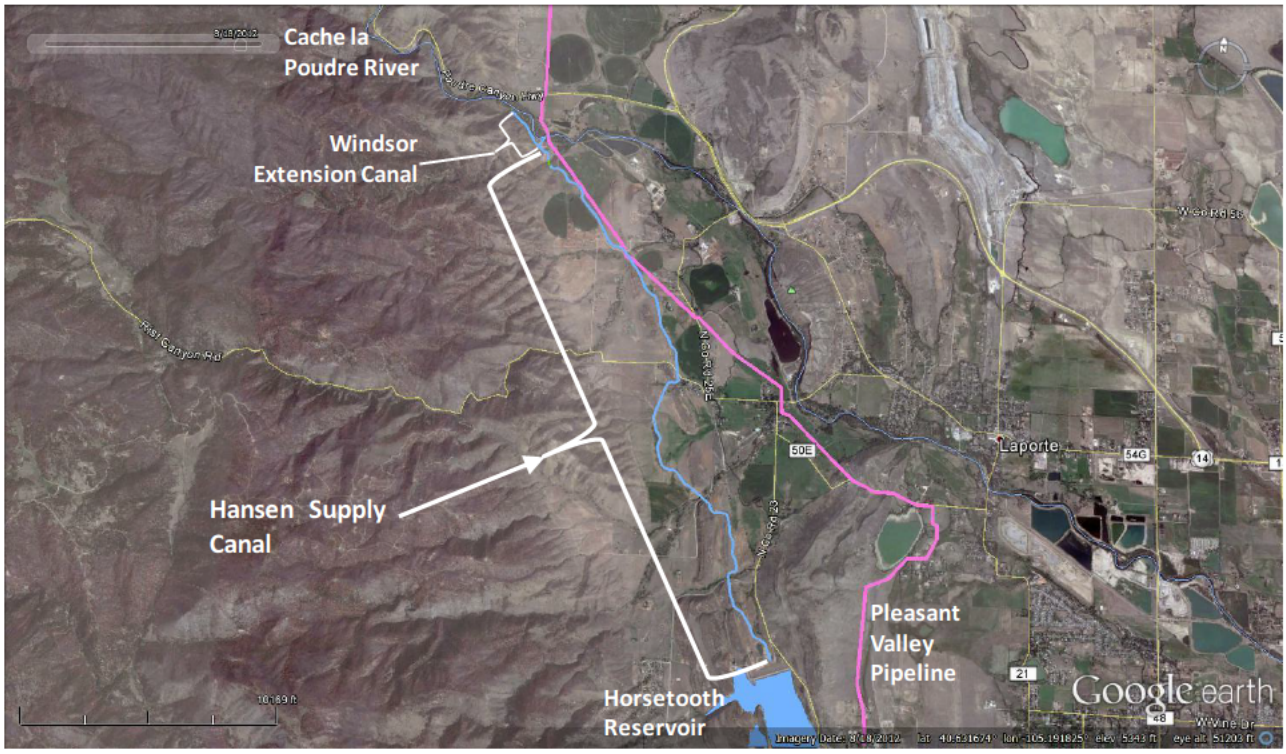
Area 2: Windsor Extension Canal



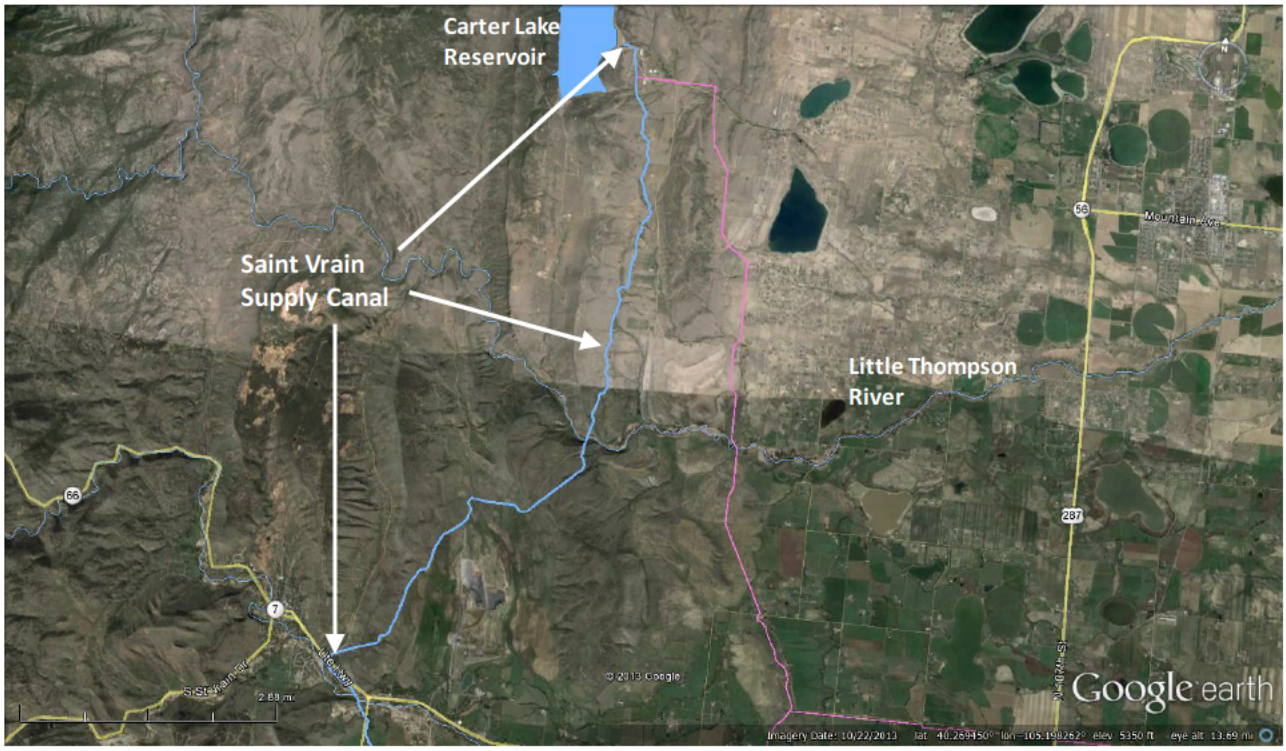
Area 3: Dixon Feeder Canal



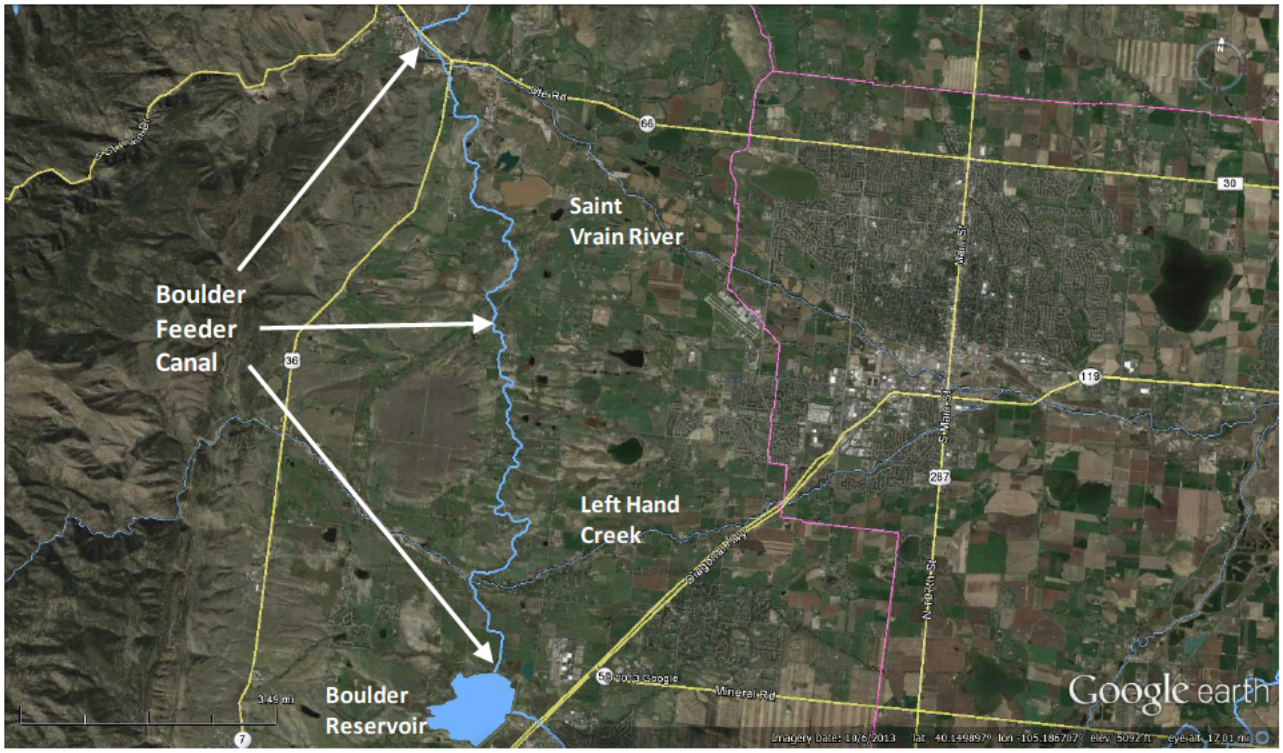
Area 4: Hansen Supply Canal



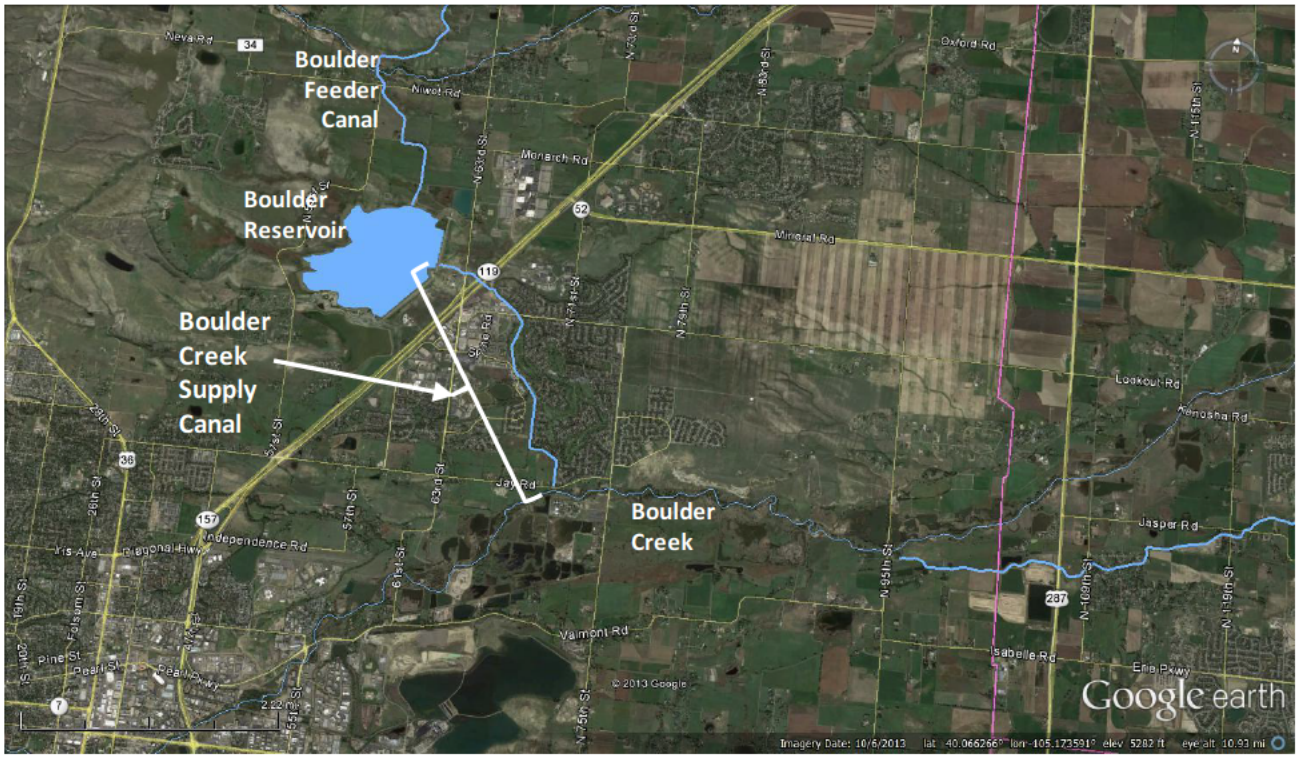
Area 5: Saint Vrain Supply Canal



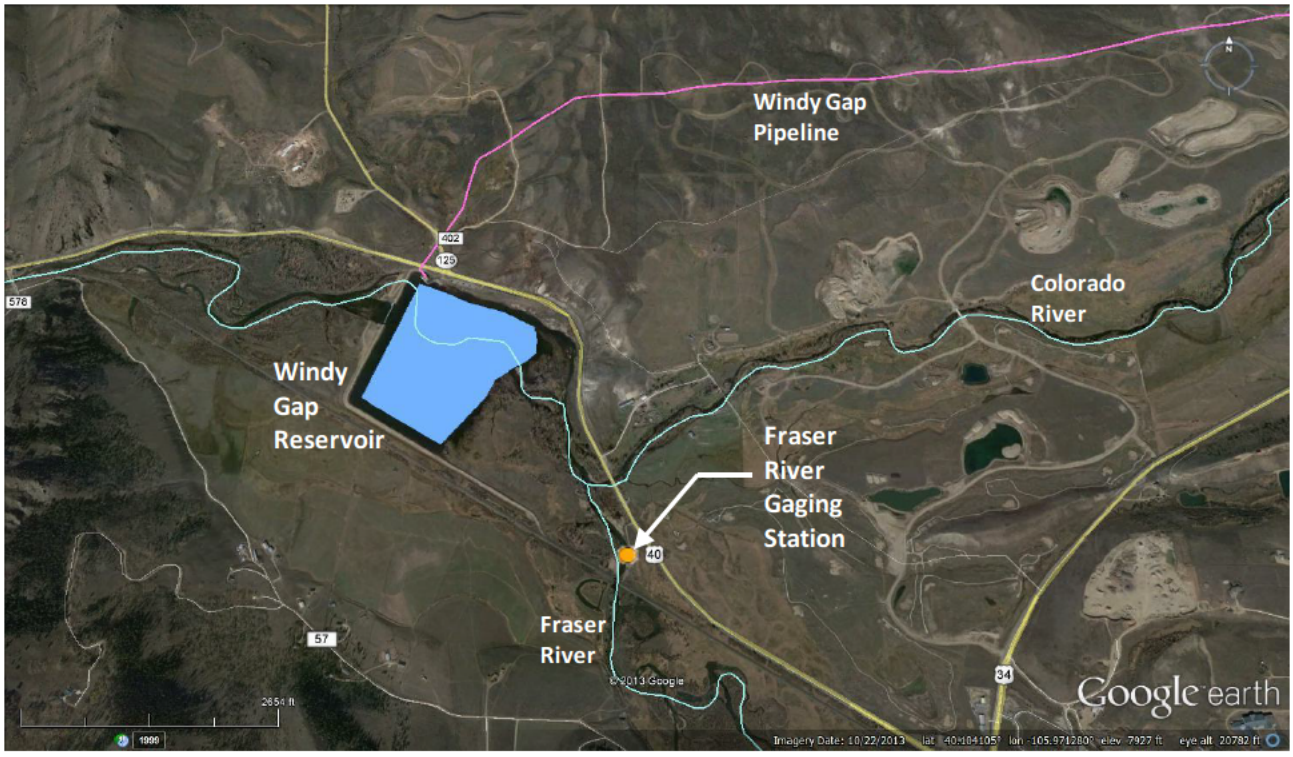
Area 6: Boulder Feeder Canal



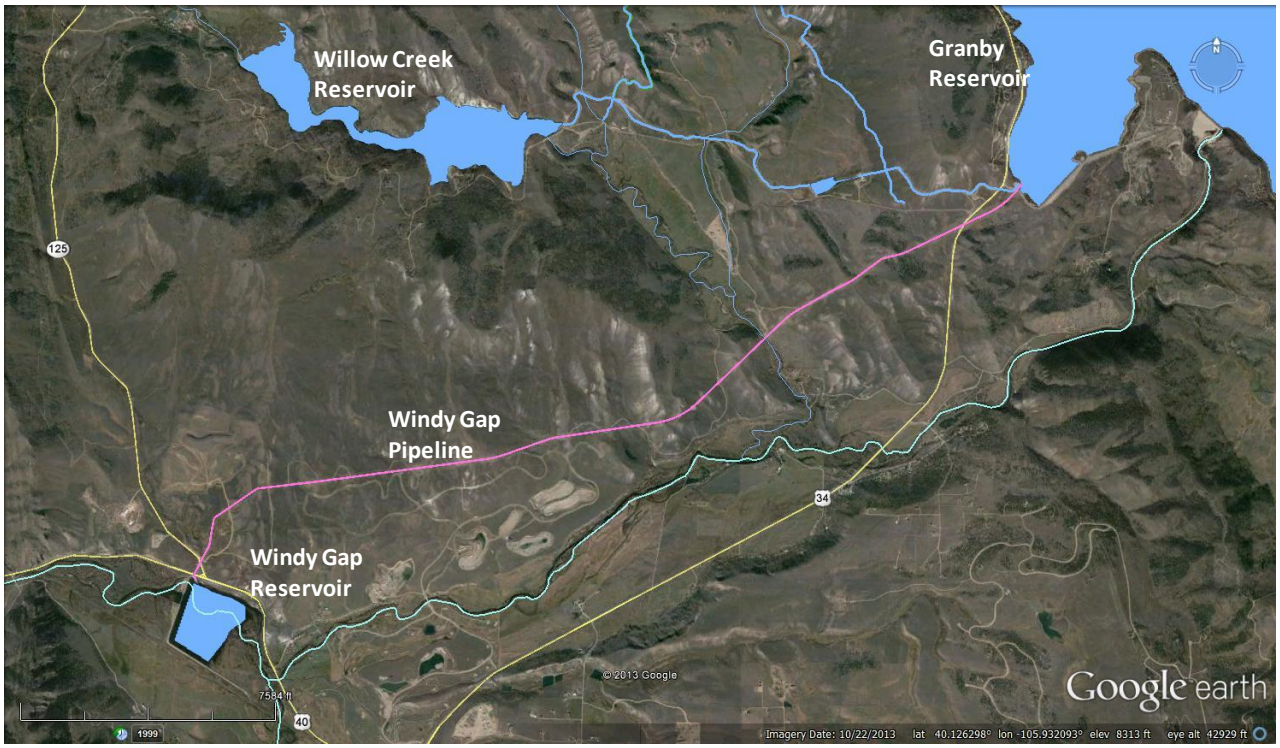
Area 7: Boulder Creek Supply Canal



Areas 8 & 9: Windy Gap Reservoir & Fraser River Gaging Station



Area 10: Windy Gap Pipeline Road



ATTACHMENT B

Integrated Pest Management Plan:
Carter Lake, Horsetooth Reservoir, Boulder Reservoir and Associated Canals
December 2015

ATTACHMENT C

Integrated Pest Management Plan:
C-BT West Slope Facilities and Windy Gap
May 2011