Application for use of a **Powered Mechanical Device** under an **Aquatic Nuisance Control Permit**
Per 10 VSA Chapter 50, § 1455

For Aquatic Nuisance Control Permit Program Use Only
Application Number: 2496-ANC

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION
LAKES & PONDS PROGRAM

Submission of this application constitutes notice that the entities listed below intend to use a powered mechanical device in waters of the State to control aquatic nuisance plants, insects, or other aquatic life; and that the entities below have demonstrated that (1) there is acceptable risk to the nontarget environment; (2) there is negligible risk to public health; and (3) there is either benefit to or no undue adverse effect upon the public good. Submit an application fee of $35 for a private pond or $175 for all other waterbodies, made payable to the State of Vermont. All information required on this form must be provided, and the requisite fees must be submitted to be deemed complete.

A. Applicant Information

1. Entity's Name: Town of Elmore

2a. Mailing Address: 1175 VT-Route 12

2b. Municipality: Lake Elmore	2c. State: VT	2d. Zip: 05657

3. Phone: 802-888-2637	4. Email: sdraper@elmorevt.org

B. Powered Mechanical Device Operator Information (Check box if same as above in Section A: ☐)

1. Entity's Name: To be Determined. See attached list of potential divers

2a. Mailing Address:

2b. Municipality:	2c. State:	2d. Zip:

3. Phone:	4. Email:

C. Application Preparer Information (Check box if same as above: Section A ☐ or B ☐)

1. Preparer's Name: Glenn Schwartz

2a. Mailing Address: 620 Camp Road

2b. Municipality: Elmore	2c. State: VT	2d. Zip: 05661

3. Phone: 802-888-1158	4. Email: glennschwartz620@gmail.com

D. Waterbody Information

1. Name of waterbody: Elmore Lake - Elmore 2. Elmore - Lamoille

3. Are there wetlands associated with the waterbody? ☒ Yes ☐ No
Contact the Vermont Wetland Program: (802) 828-1535 for additional information.

4. Are there rare, threatened or endangered species associated with the waterbody? ☒ Yes ☐ No
Contact the Vermont Fish & Wildlife Natural Heritage Inventory: (802) 241-3700 for additional information.

5a. Is this waterbody a private pond? ☐ Yes ☒ No If No, Skip to Question D6.

5b. Is this private pond totally contained on Applicant's property? ☐ Yes ☐ No

6. List the uses of the waterbody – check all that apply:
☐ Water supply ☐ Irrigation ☒ Boating ☒ Swimming ☒ Fishing ☒ Other:

Diver assisted suction harvesting shall occur no earlier than July 1st.
Specific Condition a.4.A.

E. Device Activity Information

1a. Proposed annual activity start date: ~~6/15/18~~ 1b. Proposed annual activity end date: 8/15/17

2. Nuisance(s) to be controlled:	3. Powered mechanical device to be used:
Eurasian Watermilfoil	KEENE Hand Held Suction Harvester
Submit additional information as needed.	*Submit a copy of the manufacturer's information, if applicable.*
4. Include a detailed waterbody map indicating the exact proposed activity location(s).	5. Enclose labeled photo(s) or schematic(s) of powered mechanical device.

6. Attach a narrative description of the proposed project to include the following items:
a) Reason(s) to control the aquatic nuisance;
b) Brief history of the aquatic nuisance in the waterbody; and,
c) Description of the proposed control activity.

F. Applicant/Operator Certification

As APPLICANT, I hereby certify that the statements presented on this application are true and accurate; guarantee to hold the State of Vermont harmless from all suits, claims, or causes of action that arise from the permitted activity; and recognize that by signing this application, I agree to complete all aspects of the project as authorized. I understand that failure to comply with the foregoing may result in violation of the 10 VSA Chapter 50, § 1455, and the Vermont Agency of Natural Resources may bring an enforcement action for violations of the Act pursuant to 10 V.S.A. chapter 201.

Applicant/Operator Signature: Shara Draper Town Clerk Date: 11/21/17

G. Application Preparer Certification (if applicable)

As APPLICATION PREPARER, I hereby 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 system, 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.

Application Preparer Signature: _____ Date: 11/21/17

H. Application Fees

Print Form

Submit this form and the $35 or $175 fee to:
(Municipalities are exempt from fees)

Vermont Department of Environmental Conservation
Watershed Management Division
Aquatic Nuisance Control Permit Program
1 National Life Drive, Main 2
Montpelier, VT 05620-3522

Direct all correspondence or questions to the Aquatic Nuisance Control Permit Program at:
ANR.Shoreland@vermont.gov

For additional information visit: www.watershedmanagement.vt.gov

Narrative

Reasons to control the aquatic nuisance

Lake Elmore is a small lake of 204 Acres. The Vermont Fish and Wildlife Department maintains a fishing access on the lake. In addition, the Vermont Department of Parks has campsites and a public beach on Lake Elmore. There are many camps and homes on the lake. The general public, who use the lake for recreational purposes (fishing, swimming, boating, etc.), need to be able to continue to do so. Continued growth of Eurasian Water Milfoil (EWM) without abatement could threaten further recreational use of the lake.

The Lake Elmore Lake Association (LELA) project will have short and long term impacts upon the lake and the entire watershed. It is designed to reduce and control Eurasian Water Milfoil in Lake Elmore. By doing so it will reduce the potential of EWM flowing over or through the dam and infesting downstream bodies of water. Thus, the project will both assist in the restoration of Lake Elmore and help protect the entire watershed.

By restoring the lake, the project helps to ensure that boaters and fishermen will be able to continue to have access to the lake. Without action, in the very near future access to the lake via the state boat ramp will be impossible. Restoration of the lake also will ensure safe swimming at the state park site. Failure to act will soon lead to unsafe swimming conditions at the park.

Protection of the downstream watershed is in the best interest of both residents of the area and the habitat. The watershed area is used for fishing, canoeing, kayaking, swimming, power boating and power generation. In addition to its use, it is important to protect the flora and fauna of the basin.

If left unchecked, Milfoil will form dense mats, inhibit many recreational uses and choke out native vegetation. In the case of Lake Elmore, it is also threatening two rare and uncommon plant species. While EWM is currently widespread in the Lake, there are only a few areas where it has formed very dense infestations. While it may not be realistic to completely eradicate this species from the Lake, it should be possible to halt its spread and decrease the size of the dense infestations. Such control can ensure that recreational use of the Lake can continue and the ecological integrity of the Lake ecosystem remains intact.

Brief history of the aquatic nuisance in the waterbody

Control of EWM has been undertaken for many years in Lake Elmore. Continued control will be necessary to ensure that dense infestations do not occupy an increasing area of the Lake. There are many techniques that have been used for control of aquatic vegetation, including bottom barriers, manual harvesting, suction harvesting and mechanical harvesting.

As evidenced by the dense infestations in the southern part of the Lake, EWM has the potential to become well established and choke out native aquatic vegetation. In these areas, it appears that EWM is having a significant detrimental impact on native vegetation. Outside of the Moderate and Dense infestations, the EWM is present only at low cover and does not appear to be posing a threat to native aquatic communities after this year's harvesting.

The use of bottom barriers, manual harvesting and suction harvesting have been used in the past and continue to be the best methods of control for Lake Elmore.

Description of proposed control activity

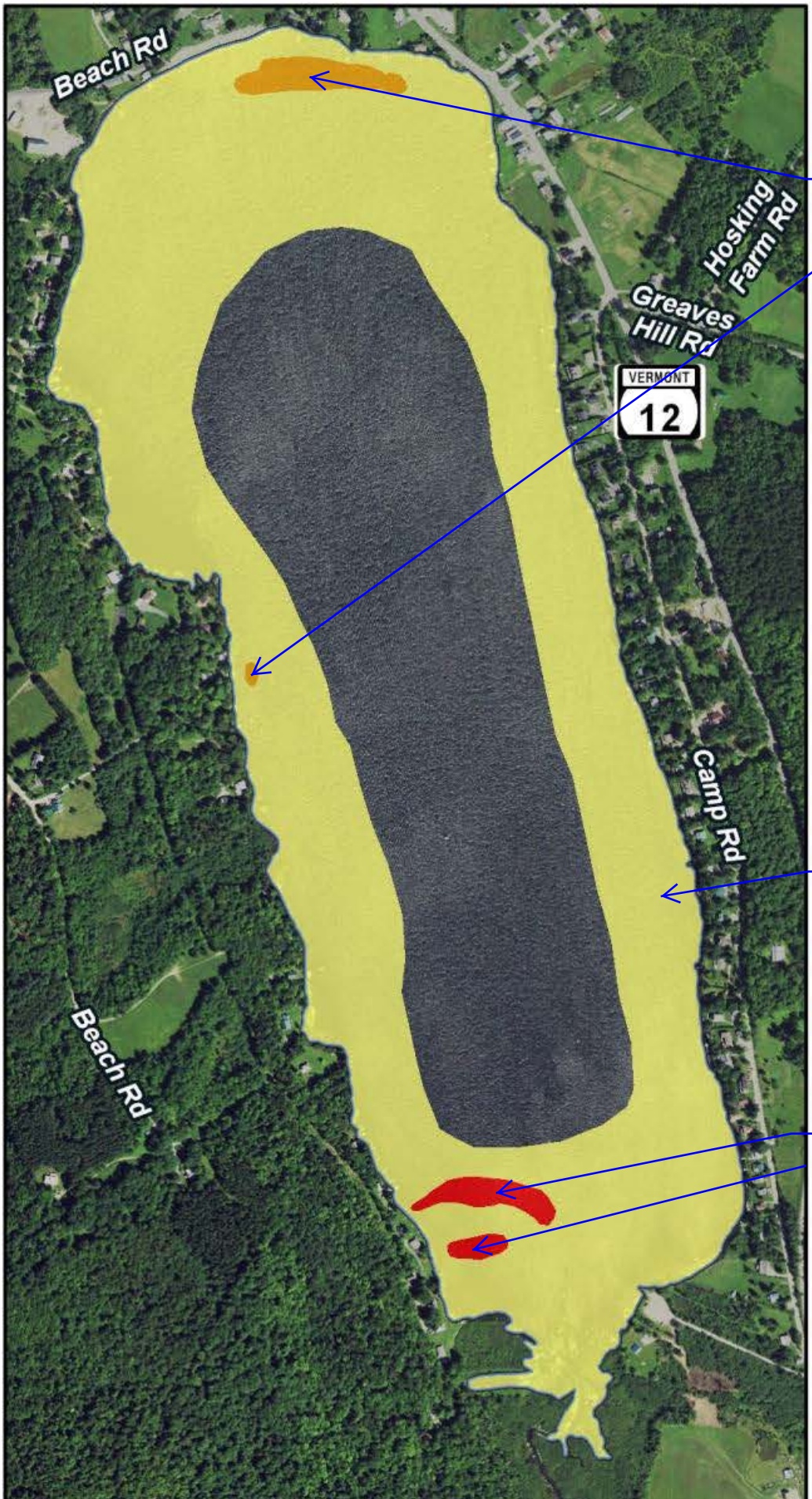
The highest priority for control next season will be the areas of dense infestation in the southern part of the Lake. Because these infestations are dense, Diver Assisted Suction Harvesting of EWM will be more efficient than harvesting by hand. Like herbicide use, the impacts on non-target organisms are unavoidable. However, since no rare or uncommon species are currently documented directly in the EWM infestation, suction harvesting continues to be one of the best options. Once the dense and moderately dense areas are removed the divers will continue removal in the sparse areas as outlined on the attached map of the lake.

The Diver Assisted Suction Harvesting Suction will remove the whole plant and root with the aid of our specially outfitted boat to increase efficiency. A pump on the boat creates suction in a hose carried by two divers. While carefully avoiding native plants, the divers will pull the entire milfoil plant by the root and send it through the hose.

On the boat, the hose discharges the EWM plants into a screened cage that allows water and milfoil to be separated on the barge. When the cage is full, the EWM will be removed from the barge and stockpiled for composting. While in practice the Diver Assisted Suction Harvesting boat uses the same techniques as hand removal the true difference is volume. It is much faster for a diver to send the milfoil up the hose than to bag it underwater.

Pictures of the equipment to be used are attached. The surrounding area will be protected by a floating turbidity curtain to contain any floating EWM. With the proposed measures it should be possible to halt the spread of the EWM and decrease the size of the dense infestations. Such control can ensure that recreational use of the Lake can continue and the ecological integrity of the Lake ecosystem remains intact.

Cover as of
September 2017



Area of Moderate Cover

Area of Sparse Cover

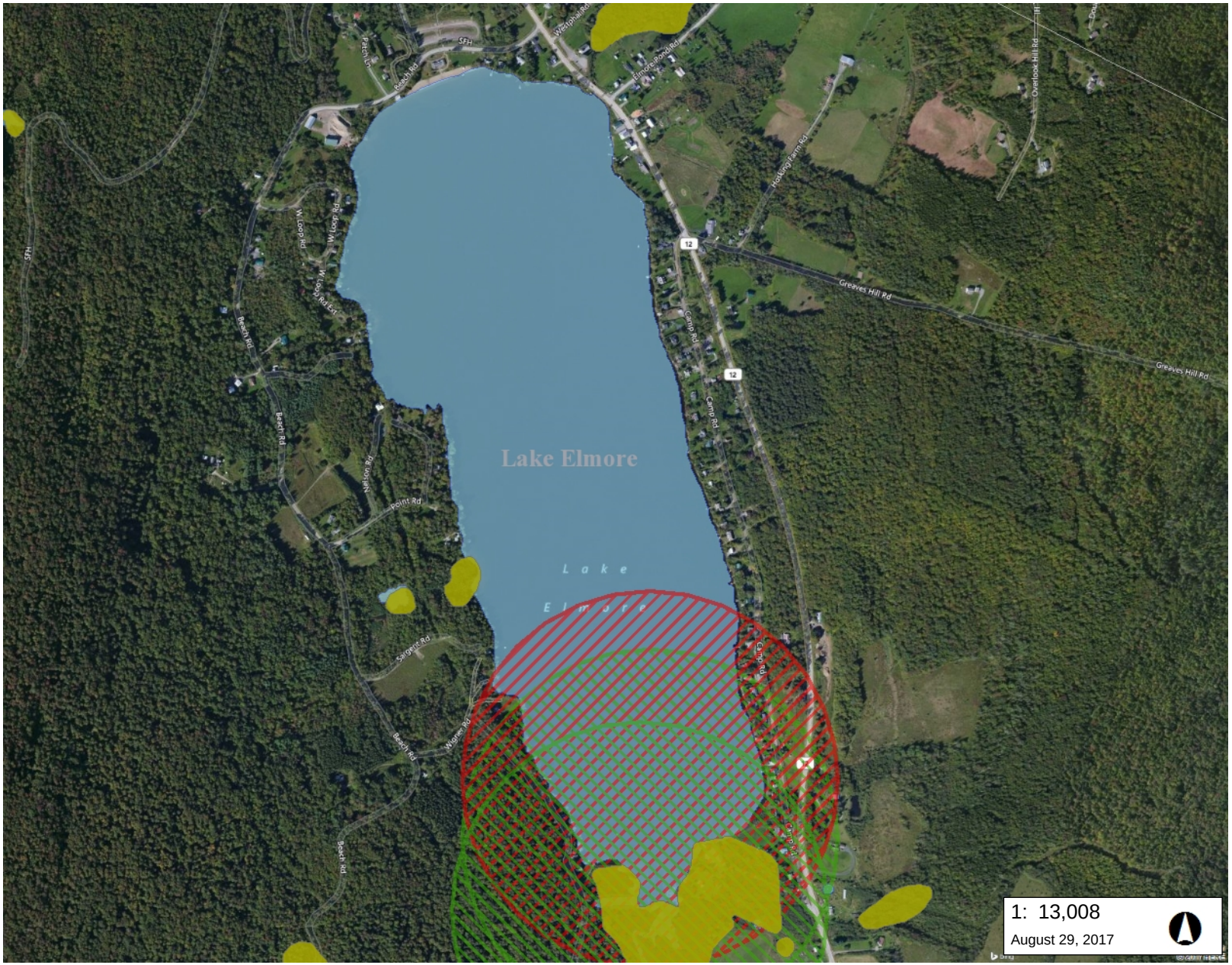
Areas of Dense Cover

VERMONT

Lake Elmore Wetlands & RTE

Vermont Agency of Natural Resources

vermont.gov



LEGEND

- Wetland - VSWI
  - Class 1 Wetland
  - Class 2 Wetland
  - Buffer
- Rare Threatened Endangered
  - Threatened or Endangered
  - Rare
- Waterbody
- Town Boundary

NOTES

Map created using ANR's Natural Resources Atlas

661.0 0 330.00 661.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere 1" = 1084 Ft. 1cm = 130 Meters

THIS MAP IS NOT TO BE USED FOR NAVIGATION

Complete Species Roster

SpeciesID	Genus/species	Earliest Record	Most Recent Record	Common Name	RTE Ranks State	Global
ELMORE				Total Number of Species:		52
CAL.CAL	*Callitriche sp.*	8/13/1991	9/11/2017	water-starwort		
CHA.CHA	*Chara sp.*	8/19/1982	9/11/2017	muskgrass		
CYP.ELE	*Eleocharis sp.*	7/27/1988	6/30/2003	spikerush		
CYP.ELE.ACI	*Eleocharis acicularis*	8/13/1991	9/11/2017	slender spikerush		
HYD.ELO.CAN	*Elodea canadensis*	8/19/1982	9/11/2017	common elodea		
HYD.ELO.NUT	*Elodea nuttallii*	6/30/2003	6/30/2003	Nuttall's waterweed	S3	G5
ERI.ERI.AQU	*Eriocaulon aquaticum*	8/19/1982	9/11/2017	pipewort		
POA.GLY.BOR	*Glyceria borealis*	6/30/2003	6/30/2003	northern manna grass	S3	G5
IRI.IRI.PSE	*Iris pseudacorus*	7/10/1997	6/30/2003	yellow iris		
ISO.ISO	*Isoetes sp.*	7/27/1988	9/6/2006	quillwort		
ISO.ISO.RIP	*Isoetes riparia*	9/11/2017	9/11/2017	river bank quillwort	S2	G5?
JUN.JUN.PEL	*Juncus pelocarpus*	9/11/2017	9/11/2017	brownfruit rush		
LYT.LYT.SAL	*Lythrum salicaria*	9/6/2006	9/6/2006	purple loosestrife		
HAL.MYR.SPI	*Myriophyllum spicatum*	9/5/2002	9/11/2017	Eurasian watermilfoil		
HAL.MYR.TEN	*Myriophyllum tenellum*	6/30/2003	9/11/2017	leafless watermilfoil		
NAJ.NAJ.FLE	*Najas flexilis*	8/19/1982	9/6/2006	common naiad		
CHA.NIT	*Nitella sp.*	8/13/1991	9/11/2017	brittlewort		
NYM.NUP	*Nuphar sp.*	7/27/1988	9/6/2006	pond-lily		
NYM.NUP.VAR	*Nuphar variegata*	8/19/1982	9/11/2017	cow lily		
NYM.NYM.ODO	*Nymphaea odorata ssp. Odorata*	8/19/1982	6/30/2003	white waterlily		
NYM.NYM	*Nymphaea sp.*	7/27/1988	9/11/2017	water lily		
POL.POL.AMP	*Polygonum amphibium*	7/27/1988	6/30/2003	water smartweed		
POL.POL	*Polygonum sp.*	8/19/1982	8/19/1982	knotweed		
PON.PON.COR	*Pontederia cordata*	9/11/2017	9/11/2017	pickerel-weed		
POT.POT.PER	*Potamogeton perfoliatus*	7/27/1988	9/11/2017	claspingleaf pondweed		
POT.POT.VAS	*Potamogeton vaseyi*	7/6/1978	9/11/2017	Vasey's pondweed	S2	G4
POT.POT.STR	*Potamogeton strictifolius*	7/27/1988	7/27/1988	straight-leaf pondweed	S2S3	G5
POT.POT.SPI	*Potamogeton spirillus*	7/27/1988	9/11/2017	snailseed pondweed		
POT.POT.ROB	*Potamogeton robbinsii*	8/19/1982	9/11/2017	Robbin's pondweed		
POT.POT.RIC	*Potamogeton richardsonii*	8/19/1982	6/30/2003	Richard's pondweed		
POT.POT.PUT	*Potamogeton pusillus ssp. Tenuis*	9/6/2006	9/6/2006	small pondweed		
POT.POT.PUP	*Potamogeton pusillus ssp. Pusillu*	9/6/2006	9/6/2006	slender pondweed		
POT.POT	*Potamogeton sp.*	7/7/1997	9/5/2002	pondweed		
POT.POT.OBT	*Potamogeton obtusifolius*	8/13/1991	8/13/1991	blunt-leaf pondweed	S3	G5
POT.POT.AMP	*Potamogeton amplifolius*	8/19/1982	9/11/2017	big-leaf pondweed		
POT.POT.NAT	*Potamogeton natans*	8/13/1991	9/11/2017	floating-leaf pondweed		

SpeciesID	Genus/species	Earliest Record	Most Recent Record	Common Name	RTE Ranks State	Global
ELMORE				Total Number of Species:		52
POT.POT.ILL	*Potamogeton illinoensis*	8/19/1982	8/19/1982	Illinois pondweed		
POT.POT.GRA	*Potamogeton gramineus*	8/19/1982	9/11/2017	variable-leaf pondweed		
POT.POT.EPI	*Potamogeton epihydrus*	8/19/1982	9/11/2017	ribbonleaf pondweed		
POT.POT.PUS	*Potamogeton pusillus*	8/13/1991	6/30/2003	small pondweed		
RAN.RAN.AQD	*Ranunculus aquatilis L. var. diffu*	9/11/2017	9/11/2017	white water-crowfoot	S3	G5
ALI.SAG.GRA	*Sagittaria graminea*	9/11/2017	9/11/2017	slender arrowhead		
ALI.SAG	*Sagittaria sp.*	7/27/1988	9/6/2006	arrowhead		
CYP.SCI	*Scirpus sp.*	8/19/1982	8/19/1982	bulrush		
SPA.SPA	*Sparganium sp.*	7/27/1988	9/6/2006	bur-reed		
SPA.SPA.ANG	*Sparganium angustifolium*	7/7/1997	9/11/2017	floating-leaf bur-reed		
SPA.SPA.FLU	*Sparganium fluctuans*	9/9/1989	6/30/2003	lesser bur-reed	S3	G5
SPA.SPA.NAT	*Sparganium natans*	8/19/1982	8/19/1982	small bur-reed	S2	G5
LEN.UTR	*Utricularia sp.*	8/19/1982	8/19/1982	bladderwort		
LEN.UTR.VUL	*Utricularia macrorhiza*	7/27/1988	9/11/2017	common bladderwort		
HYD.VAL.AME	*Vallisneria americana*	7/27/1988	9/11/2017	wild celery		
PON.ZOS.DUB	*Zosterella dubia*	7/27/1988	8/13/1991	water stargrass		

POWERED MECHANICAL DEVICE REPORT FORM

Permittee Name: _____

Permittee Address: _____

_____

Permit Number: _____ Date: _____

If required, submit report to:

Lakes & Ponds Regulatory Program
1 National Life Drive, Main 2
Montpelier, VT 05620-3522

Or via email to: ANR.WSMDShoreland@vermont.gov

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION
LAKES & PONDS PROGRAM

Date	Operator's Name	Authorized Harvesting Location	Harvesting Area Size	Density of Growth	Volume of material removed	Non-target Mitigation
MM/DD/YYYY	Example Entry	Northern half of authorized area	900 feet^2	Abundant/at surface	10 yards^3	1 musk turtle found in spoils. Returned to water.

"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 system, 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."

Operator's Signature: _____

Record all harvesting activity throughout the authorized calendar year. Submit this form annually to the address above in accordance with the Aquatic Nuisance Control Permit. Add additional sheets as necessary.

Notice of Addition of Permittee

under an **Aquatic Nuisance Control Permit**
per 10 V.S.A. § 1455

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION
LAKES & PONDS PROGRAM

Submission of this complete form constitutes notice that the entity in Section C seeks to be added as a permittee to an existing individual Aquatic Nuisance Control Permit originally issued to the entity in Section B pursuant to 10 VSA § 1455.

A. Project Information

1. Permit Number: 2. Waterbody Name:

3. Control Activity Type: ☐ Pesticides ☐ Biological Control ☐ Structural Barrier ☐ Bottom Barrier ☐ Powered Mechanical Device (mechanical harvester, DASH) ☐ Chemicals other than Pesticides

B. Current Permittee Information

Check one or both: ☐ Decision-maker ☐ Operator*

1. Name:		
2a. Mailing Address:		
2b. City/Town:	2c. State:	2d. Zip:
3. Phone:	4. Email:	

C. Additional Permittee Information

Check one or both: ☐ Decision-maker ☐ Operator*

1. Name:		
2a. Mailing Address:		
2b. City/Town:	2c. State:	2d. Zip:
3. Phone:	4. Email:	

D. Certification

I hereby certify that the statements presented on this form are true and accurate; guarantee to hold the State of Vermont harmless from all suits, claims, or causes of action that arise from the permitted activity; and recognize that by signing this application, I agree to complete all aspects of the project as authorized. I understand that failure to comply with the foregoing may result in violation of the 10 VSA Chapter 50, § 1455, and the Vermont Agency of Natural Resources may bring an enforcement action for violations of the Act pursuant to 10 V.S.A. chapter 201.

Current (Section B) Permittee:
Signature: _____ Date: _____

Additional (Section C) Permittee:
Signature: _____ Date: _____

Submit this form to:

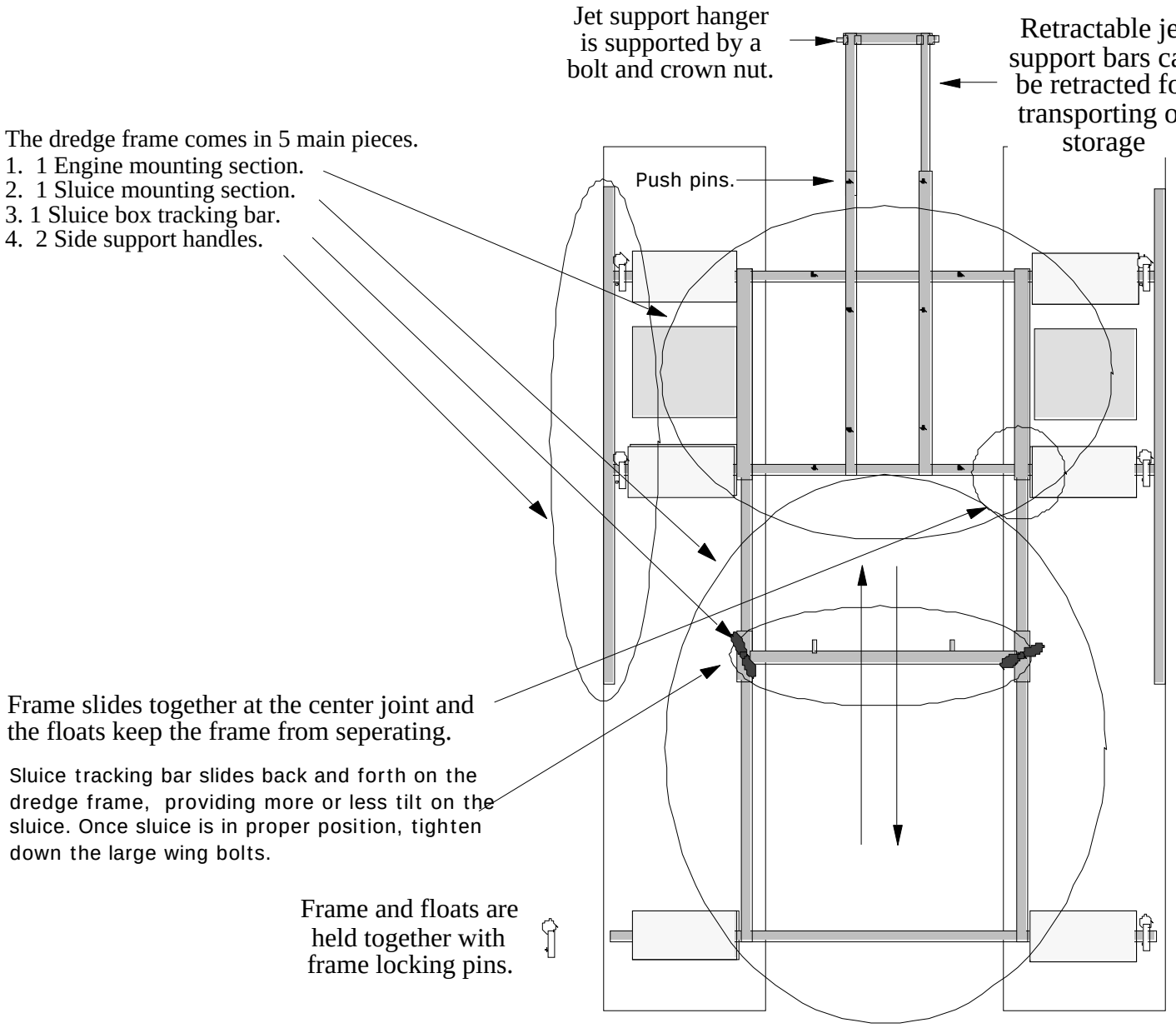
Watershed Management Division
Lake & Shoreland Permitting
1 National Life Drive, Main 2
Montpelier, VT 05620-3522

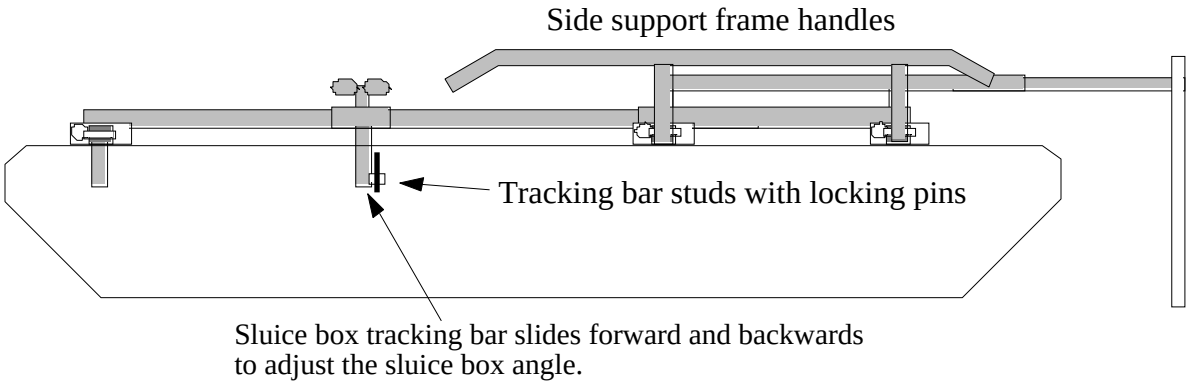
Direct all correspondence to: ***Lake & Shoreland Permitting****:* ***ANR.WSMDShoreland@vermont.gov*** ***or (802) 490-6199***

*Decision-makers & Operators as Permittees. A Permittee is defined to mean any person associated with aquatic nuisance control activities (activity) (1) who performs the activity or who has day-to-day control of the activity; or, (2) any person with control over the decision to perform the activity including the ability to modify those decisions. Permittees identified as (1) are referred to in this permit as Operators while Permittees identified as (2) are referred to in this permit as Decision-makers. More than one Operator may be responsible for complying with this permit. Permittees are defined as a Decision-maker, as an Operator, or as both. When a Permittee is both a Decision-maker and an Operator, the Permittee must comply with all applicable requirements.

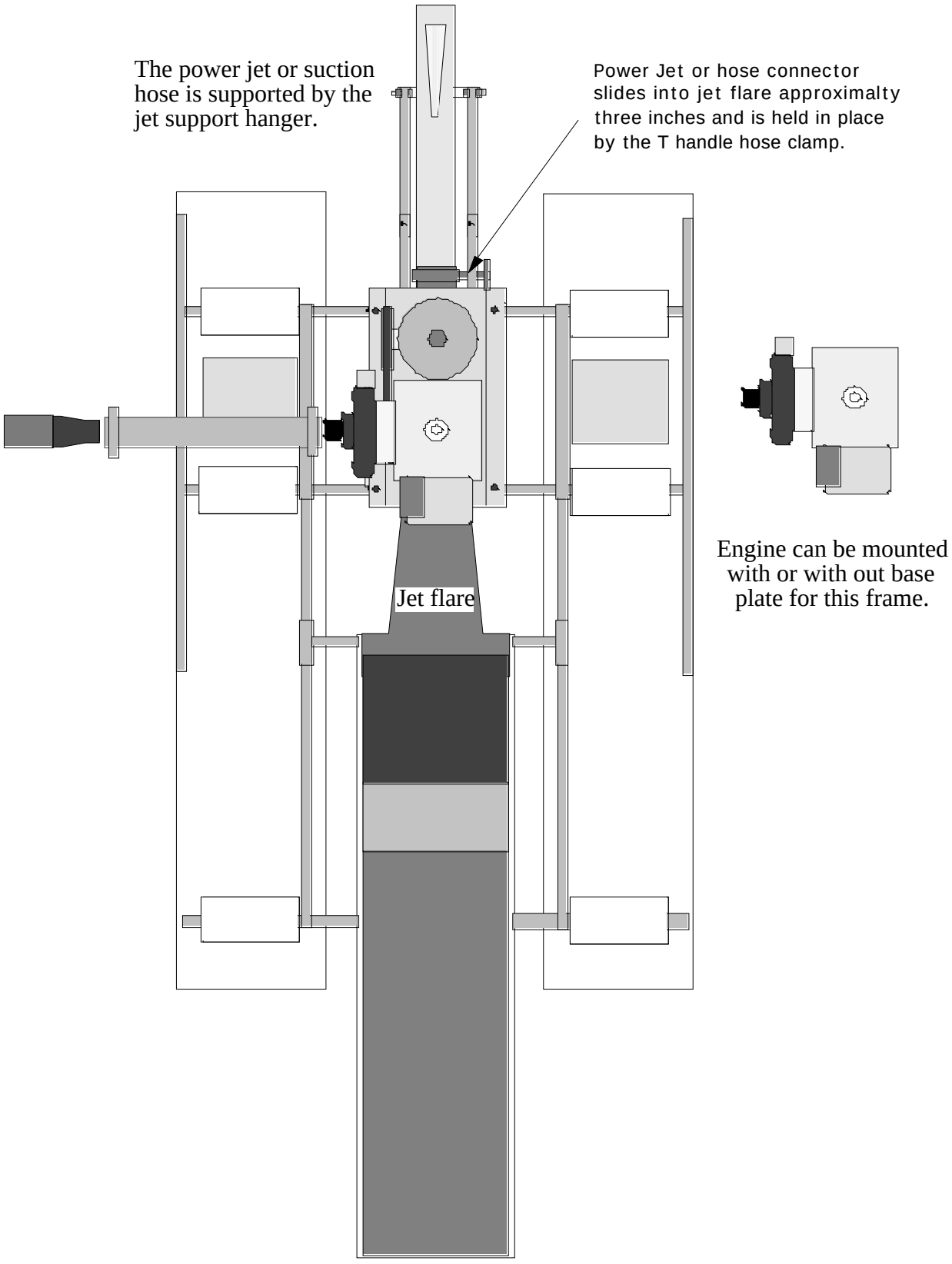
2.5 " DREDGE ASSEMBLY INSTRUCTIONS

TOP VIEW OF 2.5" DREDGE FRAME

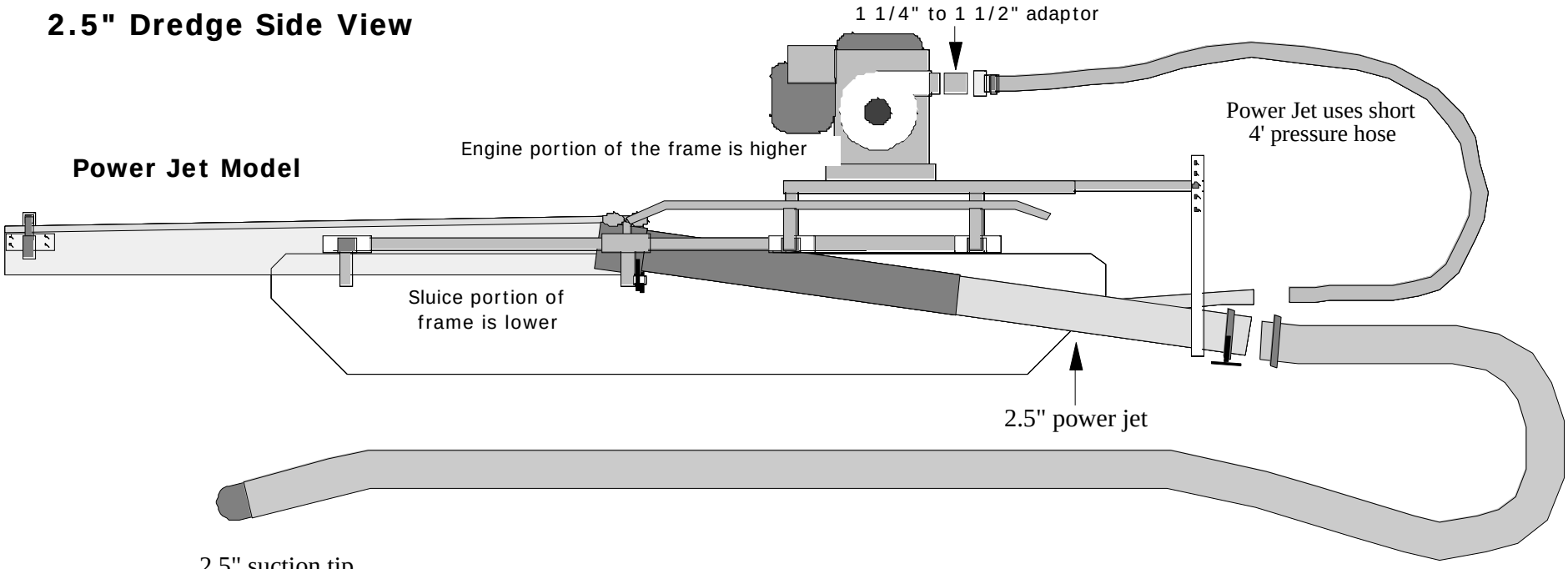


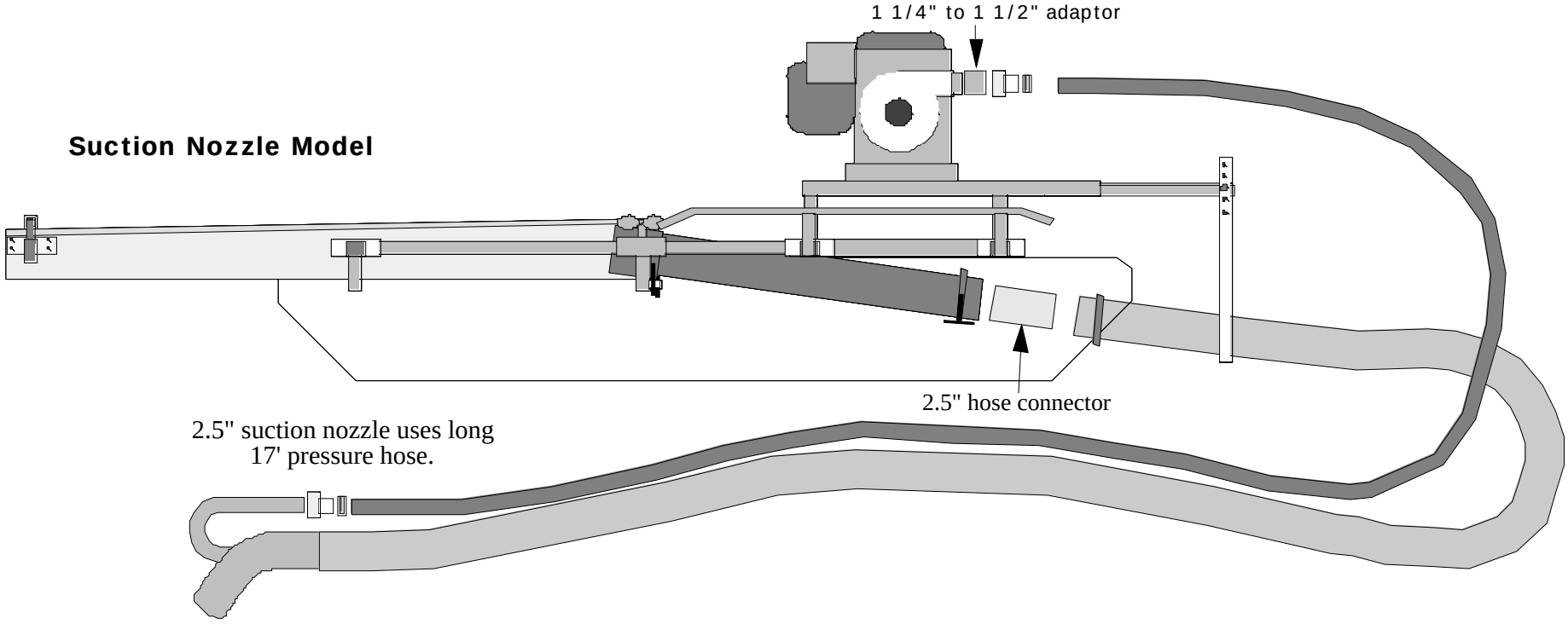


2.5 " DREDGE ASSEMBLY INSTRUCTIONS
Top view

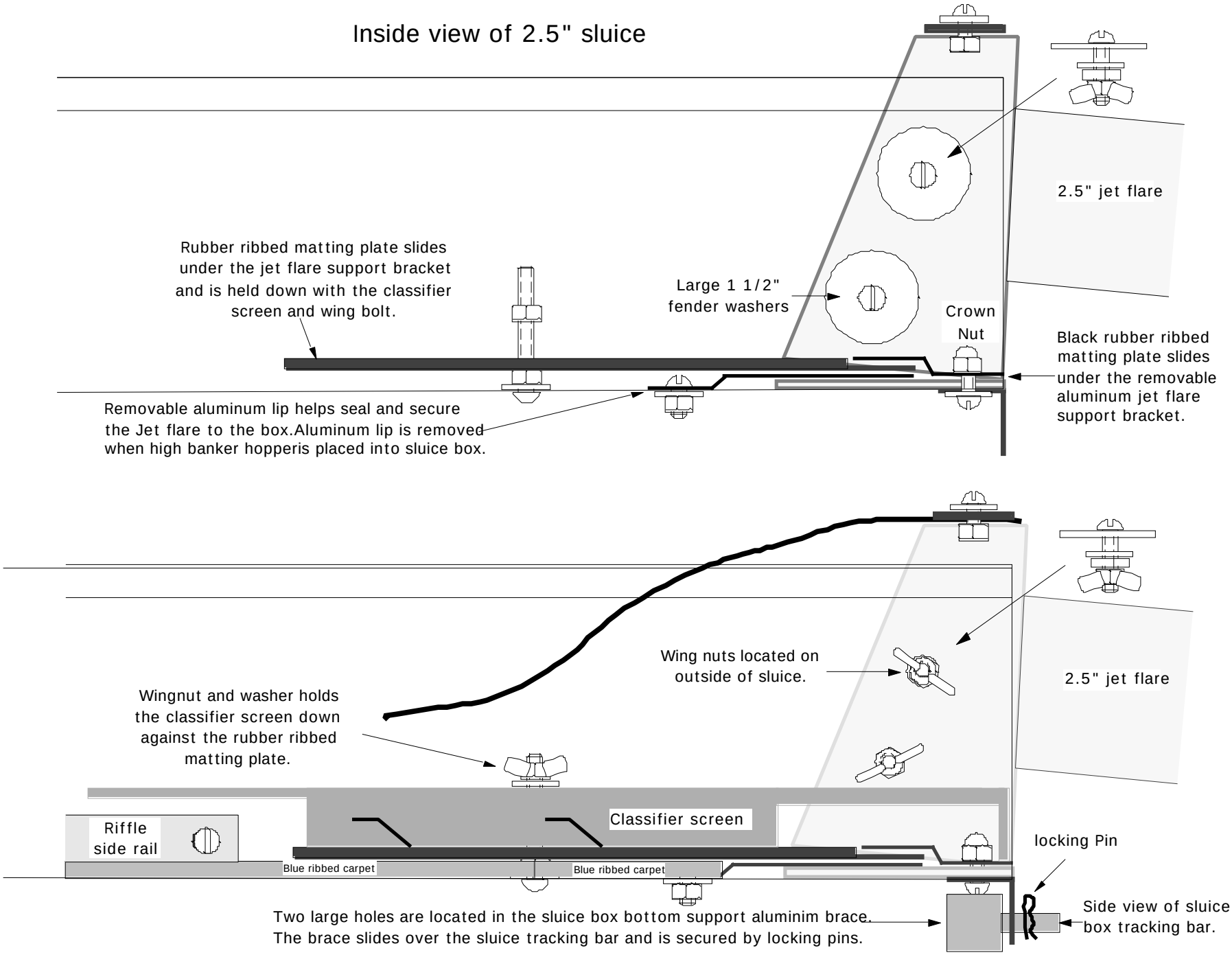


2.5" Dredge Side View

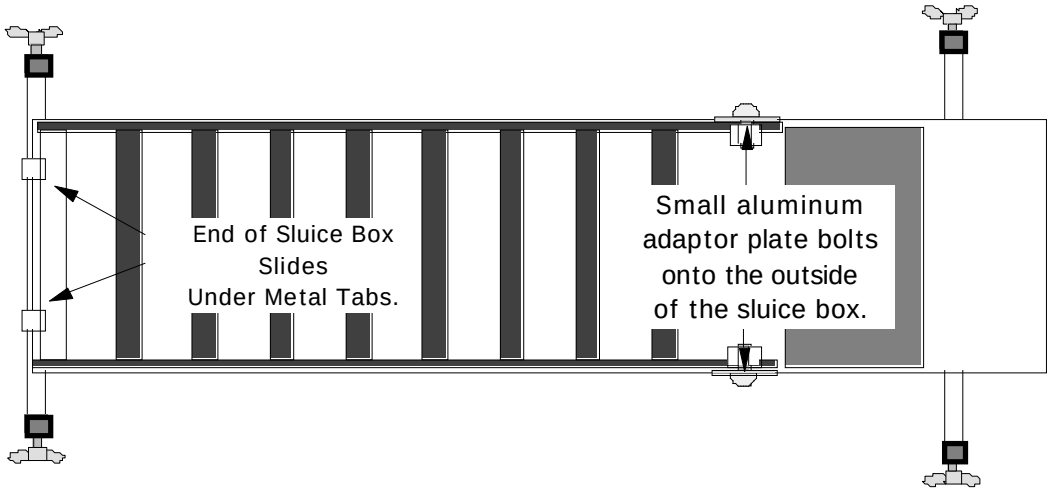


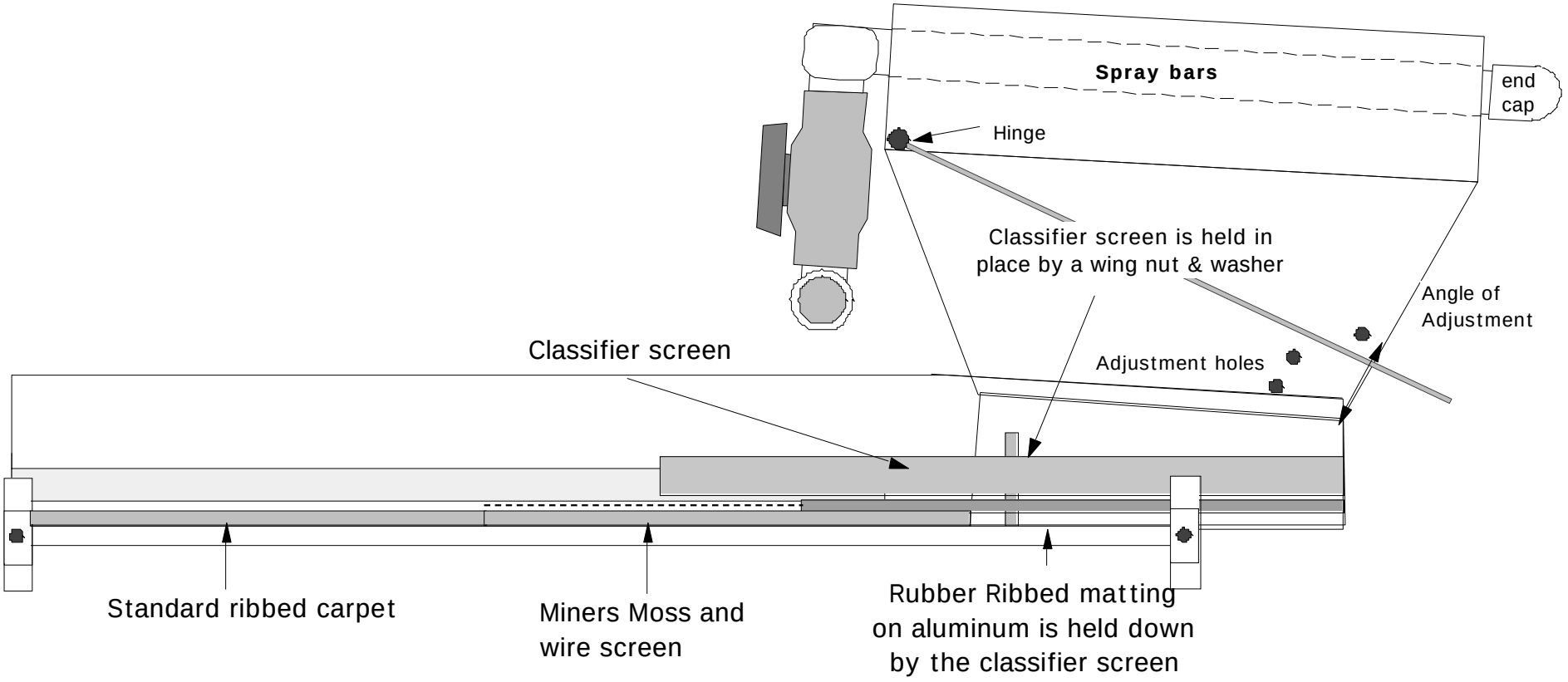


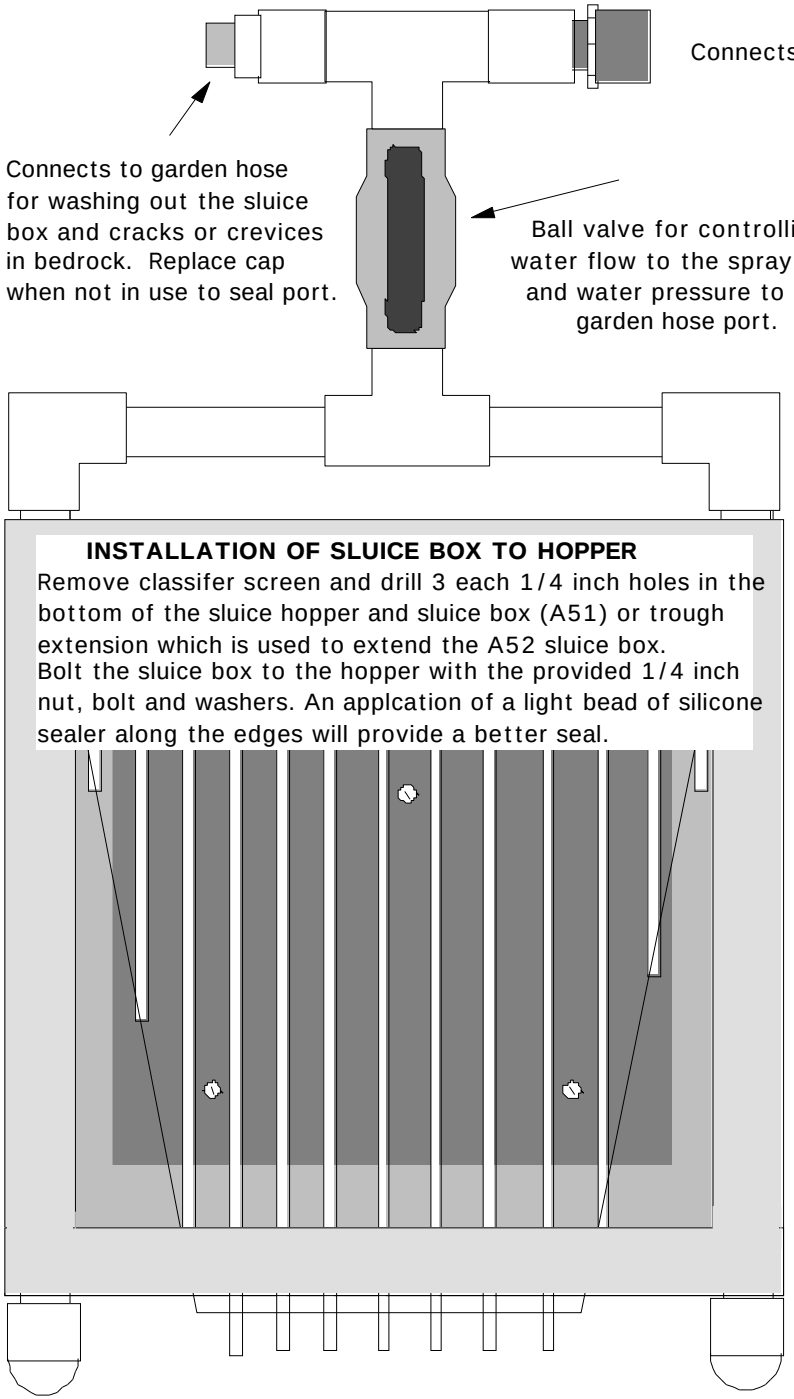
Inside view of 2.5" sluice



2503 Conversion Assembly Instructions





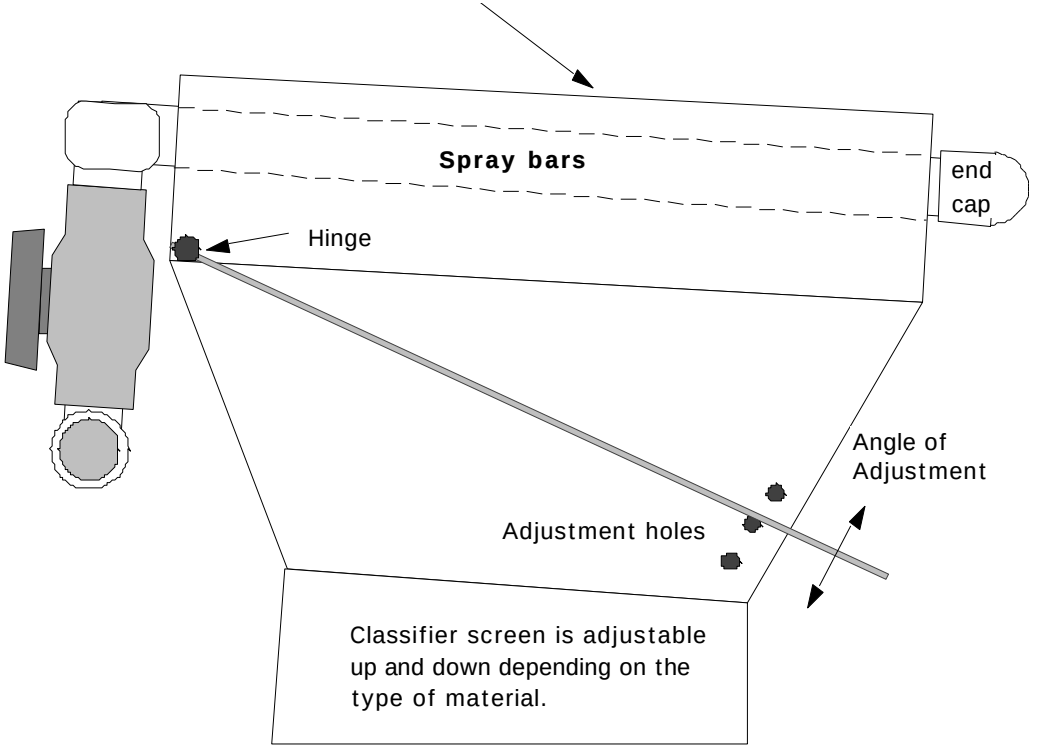


INSTALLATION OF SLUICE BOX TO HOPPER

Remove classifer screen and drill 3 each 1/4 inch holes in the bottom of the sluice hopper and sluice box (A51) or trough extension which is used to extend the A52 sluice box.

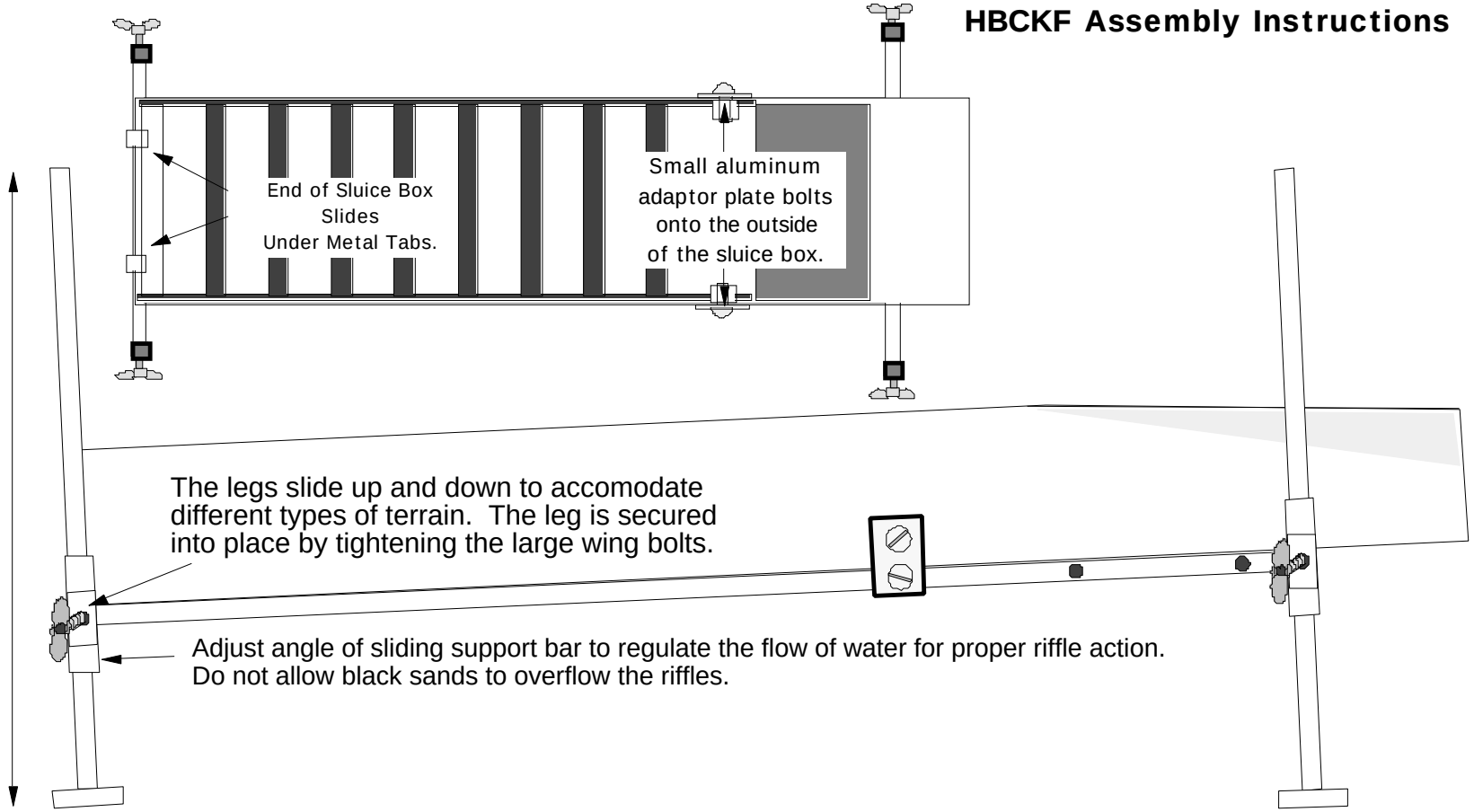
Bolt the sluice box to the hopper with the provided 1/4 inch nut, bolt and washers. An applcation of a light bead of silicone sealer along the edges will provide a better seal.

The spray bars can be adjusted to angle of flow of water to compensate for higher or lower pump pressure. The PVC spray bars and end caps are not glued together so they can be disasembled for cleaning or rotated for various types of material. A pair of channel locks may be required for removal of the end caps and spraybar adjustment.

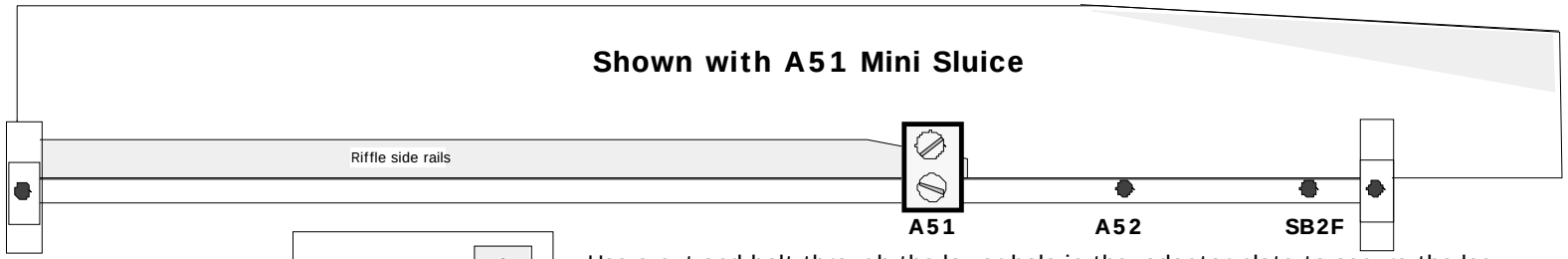


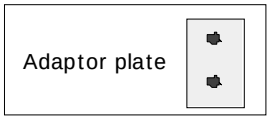
The classifier screen should be adjusted to the upper position for hard pack material or heavy clay. The classifier screen should be moved as low as possible to maximize production, however you should check the tailings to see if the oversized gravel is free of any small or loose material.

HBCKF Assembly Instructions



Shown with A51 Mini Sluice





Use a nut and bolt through the lower hole in the adaptor plate to secure the leg frame assembly to the sluice box**Note:** When using the A52 Sluice, you may want to replace the flair with the trough extension for a better fit.

GENERAL OPERATING INSTRUCTIONS

THE FOLLOWING INFORMATION SHOULD ENABLE YOU TO UNDERSTAND THE BASIC THEORY OF OPERATION OF A PORTABLE DREDGE.

For more complete understanding on this subject, we recommend you read any one of a variety of books available through the Keene Library of Books, such as The Gold Miners Handbook, Dredging for Gold or Advanced Dredging Techniques. The vacuum on a portable dredge is created by a "venturi principal". A volume of water is pumped through a tapered orifice (jet), by a special designed water pump. A high velocity jet stream is created within the jet tube producing a powerful vacuum. As indicated in the diagram gravel is dredged into the suction hose and is delivered to the sluice jet flare. As a slurry of water and gravel enters the jet flare and is spread evenly over a classifier screen. The smaller and heavier particles drop below the classifier screen into an area of less velocity, allowing a slower and more selective classification of values. Often values are recovered and easily observed before they even enter the riffle section. The lighter non bearing values and larger aggregate are returned back into the water. The riffles, or gold traps in the sluice box are best described as "Hungarian Riffles". This type of riffle has proven to be the most efficient gold recovery system. As material flows over the riffles, a vortex, or eddy current is formed between each riffle opening. This force allows the heavier material to settle out of suspension and the lighter, non value bearing material to be washed away. This continuous self cleaning principal allows a dredge to be operated for prolonged periods of time. Normal conditions require a sluice box to be cleaned only once or twice a day.

PRIMING THE PUMP

Before starting the engine, the pump must be fully primed. This means the pump must be full of water and all air removed. All jetting pumps provided with our dredges have a mechanical water pump seal. Without the presence of water in the pump, friction could cause a seal to overheat and require replacement. Priming the pump on some of the smaller models is accomplished by thrusting the foot valve back and forth under the surface of the water in a reciprocating motion. This will pump water into the foot valve assembly and into the pump. A pump is fully primed when water is observed flowing out of the discharge end of the pump. It may sometimes become necessary to hold the discharge hose above the level of the pump to complete the priming operation. The larger dredges that have a rigid foot valve, are easily primed by removing the cap provided on the foot valve and filling, until water overflows. Caution must be exercised to prevent sand from entering the foot valve or intake portion of the pump. Excess amounts of sand could damage the water pump seal, or pump impeller. It is recommended that the intake portion of the foot valve be placed in a sand free environment underwater, such as a small bucket or pan.

PRIMING THE SUCTION HOSE

Priming the suction hose need not be of concern in most dredging operations, but is important to understand the principal. When the tip of the suction hose is taken out of the water during operation air will enter the suction system and cause the suction power to cease temporarily, until submerged again. The suction will commence as soon as the air has passed through the system. It is important to ensure that no air leaks occur in the suction system.

SUCTION SYSTEM OBSTRUCTIONS

The suction system can become jammed while dredging. This can be caused by dredging an excess of sand, causing the suction hose to load up, or a rock that has become stuck in the suction system. Rock jams generally occur in the jet, or just before entry into the jet. This can easily be cleared by removed by flipping the rubber damper back over the jet flare and thrusting the probe rod down through the jet flare and jet in an effort to strike the obstructed area. It may occasionally be necessary to remove the suction hose to remove an obstruction. If this is not successful. it may be necessary to locate the blockage in the transparent hose and dislodge it by a striking the obstruction, taking care not to damage the hose.

SOLID CONTENT

Care must be exercised to prevent dredging excess amounts of sand. A solid to water balance must be maintained. The solid content being dredged should never exceed 10%. If a suction tip is buried in the sand and not metered properly the solid content could cause the suction hose to become overloaded with solids and suction will cease, this will also cause the sluice box to become overloaded with solid content, resulting in a loss of values.

SLUICE BOX ADJUSTMENT

Most models have a slight adjustment to raise or lower the sluice box. The proper sluice box adjustment can effect the recovery of values. If the sluice does not have enough angle, the sluice box will "load up" causing the riffle openings to fill with unwanted excess material. Too much angle will cause the material to flow too fast, resulting in loss of values, evidenced by the riffles running too clean. The optimum adjustment of a properly working sluice box is evident by only a portion of the riffle is visible while operating. A loss of values can also occur if the solid content of the suction discharge is too heavy in solid content. Remember, the solid content should not exceed 10 %. A normal sluice box tilt is approximately 3/4” inch to the running foot. Afour foot sluice box should have an approximate tilt of 3"

CLEANING THE SLUICE BOX

Before attempting to clean the sluice box, it should be allowed to run with only water for a few minutes in order to wash

out any excess gravels that have accumulated. Either turn engine off, or let run with a slow idle, then remove the classifier screen and replace the wing nut to prevent losing it. Unsnap the riffle latches, fold the riffle tray up, and let rest against the jet flare, taking care not to let it drop back into place while cleaning. This could result in a potential injury! Place a wide tray, bucket or large gold pan at the end of the sluice, then carefully roll up the riffle matting and wash into the container at the end of the sluice. Rinse any excess gravel that remains in the sluice into container. All material must be removed before replacing the riffle matting, riffle tray and classifier screen.

ENGINE SPEED

Most small engines are throttle controlled. The speed of the engine can be controlled with the use of a lever. Although the rated horsepower is achieved on most small engines at 3600 R.P.M., it may not be necessary to operate the dredge at full speed. Lower speeds conserve engine life and fuel economy. Be sure to read all instructions and especially the engine instructions that are provided with each unit. **ENGINES ARE NOT SHIPPED FROM THE FACTORY CONTAINING OIL. OIL MUST ADDED PRIOR TO USE! ENGINES OPERATED WITHOUT SUFFICIENT OIL SUPPLY WILL INVALIDATE ENGINE WARRANTEE!**

TROUBLE SHOOTING

[A] IF SUCTION DECLINES

1. Check the suction device for an obstruction. An obstruction can be removed by probing the obstructed area with the provided probe rod. I may be necessary to check the suction hose for a visible obstruction. This can be remedied by either back flushing the system or dislodging the obstruction with a gentle blow.

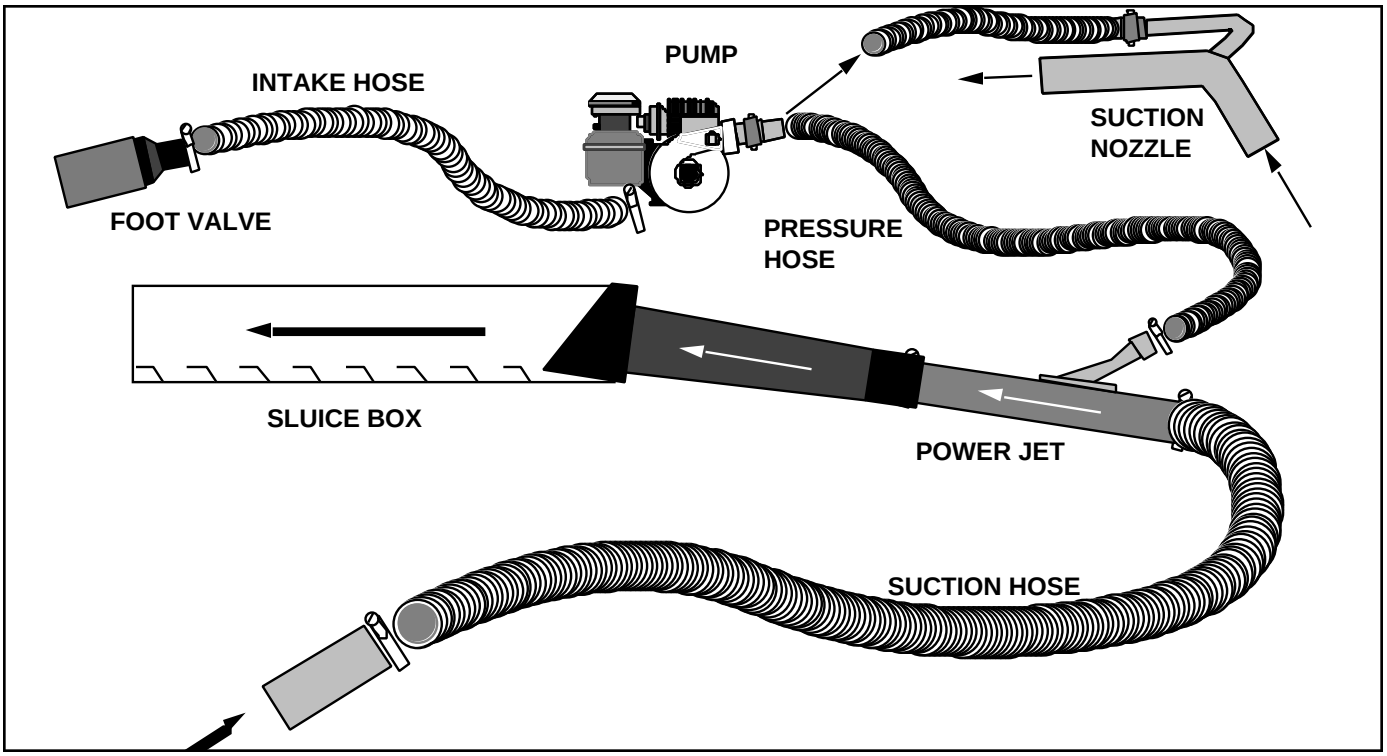
2. Check the pump for loss of prime or blockage. The foot valve may be too close to the surface of the water and air may enter the intake of the pump via a small whirlpool. The pump intake or foot valve screen may be plugged with leaves or moss, restricting flow into the intake of the pump. Check and tighten all clamps to prevent an air leak.

[B] IF PRIMING THE PUMP BECOMES DIFFICULT

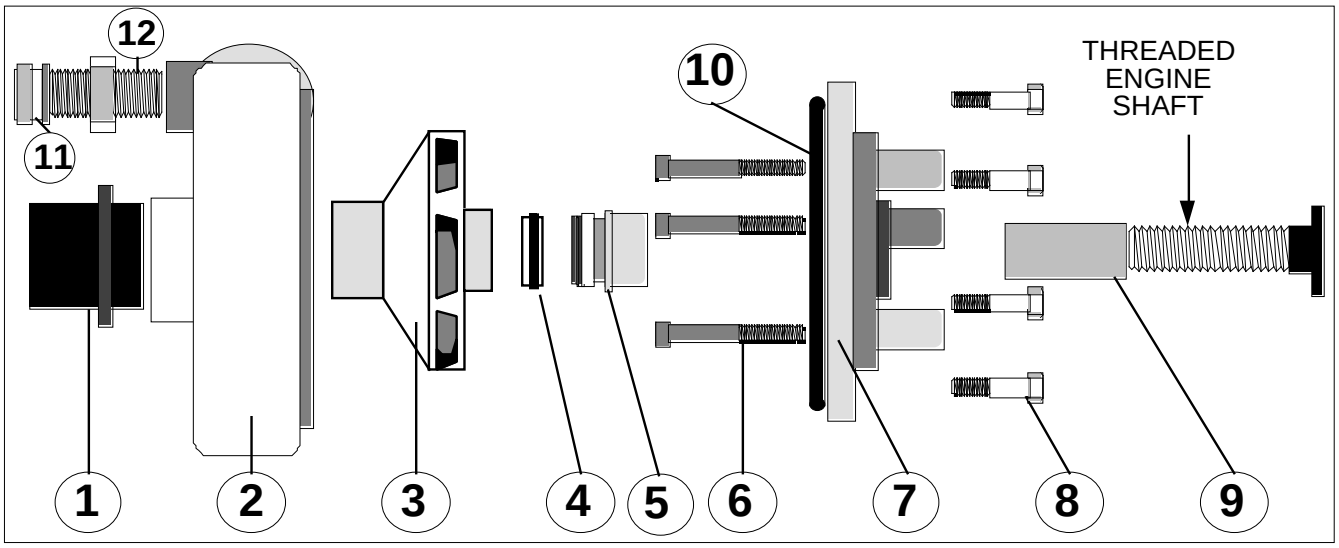
1. Check all clamps for an air leak.

2. It may be necessary to check the foot valve for a small leak. This is accomplished by removing the foot valve assembly from the pump and blowing air into the hose portion of the assembly and listening for an air escape. It may be necessary to remove the hose and check the rubber valve for an evidence of a leak, or for a small obstruction preventing the valve from sealing.

3. If a water pump seal is either defective or damaged, a leak will be evident on the inside portion of the pump around the drive shaft. Often a new pump will leak slightly, until the seal and gasket has become fully seated. This is a common occurrence in most new pumps.



CENTRIFUGAL PUMP ASSEMBLY
STANDARD 5/8" TREADED SHAFT ENGINE



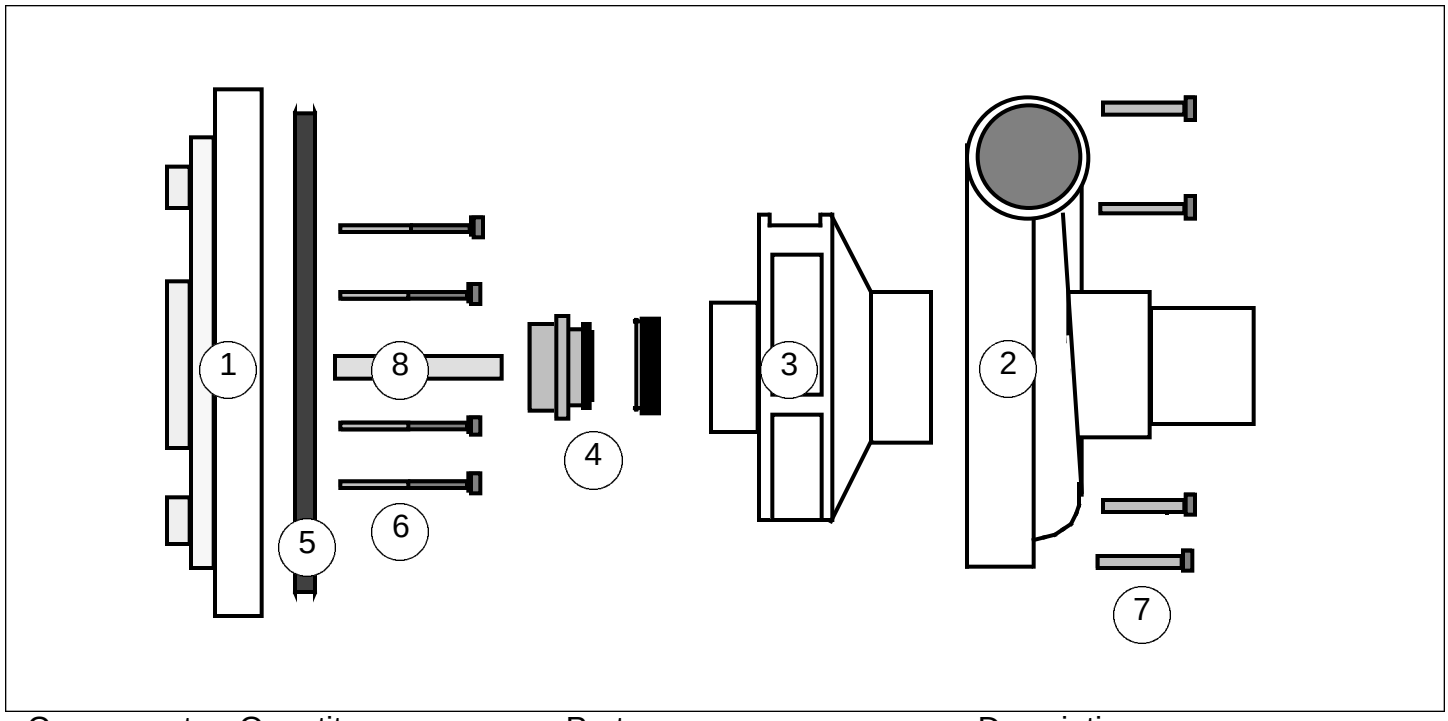
P100 and P180 PUMPS

			P100	P180
ITEM	DESCRIPTION	QUANTITY	PART NO.	PART NO.
1	HOSE ADAPTER	1	HA1	HA1
2	OUTER HOUSING	1	101	181
3	IMPELLAR	1	102	182
4	PUMP SEAL (CERAMIC SEAL)	1	WPS2(PT.1)	WPS2(PT.1)
5	PUMP SEAL (SPRING & CASING)	1	WPS2(PT.2)	WPS2(PT.2)
6	MOUNTING PLATE BOLT	3	MB	MB
7	MOUNTING(BACK) PLATE	1	105	105
8	HOUSING BOLT	4	HB	HB
8A	HOUSING BOLT WASHERS	4	HW	HW
9	SHAFT BUSHING	1	SB	SB
9A	COMPRESSOR DRIVE	1	P3	P3
10	"O" RING(GASKET)	1	104	104
11	FLUSHER ADAPTER CAP	1	FAC	FAC
12	FLUSHER ADAPTER	1	FA	FA
13	FAC RUBBER SEAL(INSIDE CAP)	1	FACS	FACS

INSTALLATION NOTES:
The rotation of all is counter-clockwise. Water must be contained within the pump while it is running. Do not run the pump dry, as it will damage the pump seal and may lead to the need to replace the seal. To ensure continuous performance, it is always a good idea to carry a spare seal, in case you need to replace it. For maximum pump performance, use only Keene Engineering foot valves.

INSTALLATION INSTRUCTIONS:
1. Before installing the mounting plate (7) to the engine, the spring portion of the water pump seal (5) must be installed. Place this portion of the seal into the center of the mounting plate, with the use of a light hammer and or blunt instrument and a seal setting tool. Tap the perimeter metal portion of the seal to set the seal into position. Care must be taken to avoid contact with the carbon portion of the seal. A small amount of Silicone Rubber Cement placed in this section will insure a water tight seal. Insert the FOURmounting bolts (6) into the mounting plate (7). Tighten the bolts evenly so as to prevent mis-alignment.
2. Fit "O" Ring gasket (OR1) into "O" slot on the front face of the mounting plate, making sure that it is properly seated. Place the ceramic portion of the water pump seal (4) into the center of the impeller (3) firmly, using the heal of your hand to insure a proper fit. The ceramic surface of the seal must be facing outwards. Thread the impeller onto the engine shaft by turning it gently in a clockwise rotation, taking care to avoid damage to the threads on the impeller.
3. Attach the outer housing (2) to the mounting plate, using the housing bolts (8) and washers (8A). Tighten the housing bolts evenly to ensure proper tension and alignment. Extreme care must be taken to prevent over tightening of the bolts. Too much torque will damage the threads in the outer housing.

P90 Pump Breakdown Assembly



Component Number	Quantity Used	Part Number	Description
1	1	903	P90 PUMP MOUNTING PLATE
2	1	951	P90 PUMP HOUSING
3	1	952	P90 PUMP IMPELLER
4	1	WPS2	PUMP SEAL 2.5/3.5/5HP
5	1	953	P-90 CORK GASKET
6	4	AHSFH250281000	Flat Head allen head bolt 1/4"-28x1"
7	4	AHS250201250	1/4"-20 X 1 1/4" ALLEN HEAD BOLT
8	1	954	1/4 28 x 1 Full Thread Stud
9	1	P90H (Not Shown)	New Handle for P90GH 2.5 Honda

SEAL REMOVAL AND INSTALLATION

1. Remove the four housing bolts and remove the pump housing. 2 The impeller is directly mounted to the engine shaft. Unscrew in a counter clockwise direction. Lock the shaft in a fixed position to prevent it from turning. Insert a simple a pointed tool such as a screwdriver or an awl through starter housing cover, locking the flywheel into place. Rotate the pump impeller counterclockwise until it breaks loose. Unscrew the impeller until it comes off. All of our pumps use a two piece seal assembly. The ceramic side of the seal fits in side the back of the (3) P90 PUMP IMPELER. . The rubber side goes against the impeller. The spring loaded side is pressed inside the (1) P90 PUMP MOUNTING PLATE. The spring side of the seal should be pressed in with a thin bead of silicon sealant. We recommend that the seal be pressed in with or pump setting tool WPK2 Pump Seal Kit. Thread the impeller onto the engine shaft until the impeller is hand tight. Install the housing and use care not to over tighten the bolts to avoid stripping the threads as they are a soft alloy aluminum.

ALWAYS REMEMBER THAT RUNNING YOUR PUMP DRY WILL LEAD TO POSSIBLE DAMAGE AND DESTRUCTION OF THE WATER PUMP SEALS. IT IS RECOMMENDED TO KEEP A SPARE WATER PUMP SEAL KIT (WPK2) AND ONE ADDITIONAL WATER PUMP SEAL (WPK2) WHEN WORKING IN AN ISOLATED AREA.

See “INSTALLATION & REPLACEMENT OF A PUMP SEAL, HOSE COUPLER & COMPRESSOR DRIVE ASSEMBLY” For further details on pump repair.

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INSTALLATION & REPLACEMENT OF A PUMP SEAL, MARLEX PUMP COUPLER & A COMPRESSOR DRIVE ASSEMBLY

The water pump seal must be replaced if water is observed leaking between the engine and pump adapter or around the engine shaft,. To replace a seal or to install a compressor drive assembly (engine shaft pulley and drive belt), the pump must first be removed from the engine.

INSTRUCTIONS TO REMOVE THE PUMP FROM THE ENGINE:

Note: If the pump has been in use for a year or more, we suggest that you apply a penetrant such as "WD-40" to the engine shaft threads and allow it to penetrate the threads of the engine shaft. Saturate for 24 hours before attempting to remove the impeller from the engine shaft!

1. Remove the four housing bolts and remove the pump housing. If the housing does not pull off easily, gently pry it off with a screwdriver. Inspect the housing gasket and replace if necessary.
2. The impeller is directly mounted to the engine shaft and will unscrew in a counter clockwise direction. Before attempting to remove the impeller the engine shaft must be locked in a fixed position to prevent it from turning. A simple way of locking the shaft is to insert a pointed tool such as a screwdriver or an awl through one of the many holes in the starter assembly and turning the engine over until the tool is firmly locked in place by the starter housing cover.

IMPORTANT: Always disconnect the spark plug wire before attempting any repairs or service on your pump or engine. Once the engine shaft is locked into position, there are two methods that can be used to remove the impeller.

Method #1. Use a block of wood, such as a 2x4 and place one corner of it into one of the impeller vanes on the left side of the impeller and strike the block of wood sharply with a hammer. This should loosen the impeller and enable it to be unscrewed in a counter clock-wise direction.

Method #2. If the above is not successful, use a thin breaker bar or a heavy duty screw driver. Insert the blade into one of the impeller vanes towards the left side and try to unscrew the impeller by applying a downward pressure. If this still does not work carefully strike the end of the bar with a hammer until the impeller loosens from the shaft. If this still does not work, strike gently with a hammer. This method may cause a chip in the vane of the impeller. Depending on the size break of the corner of the impeller, it may or may not have adverse effects on the performance of the pump. So be careful!

SEAL REMOVAL AND INSTALLATION:

1. All of our pumps use a two piece seal assembly, with the exception of some older models (P-50 and P-60). One half of the seal located in the backside of the impeller is called the "seat", or ceramic portion. The other side of the seal is shrouded in a brass encasement, encasing a hardened material that rests against the ceramic portion of the seal. Always replace both sides of the seal. Remove the ceramic portion with a sharp object similar to a screwdriver and press the new seat into place by hand. Always inspect the seal to note that it is not cracked. Always place the smooth surface of the seal to the outside.

2. Remove the pump adapter from the engine and press the brass portion of the seal towards the outside from the back of the adapter. If it cannot be pressed out easily, place a screwdriver handle on the seal and gently tap it out. When replacing, it is suggested that a small amount of silicone sealant be placed on the brass portion that fits into the adapter to ensure that it will not leak. Be careful not to get any sealant on the face of the seal. Position the seal in the center of the hole and press gently by hand into the cavity as far as possible. Use a screwdriver or a blunt instrument and tap the seal gently around the edge of the seal in a circular motion until the seal is firmly fitted into place. Wipe off seal facing with a clean cloth before reassembling.
3. After both sides of the seals is installed, replace the pump adapter onto the engine and carefully tighten. Thread the impeller onto the engine shaft until the impeller is hand tight. Install the housing and use care not to over tighten the bolts to avoid stripping the threads as they are a soft alloy aluminum.

HOW TO INSTALL THE HOSE ADAPTOR PUMP INTAKE COUPLER: (For all models except the P-50 and P-300 Series).
The tolerance of the Hose Adapter is critical for proper pump performance. The hose Adapter should be installed as close as possible to the intake portion of the impeller. Center the adapter into the housing opening and press in by hand to locate it into place and place a wooden block against the outside of the adapter and gently tap until the adapter is firmly seated against the face of the impeller. Pull the starter rope until the engine turns. When the coupler is properly seated, the engine should be somewhat difficult to turn over, making sure that the adapter is against the face of the impeller.

COMPRESSOR DRIVE INSTALLATION:
To install the shaft pulley and belt for a compressor adaptation, the pump must be completely removed from the engine. For larger engines to include the 8 HP through 18 HP engines, slide the pulley to the back of the engine shaft and tighten the set screw. To install the engine pulley on smaller engines to include the 3HP to 5HP Engines, the furnished bushing should be pressed onto the pulley at the factory to ensure proper alignment and spacing. If you choose to install it yourself, this can be accomplished by placing the pulley on a flat surface, center the bushing in the hole of the pulley and gently drive it through by tapping it with a hammer taking care not to damage the bushing. The bushing should be pressed or driven through the pulley, in a flush position to the other side of the pulley. It should not extend though the other side. Then install the V Belt before placing the pulley and bushing over the engine shaft. After the pump is installed and secured, mount the compressor and compressor pulley. Install the V Belt to compressor and make sure that the alignment is correct. You can compensate for some misalignment by adjusting the compressor pulley on the compressor shaft. Tighten firmly the set screw and all bolt and check for any misalignment before starting.


Milfoil is pumped into and captured into this containment cage
Floating Barriers placed around the work Area


Containment Cage


Work Barge with
suction harvester
Containment Cage

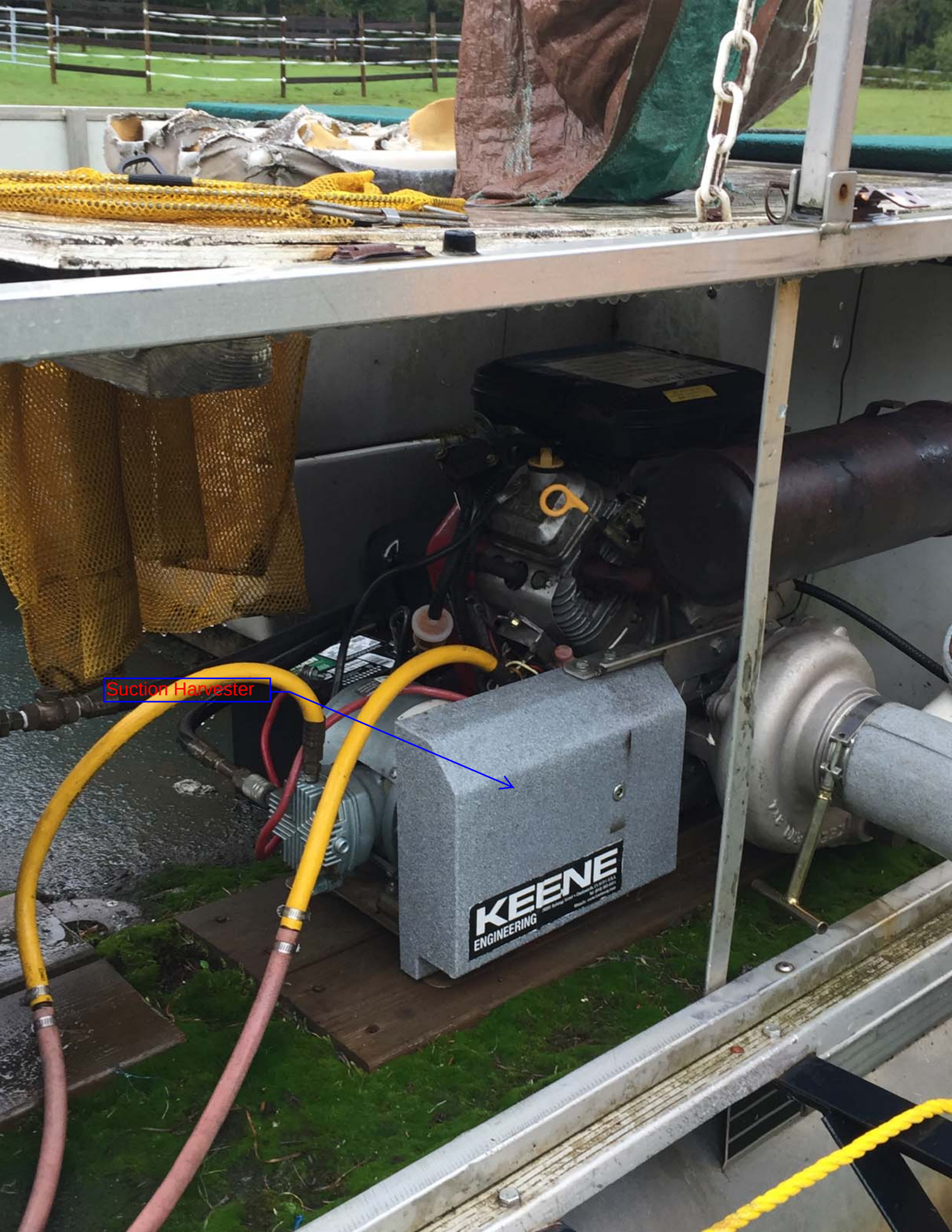

Work Barge
Containment Barge


Suction Harvester
KEENE
KEENE


Suction Harvester


Suction Harvester


Suction Harvester


Suction Harvester
KEENE
ENGINEERING


Suction Harvester
KEENE
ENGINEERING

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Lake Elmore

Aquatic Plant Inventory

October 31, 2017

ARROWWOOD ENVIRONMENTAL
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1. Introduction

Lake Elmore is a low-alkalinity, mesotrophic lake in the town of Elmore, Vermont. It sits at the base of Elmore Mountain and is surrounded by private homes and cottages. Elmore State Park is located on the northern end of the Lake and there is a Vermont fish and Wildlife public boat access at the southern end of the Lake. Both private residents and visitors recreate on the Lake throughout the year by fishing, boating, kayaking, and bird-watching. For many years, the Lake Elmore Association has undertaken efforts to control Eurasian water-milfoil (EWM) in the Lake. As part of the EWM control permitting process, periodic aquatic plant inventories are required.

In 2017, Arrowwood Environmental was retained by the Lake Elmore Association to conduct an aquatic plant inventory of Lake Elmore. The purpose of the inventory was twofold: First, to document and map the current status of Eurasian water-milfoil in the Lake and secondly, to conduct an inventory for rare, threatened and endangered aquatic plant species in the Lake. This report outlines the methodology and results of those inventories and presents management recommendations based on those results.

2. Methods

The study area for the inventory consisted of the open water of Lake Elmore and based on the boundaries of the Lake from the Vermont Hydrography Dataset. The inlet at the south end of the Lake includes Elmore Brook and the extensive wetlands associated with the inlet. Only aquatic species and emergent species that typically occur within aquatic plant communities were included in this inventory. The Cattail Marshes and Deep Broadleaf Marshes in the Elmore Brook wetlands, for example, were not inventoried as part of this study. Three days of field work were conducted from September 11-26, 2017 by Michael Lew-Smith. Two different survey methodologies were employed to document and map the aquatic species in the Lake, the Grid-Point Survey and Transect Sampling. Each of these techniques is outlined below.

Figure 1. Study area and Grid Points

a. Grid-Point Survey

The purpose of the grid-point survey is to ensure that all areas of the Lake receive a standardized vegetation sample and to aid in the development of vegetation community boundaries. A series of points 200m apart were established over the study area in an auto-generated grid pattern. To ensure full representative coverage, the position of some points established by the grid were adjusted. For example, points that were established directly on the shoreline or just into the upland were moved into the open water of the Lake. This resulted in a total of 26 sampling points established over the study area. The study area and grid points are shown in Figure 1.

The study area and the location of each point were uploaded to a Trimble Juno 3B GPS unit, which was used to navigate to each point on the Lake using a motor boat. An aquatic survey rake was used to take three vegetation samples at each point location. In waters shallower than 12', a rake on a pole was used to sample vegetation. In waters deeper than 12', a survey rake attached to a rope was used to sample vegetation. Rake fullness was recorded for each sample to obtain information about vegetation density (Hauxwell et al., 2010). In addition, each aquatic plant on the rake was identified to species (when

possible). Additional data collected at each point included water depth, substrate, and percent cover of vegetation, when visible. A view-scope was used to view the vegetation when necessary. Presence and abundance of aquatic invasive species (AIS) was also documented at each point. All data was recorded using a digital data form on the GPS unit. Notes on vegetation and AIS were also taken incidentally in between sampling points when appropriate.

b. Transect Sampling

Transect sampling was established during the field inventory in order to provide a more informal sampling approach and to document species and trends that the grid-point survey may have missed. This methodology is based on the Vermont Water Quality Division Field Methods Manual (2006). Transects were conducted in one of three ways. First, by visible inspection of the vegetation from the motor boat or from a kayak. Secondly, some transects were conducted by snorkeling. This method is slower than the boat-based transects, but more in-depth data is obtained and it enables the collection of plant specimens when necessary. Finally, some transects were conducted using SCUBA gear in order to obtain data from the deeper areas and allow for more time below the surface.

A continuous transect was conducted along the entire shoreline of the lake as well as across the shallower northern and southern ends of the Lake. Notes on AIS and native vegetation presence and abundance were taken along the transects. Narrative data not entered into the digital data forms was recorded in a field notebook.

Once field work was completed, the data was analyzed on an ArcGIS platform. Data from the grid-point survey and transects were used to create an aquatic natural community map and a map of Eurasian water-milfoil (EWM).

Figure 2. Aquatic Natural Communities of Lake Elmore

3. Results

The results of the inventory are presented below. Section 3a outlines the results relating to native aquatic vegetation. Section 3b outlines the findings related to Eurasian water-milfoil and Section 3c includes species lists and a discussion of rare species.

a. Native Aquatic Vegetation Communities

A natural community is an interacting assemblage of organisms, their physical environment, and the natural processes that affect them (Thompson and Sorenson, 2010). Most studies done by scientists on vegetation natural communities has been done in terrestrial systems. Much work still needs to be done on classifying groups of aquatic plants into natural communities. There are a few groups, such as the Water Lily Aquatic Community, that appear to be well-understood, common components of aquatic systems throughout the region. Other groupings of plants are referred to as "assemblages" because more studies need to be done to determine if they are established groupings that warrant the "natural community" designation.

The native aquatic vegetation in Lake Elmore has been categorized into three different groups, the Robbin's Pondweed Assemblage, the Arrowhead-Mud Rush Assemblage and the Water Lily Aquatic Community. Each of these is described below.

Robbin's Pondweed Assemblage

As the name indicates, the Robbin's Pondweed Assemblage is overwhelmingly dominated by one species: Robbin's pondweed. This species is known for forming dense, nearly monotypic low-growing stands in lakes and ponds. The most common associate in Lake Elmore is the broad-leaved pondweed. In contrast to the low-growing form of Robbin's pondweed, this species can grow up to 9fttall and often towers above the dense mat of Robbin's pondweed below. Other species present at low abundance include water-weed (*Elodea canadensis*), eel-grass (*Vallisneria americana*), stonewort (*Nitella spp*.) and clasping-leaved pondweed (*Potamogeton perfoliatus*). Both water-weed and stonewort can form small, dense colonies, but these are typically occupy less than 100sq feet in area and are not widespread.

Figure 3. Dense mat of Robbin's Pondweed

As can be seen from Figure 1, the Robbin's PondweedAssemblage is the most common and abundant plant assemblage in Lake Elmore. It occupies fairly shallow areas from 2-3 feet deep as well as deeper sites up to 12 feet deep. On the deeper end, towards the middle of the Lake, the vegetation in this community becomes sparser and grades into a silty un-vegetated lake bottom.This mapped assemblage also includes un-vegetated patches in shallower water. These include un-vegetated patches in areas of moderate depth (6 feet) as well as shallow areas along the shoreline (1-2 feet deep). The swimming area at the north end of the Lake is one of the largest, shallow un-vegetated areas included in this mapped assemblage.

Arrowhead-Mud Rush Assemblage

The Arrowhead-Mud Rush Assemblage is characterized by low-growing aquatic species which all have a rosette of short leaves. Dominant species include grass-leaved arrowhead (*Sagittaria graminea*), mud-rush (*Juncus pelocarpus*), leafless water-milfoil (*Myriophyllum tenellum*), and quillwort (*Isoetes riparia*). Many of these species look similar and will not flower except in conditions of very shallow water. This is a sparsely vegetated community, with total plant cover in the 25%-40% range and the remaining area an un-vegetated silty-sand lake substrate. Other species such as snailseed pondweed (*Potamogeton spirillus*) and white water-crowfoot (*Ranunculus aquatilis var. diffusus*) are also common in this assemblage. There are two mapped occurrences of this assemblage in Lake Elmore (Figure 1). Both occur in shallow areas in a silty-sand substrate. It is likely that ice scour and wave action play an important role in the development of this assemblage.

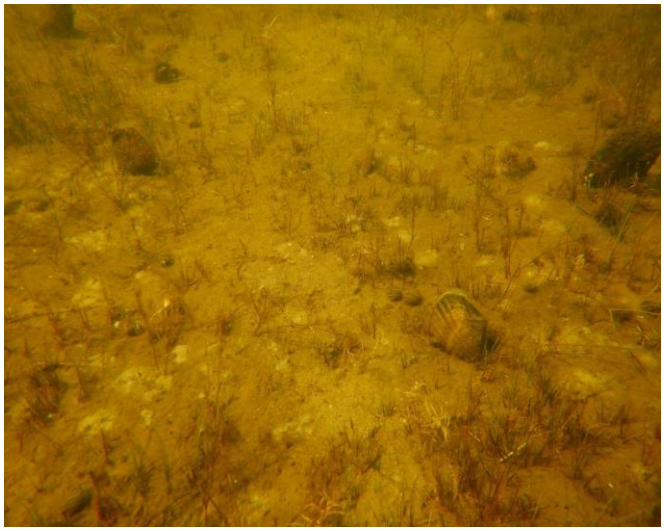

Figure 4. The sparsely vegetated Arrowhead-Mud Rush Assemblage

Water Lily Aquatic Community

The Water Lily Aquatic Community is a common and widespread community throughout the region. It occupies shallow, sheltered bays of many water bodies and is dominated by floating-leaved aquatics. The largest occurrence on Lake Elmore is in the southern part of the Lake where it is part of the wetland at the Lake inlet. At this location, both floating-leaved and submersed aquatic vegetation is abundant and comprises nearly 100% cover. Narrow-leaved bur-reed (*Sparganium angustifolium*) is the most common floating-leaved aquatic and is

interspersed with moderate amount of water lily (*Nymphaea odorata*) and yellow pond lily (*Nuphar variegata*). Other species with floating leaves such as floating pondweed (*P. natans*) and Vasey's pondweed (*P. vaseyi*) are also present but at lower percentage cover. The submersed aquatics are quite diverse and include common bladderwort, ribbon-leaved pondweed, water starwort, and stonewort. As the community grades into a palustrine wetland community, emergent species such as pickerel weed, American bur-reed and cattails become dominant.

Figure 5. Water Lily Aquatic Community

In addition to the large occurrence of this community in the southern part of the Lake, there are smaller, scattered occurrences along the western shoreline (Figure 1). While these areas are dominated by narrow-leaved bur-reed and water lily, they typically lack the abundant submersed vegetation that is present in the southern Lake.

b. Aquatic Invasive Species

Eurasian water-milfoil (EWM) was the only non-native aquatic invasive species documented in the Lake. The Lake-wide distribution and abundance of this species is shown in Figure 6 and includes areas of Sparse, Moderate and Dense cover. Sparse cover consists of areas where EWM is present at less than 5% cover. The Moderate cover class consist of areas where EWM cover ranges from 5-50% and Dense includes areas where cover generally exceeds 50%. As can be seen from this figure, EWM is present throughout vegetated areas of the Lake at Sparse cover. This species is fairly well-established in the Lake and scattered individuals can be found

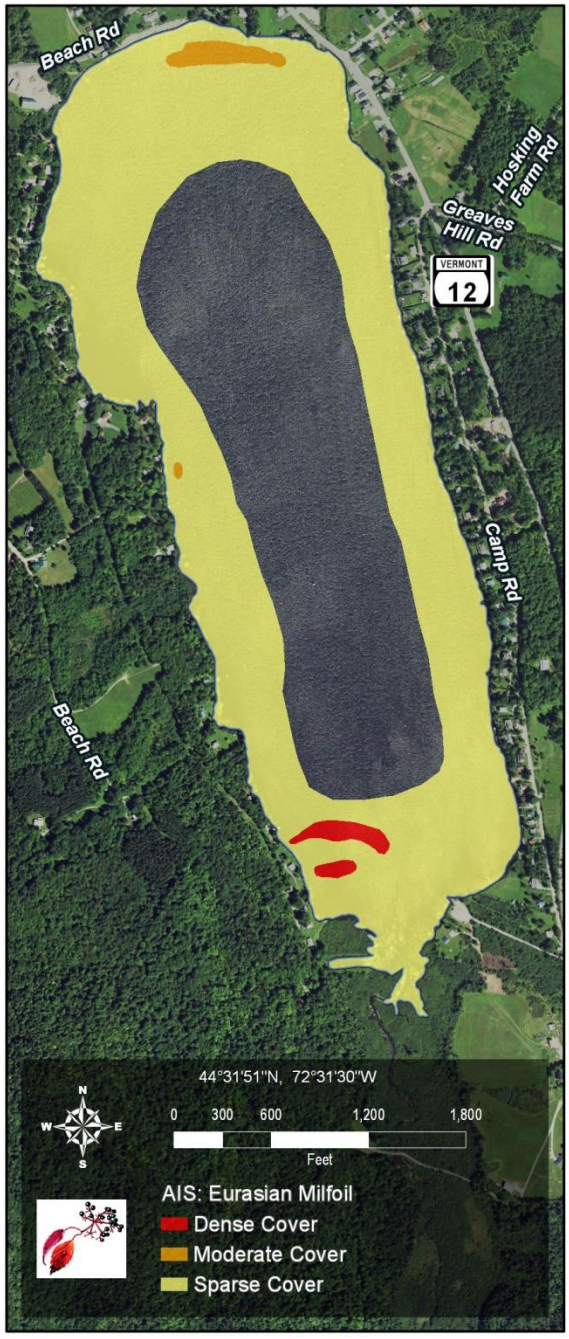

Figure 6. Eurasian water-milfoil in Lake Elmore

everywhere except for the deeper, unvegetated areas. In addition to this widespread and sparse background population, there are 4 areas of concentrated EWM growth. The Moderate density patch in the northern end of the Lake mostly consists of 5-25% cover of EWM within the Robbin's Pondweed Assemblage. There is a small area on the eastern end of this infestation where EWM is denser, reaching 25-50% cover. The other Moderate density infestation exists as a small patch on the western shore of the Lake and consists of 5-25% cover of EWM.

The only Dense infestations documented in Lake Elmore consist of two patches in the southern end of the Lake, as shown in Figure 6. The more northern of these two patches is the densest, with EWM reaching 75-100% cover. EWM cover in the southern patch ranges from 25-75% cover. This is currently a buoy in this area which marks the location of an old bottom barrier used to control EWM. Both of these infestations occur within the Robbin's Pondweed Assemblage, just north of the border with the Arrowhead-Mud Rush Assemblage boundary.

c. Rare, Threatened and Endangered Species

One objective of this inventory was to document and map occurrences of uncommon, rare, threatened or endangered species in the Lake. Appendix 1 includes a list of all plant species documented during this inventory along with notes on distribution and abundance in the Lake. Appendix 2 consists of this same list and includes scientific names, common names, plant family and S-rank. The "S-Rank" is a state ranking of the rarity of uncommon and rare species. An S-rank of S1 indicates that a species is "very rare" in the state. S2 indicates a "rare" species and S3 indicates an "uncommon" species in the state. The presence of one of these species could potentially have an impact on the methods and implementation of control activities. A number of S1-S3 species have been historically documented for Lake Elmore and are addressed below.

Vasey's Pondweed (Potamogeton vaseyi)

This species is ranked as S2 "rare" in the state and was first documented in Lake Elmore in 1968. Since that time, the population has been verified and monitored for a number of years. It has previously been reported to be "common to abundant at the southern end of the lake" (Vermont NHI EO-record 2063), though no actual count of plants present has been undertaken. The current inventory documented this species in the Arrowhead-Mud Rush assemblage and in the Water Lily Aquatic Community at the southern end of the Lake. This species is a submerged aquatic, but can form small floating leaves in the early part of the summer. By the time of the current inventory in September, the diagnostic floating leaves were no longer present. During the current inventory this species was considered "frequent" but not abundant enough to be considered common. It is unclear if this is an actual decline in the population or a mis-interpretation of admittedly vague terms. Also, the fact that floating leaves were not present during the current inventory (and the species therefore less visible) may have resulted in under-reporting its abundance. Regardless of the terminology, this species appears to be stable at Lake Elmore.

Blunt-leaved pondweed (Potamogeton obtusifolius)

Blunt-leaved pondweed is considered an "uncommon" (S3-ranked) species in the state. It was documented in Lake Elmore in 1991 by the Vermont Lakes and Ponds Management and Protection Program. This species was not documented during the current inventory.

Nutall's waterweed (Elodea nutallii)

Nutall's waterweed is considered an "uncommon" (S3-ranked) species in the state and is a close relative of the common waterweed, which is common throughout Lake Elmore. It was documented in Lake Elmore in 2003 by the Vermont Lakes and Ponds Management and Protection Program. This species was not documented during the current inventory.

Blunt-leaved pondweed (Potamogeton strictifolius)

Blunt-leaved pondweed is a rare to uncommon species in the state (ranked S2S3). It was first reported in the Lake in 1988. However, more recent surveys have not document this species (Vermont NHI EO-record 1229). This species was not documented during the current inventory.

Bur-reeds (Sparganium spp.)

The bur-reeds are a genus of plants that occur with emergent leaves or, in some species, with floating leaves. Three different species of the floating-leaved bur-reeds have been documented in Lake Elmore in the past: least bur-reed (*Sparganium natans*), narrow-leaved bur-reed (*Sparganium angustifolium*) and water bur-reed (*Sparganium fluctuans*) (Vermont NHI EO-records 2872 and 5248). Least bur-reed is a rare-uncommon species (S2S3-ranked) which is also a state listed Threatened species. Water bur-reed is an uncommon species (S3-ranked) and narrow-leaved bur-reed is a common and widespread species. While there are some differences in leaf-width between the species, in order to definitively distinguish these species, fruiting specimens are required. To further complicate matters, these species are only rarely found in flower or fruit. In all of the fruiting material examined during the current inventory, only narrow-leaved bur-reed was documented. It is possible that previous identifications were made based on vegetative material. It is also possible that identifications were made based on fruiting

material, but no specimens of either the least bur-reed or water bur-reed from Lake Elmore exist and can be confirmed. Regardless of previous inventories, only the common species in this group was documented during the current inventory.

White water-crowfoot (Ranunculus aqualitis var. diffusus)

White water-crowfoot is an aquatic plant in the buttercup family that is uncommon (S3-ranked) in the state. A number of small but dense colonies of this species were documented in the southern end of the Lake in the Arrowhead-Mud Rush Assemblage and the Water Lily Aquatic community.

4. Management Recommendations

The following management recommendations are based on the distribution and abundance of both EWM and the native plant communities and rare-uncommon species documented in the Lake. As evidenced by the dense infestations in the southern part of the Lake, EWM has the potential to become well established and choke out native aquatic vegetation. In these areas, it appears that EWM is having a significant detrimental impact on native vegetation. Outside of the Moderate and Dense infestations (Figure 6), however, EWM is present only at low cover and does not appear to be posing a threat to native aquatic communities. Low levels of this species in the Lake, therefore, may be tolerable. Complete eradication of this species from the Lake, in addition to being extremely difficult, may not be necessary to protect native vegetation, rare-uncommon species and recreational activities.

Control of EWM has been undertaken for many years in Lake Elmore. Continued control will be necessary to ensure that dense infestations do not occupy an increasing area of the Lake. There are many techniques that have been used for control of aquatic vegetation, including herbicides, bottom barriers, manual harvesting and mechanical harvesting. Given the nature and extent of the current infestation, herbicide use and mechanical harvesting are not the best options for control in Lake Elmore. Herbicides are generally broad acting and have a significant detrimental

effect on native vegetation. Mechanical harvesting works best on large and extensive infestation. Since the areas of dense growth in Lake Elmore are relatively small, these techniques may not be cost-effective. In addition, since rare and uncommon aquatic plants have been found in the vicinity of the EWM, methods that can have significant impacts on these non-target species should be avoided.

Figure 7. Dense infestation of Eurasian water-milfoil

Both bottom barriers and manual harvesting have been used in the past and continue to be the best methods of control for Lake Elmore. Bottom barriers can be effective if small areas are targeted for control and the barriers are properly installed and maintained. The dense infestations in the southern part of the Lake are good candidates for this treatment. Like herbicide use, the impacts on non-target organisms are unavoidable. However, since no rare or uncommon species are currently documented directly in the EWM infestation bottom barrier continues to be a viable option. Manual harvesting has the advantage of being a targeted control, avoiding impacts on non-target species. In addition, it has the flexibility of addressing not just the very dense infestations of EWM, but those with moderate cover as well.

The highest priority for control should be the areas of Dense infestation in the southern part of the Lake for many reasons. First, EWM is having a detrimental impact on the native vegetation in these areas. EWM is so dense that native species are out-competed and cannot become established. Secondly, these areas are likely serving as a propagule source for other infestations in the Lake. When a piece of an EWM plant breaks off, this fragment can re-root and become established in a different part of the Lake. If these areas of dense infestation can be controlled, the number of plant fragments and the likelihood of further spread is subsequently decreased.

Thirdly, both of the rare-uncommon species documented in the Lake occur in the southern part of the Lake near these infestations. This includes populations of Vaseyi's pondweed and white water-crowfoot. The spread of EWM into these areas would threaten these populations. Lastly, because these infestations are dense, harvesting of EWM will be more efficient than harvesting from the areas of sparse cover.

5. Conclusion

With a State Park on the northern end, a state boat launch on the southern end, and numerous private homes along it shores, Lake Elmore receives a lot of use by humans. It has been well documented that EWM, if left unchecked, can form dense mats, inhibit many recreational uses and choke out native vegetation (Madsen et al. 1991). In the case of Lake Elmore, it is also threatening two rare and uncommon plant species. While EWM is currently widespread in the Lake, there are only a few areas where it has formed very dense infestations. While it may not be realistic to completely eradicate this species from the Lake, it should be possible to halt its spread and decrease the size of the dense infestations. Such control can ensure that recreational use of the Lake can continue and the ecological integrity of the Lake ecosystem remains intact.

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Appendix 1.

Notes on distribution and abundance of each species documented in Lake Elmore

Latin Name	Notes
Callitriche sp.	Common in southern Lake, especially in the Water Lily Community
Chara sp.	Infrequent throughout Lake, most common in southern Lake
Eleocharis acicularis	Infrequent in the Arrowhead-Mud Rush Assemblage
Elodea canadensis	Common throughout the Lake
Eriocaulon aquaticum	Frequent in the Arrowhead-Mud Rush Assemblage
Isoetes riparia	Infrequent in the Arrowhead-Mud Rush Assemblage
Juncus pelocarpus	Frequent in the Arrowhead-Mud Rush Assemblage
Myriophyllum spicatum	Common throughout the Lake
Myriophyllum tenellum	Frequent in the Arrowhead-Mud Rush Assemblage
Nitella sp.	Common throughout the Lake
Nuphar variegata	Frequent in the southern occurrence of the Water Lily Community
Nymphaea odorata	Common throughout the Lake; most abundant in the southern Water Lily Community
Pontederia cordata	Restricted to the southern occurrence of the Water Lily Community
Potamogeton amplifolius	Second most common and abundant species in the Lake
Potamogeton epihydrus	Common in southern Lake; sub-dominant in the Water Lily Community
Potamogeton gramineus	Infrequent in the southern part of the Lake
Potamogeton natans	Common in the southern part of the Lake
Potamogeton perfoliatus	Common throughout the Lake
Potamogeton robbinsii	Most common and abundant species in the Lake
Potamogeton spirillus	Frequent in the Arrowhead-Mud Rush Assemblage
Potamogeton vaseyi	Frequent in the southern part of the Lake
Ranunculus aquatilis var. diffusus	Frequent in the Arrowhead-Mud Rush Assemblage and southern Water Lily Community
Sagittaria graminea	Frequent in the Arrowhead-Mud Rush Assemblage
Sparganium angustifolium	Common in all occurrence of the Water Lily Community
Utricularia macrorrhiza	Common in the southern occurrence of the Water Lily Community
Vallisneria americana	Common and widespread throughout the Lake

Appendix 2.

List of each species documented in Lake Elmore with latin name, common name, S-rank and plant family

Latin Name	Common_name	S-Rank	FAMILY
Callitriche sp.	water starwort		Plantaginaceae
Chara sp.	muskgrass		Characeae
Eleocharis acicularis	needle spike-rush		Cyperaceae
Elodea canadensis	water-weed		Hydrocharitaceae
Eriocaulon aquaticum	pipewort		Eriocaulaceae
Isoetes riparia	quillwort	S2	Isoetaceae
Juncus pelocarpus	mud-rush		Juncaceae
Myriophyllum spicatum	Eurasian water-milfoil		Haloragaceae
Myriophyllum tenellum	leafless water-milfoil		Haloragaceae
Nitella sp.	stonewort		Characeae
Nuphar variegata	common yellow pond-lily		Nymphaeaceae
Nymphaea odorata	waterlily		Nymphaeaceae
Pontederia cordata	pickerelweed		Pontederiaceae
Potamogeton amplifolius	broad-leaved pondweed		Potamogetonaceae
Potamogeton epihydrus	ribbon-leaved pondweed		Potamogetonaceae
Potamogeton gramineus	grass-leaved pondweed		Potamogetonaceae
Potamogeton natans	floating pondweed		Potamogetonaceae
Potamogeton perfoliatus	clasping-leaved pondweed		Potamogetonaceae
Potamogeton robbinsii	Robbins' pondweed		Potamogetonaceae
Potamogeton spirillus	common snailseed pondweed		Potamogetonaceae
Potamogeton vaseyi	Vasey's pondweed	S2	Potamogetonaceae
Ranunculus aquatilis var. diffusus	white water-crowfoot	S3	Ranunculaceae
Sagittaria cf graminea	grass-leaved arrowhead		Alismataceae
Sparganium angustifolium	narrow-leaved bur-reed		Typhaceae
Utricularia macrorrhiza	common bladderwort		Lentibulariaceae
Vallisneria americana	eel-grass		Hydrocharitaceae