



UNIVERSITY OF MARYLAND  
MAY 31 - JUNE 1, 2024

# Pool Course Build Guide

Version 1 (September 2023)

## Introduction

### Welcome to the International SeaPerch Challenge!

This Team Handbook contains information that teams need to compete at the International SeaPerch Challenge. It includes task descriptions, rules and requirements, and other guidance and specifications. Teams are encouraged to read this document for a thorough understanding of what is necessary to compete effectively.

These instructions apply specifically to participation in the 2024 International SeaPerch Challenge. Please check with your local regional competition coordinator for rules and required submissions related to that event which may differ from the International SeaPerch Challenge.

**Why compete in the International SeaPerch Challenge?** The annual International SeaPerch Challenge is an invitation-only event open to teams that excel at registered regional competitions and earn a slot to compete in the season's culminating event.

On land, teams show off their engineering skills through technical papers and presentations. In the pool, they navigate their SeaPerch through a series of obstacles inspired by the real world that test maneuverability, control, and utility. Each season has a new theme and a new set of competition tasks, challenging teams to expand on their original vehicle design.

Beyond the friendly rivalry, all competitions bring students together from different schools, states, and countries to form a supportive community.

**Why robotics competitions?** The goals of the RoboNation student competitions are to provide opportunities for students to experience real-world engineering challenges and to develop the skills needed to solve those challenges. The objective is to produce the people who will push the envelope in the future. Competitors gain an appreciation for the tradeoffs inherent in any system design and the lessons learned in transitioning from a working bench prototype to operating reliably in the real world.



The International SeaPerch Challenge is hosted by RoboNation. We are pleased to announce an exciting partnership with NOAA Ocean Exploration and the Ocean Exploration Cooperative Institute (OECI) for the 2024 season theme of deep-sea exploration.

# Pool Courses – Build Guide

2024 SeaPerch Season

[www.seaperch.org](http://www.seaperch.org)

This build guide includes instructions for building the obstacle course and mission course for the *Deep-Sea Exploration Mission* within the 2024 International SeaPerch Challenge.

Please check with your local regional coordinator for information related to which courses may be used at your local regional competition.

For the International Challenge, both courses will be suspended from the pool's lane dividers with the lower frames for the courses being approximately 5 to 5-1/2 feet below the water surface.

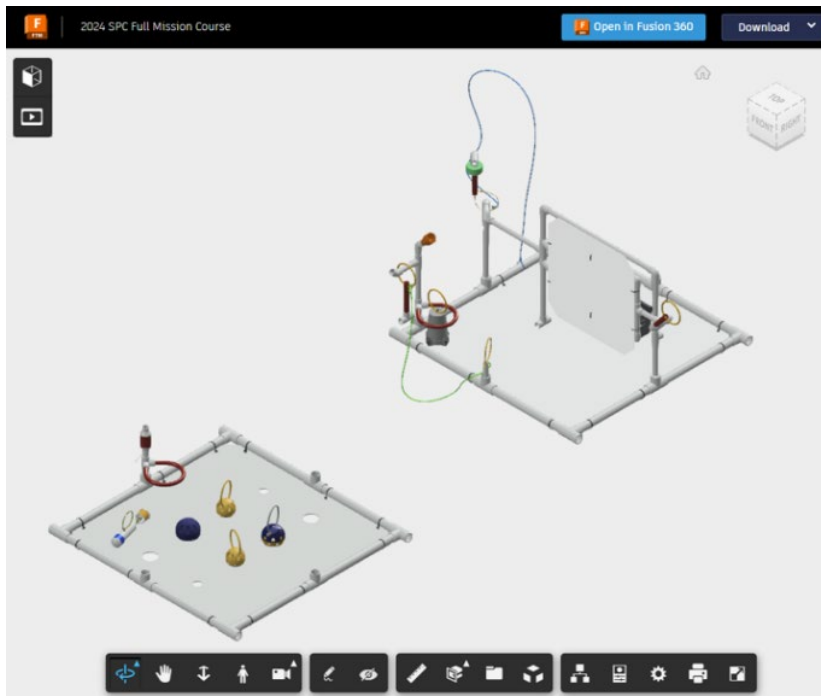
## Build Guide Contents:

- **Obstacle Course Build Guide (Recommended Regional Competition version):** Page 3
- **Mission Course Build Guide:** Page 6
- **Alternatives to Using Special Fittings:** Page 34
- **2024 International Challenge Mission Course Hydrothermal Vent Air Supply:** Page 35

Master parts list for the 2024 International SeaPerch Challenge available at: [2024 International SeaPerch Challenge Master Parts List](#)

This parts list provides vendor links and calculates total quantities based on the number courses being built.

Full Mission Course CAD Model available at: <https://a360.co/3Lo6O8c> (for viewing only)



## Obstacle Course Build Guide

This obstacle course is the standard SeaPerch 5-hoop course with 4-foot spacing between the hoops. For the International SeaPerch Challenge, *the hoops may be oriented differently than shown*. The International SeaPerch Challenge obstacle course frame is made from 3/4" Schedule (Sch) 40 PVC piping and fittings. The obstacle course frame presented in this build guide is made from 1/2" Sch 40 PVC piping and fittings which is commonly used in regional competitions.

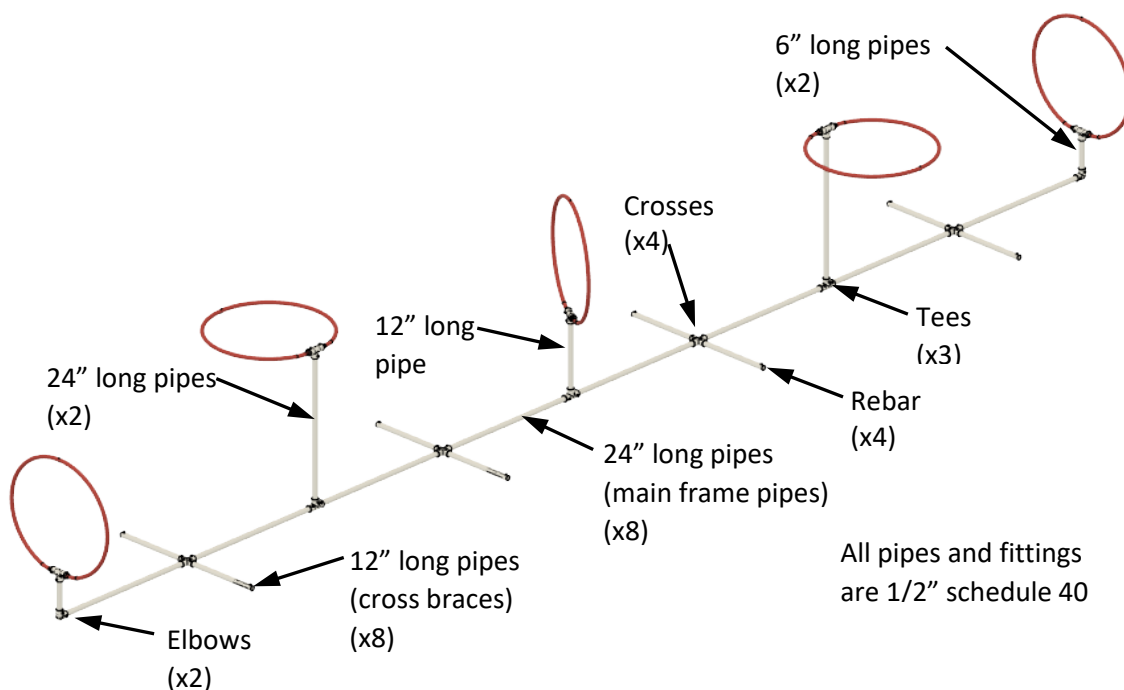
### Parts Lists

Obstacle Course Frame & Hoop Supports (5 hoops, 4-foot hoop spacing)		
Item	Unit	Qty.
1/2" Sch 40 PVC Elbow	Each	2
1/2" Sch 40 PVC Cross	Each	4
1/2" Sch 40 PVC Tee	Each	3
1/2" Sch 40 PVC Pipe X 6" Long	Each	2
1/2" Sch 40 PVC Pipe X 12" Long	Each	9
1/2" Sch 40 PVC Pipe X 24" Long	Each	10
#4 Rebar (1/2" Dia.) X 24" Long	Each	4
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	40

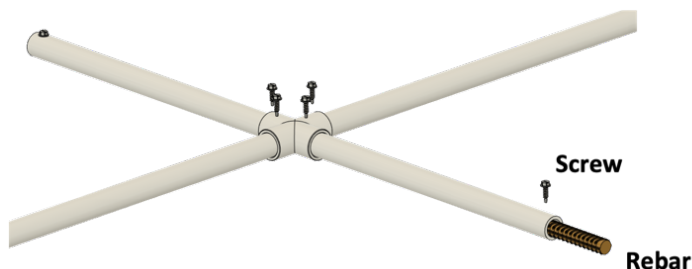
Obstacle Course Hoops (5 Hoops)		
Item	Unit	Qty.
1/2" Sch 40 PVC Tee	Each	5
1/2" Sch 40 PVC Pipe X 1" Long (if using pipe for PEX connector)	Each	10
1/2" PEX Tubing (Red) X 57" Long	Each	5
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	10
1/2" in. CPVC to PVC Bushing (alternative for PEX connection)	Each	10

**Frame and Hoop Supports:** The suggested hoop support pipe lengths (24", 12", 6") are suitable for pool depths of 4' – 7' and may need to be adjusted for pools that are shallower or deeper.

It is recommended that all pipe joints be secured with self-drilling screws from the parts list. More weight may be added to provide more stability. The total weight of the rebar is 5.4 pounds.

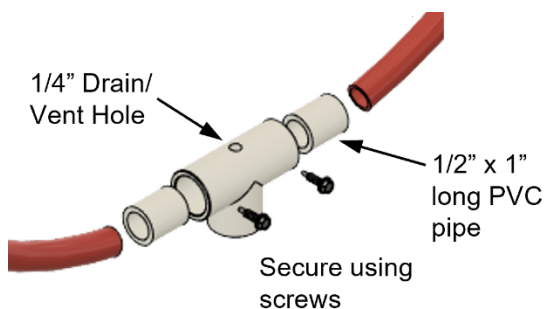


For the base of the obstacle course frame, insert rebar into the cross braces (12" long pipes). Secure the rebar with screws in the end of pipes and secure cross brace pipes to tee after inserting rebar.

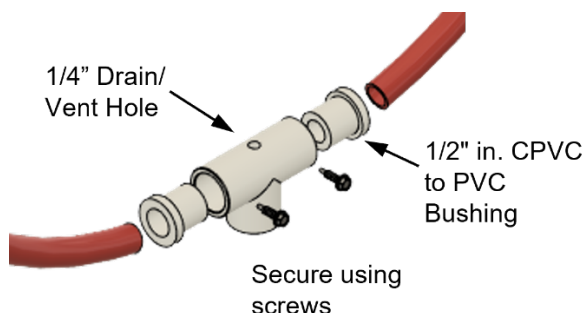


*Obstacle Course Hoops:* Assure that the PEX pipe is fully inserted into the pipes or bushing before securing with screws. Drain/vent holes (1/4") must be drilled in the hoops and pipe tees to allow air to escape when submerging and water to escape when removing from the pool.

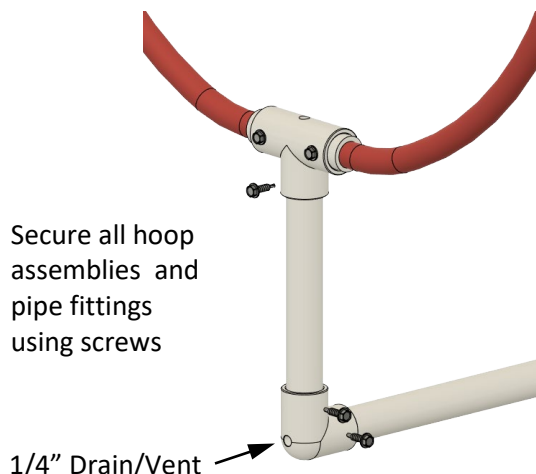
The outside diameter of the PEX pipe may be slightly larger than the inside diameter of the PVC pipe, making it extremely hard to push the PEX pipe into the PVC pipe. The 1/2" CPVC to PVC bushing provides a solution that is easier to assemble.



Traditional PEX connection method



Alternative PEX connection method

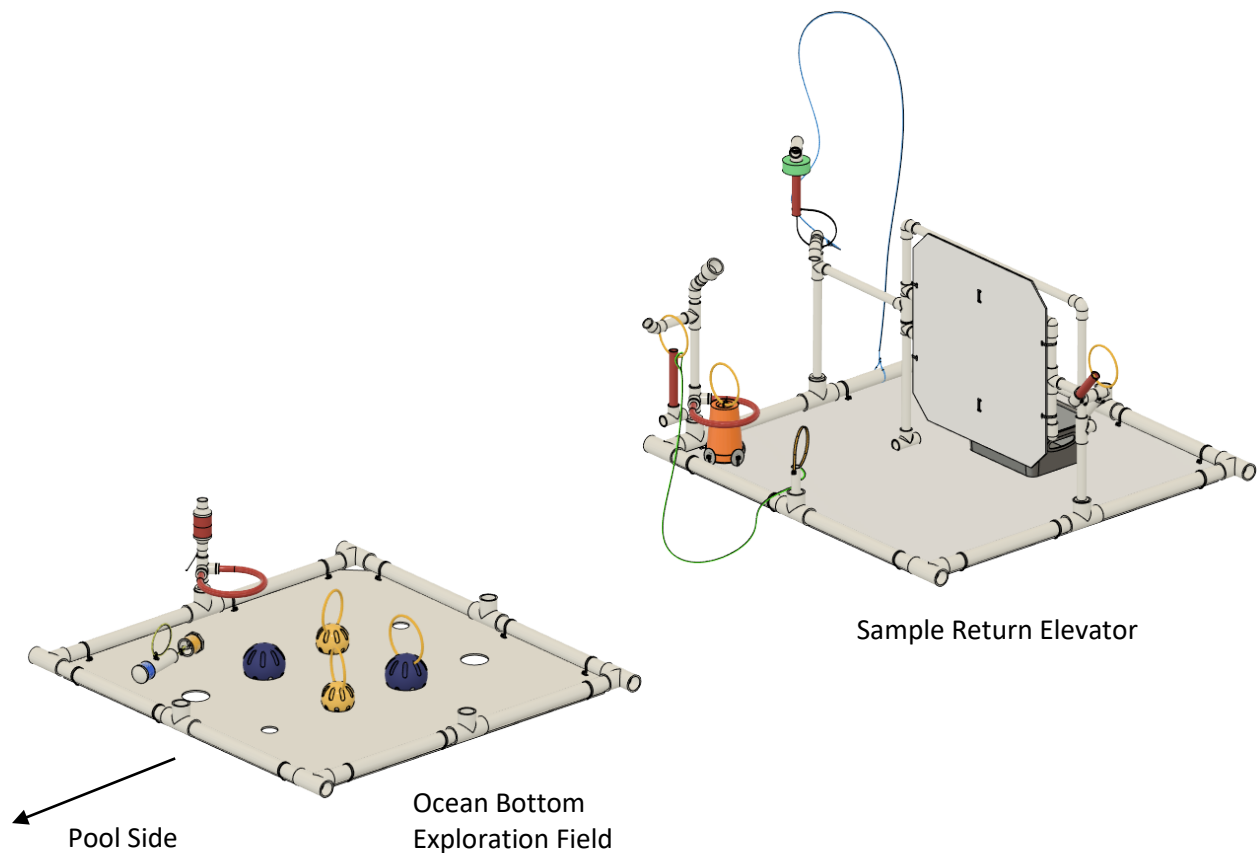


End assembly

## Mission Course Build Guide

The mission course is built upon two standard SeaPerch Challenge task frames. The frames were first used for the 2019 International SeaPerch Challenge and have been used as the foundation for the mission courses since then. The course can be constructed without the task frames if desired; however, the task frames provide a stable base and future mission courses will be built using these frames. Some elements of the mission course are reused from previous years to help reduce the cost and effort of building the courses.

Components from previous SeaPerch Challenges being reused: The gate from 2019, 2021, and 2022, the water sample pipes from 2023, the plastic baseball and softball practice balls from 2019 and 2021.



### General Construction Notes

1. It is recommended that all pipe joints be secured with self-drilling screws called out in the parts lists.
2. Pipe fittings with the potential to trap air should have drain/vent holes drilled with 1/4" or larger drill bits.
3. Pipe fitting specifications vary from one manufacturer to the next. The assembled sizes of structures could vary from the dimensions listed in this guide due to these differences. You may need to adjust the pipe lengths slightly as you construct the assemblies to ensure mating assemblies line up.

4. Anything requiring buoyancy needs to be tested and adjusted for the pool that the course will be used in.
5. Objects that must be lifted and transported have been weighed in air and in water. Weights listed may vary slightly in the pool that the course will be used in since the water density in the test pool may be different.
6. If the course is set on the pool floor, then it may be helpful to use weights on the platforms to keep the platforms from being moved by the ROVs during competition.

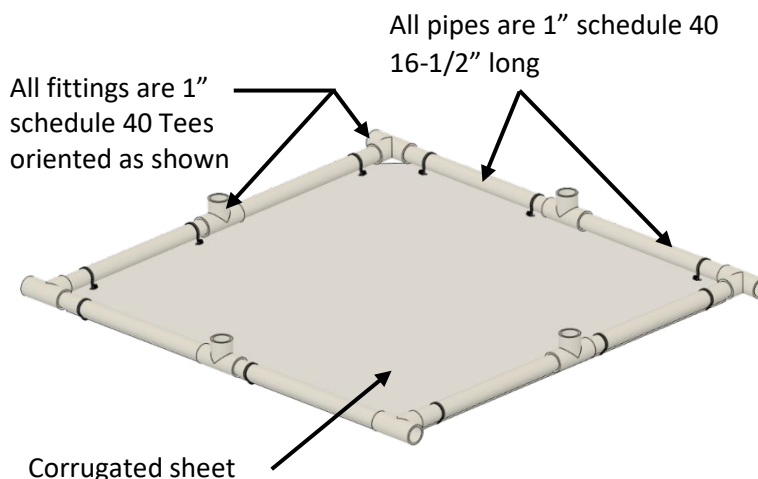
### Task Frames (Task Platforms)

The polypropylene plate is optional for courses used on the pool floor. Use cable ties to secure the polypropylene plate to the frame.

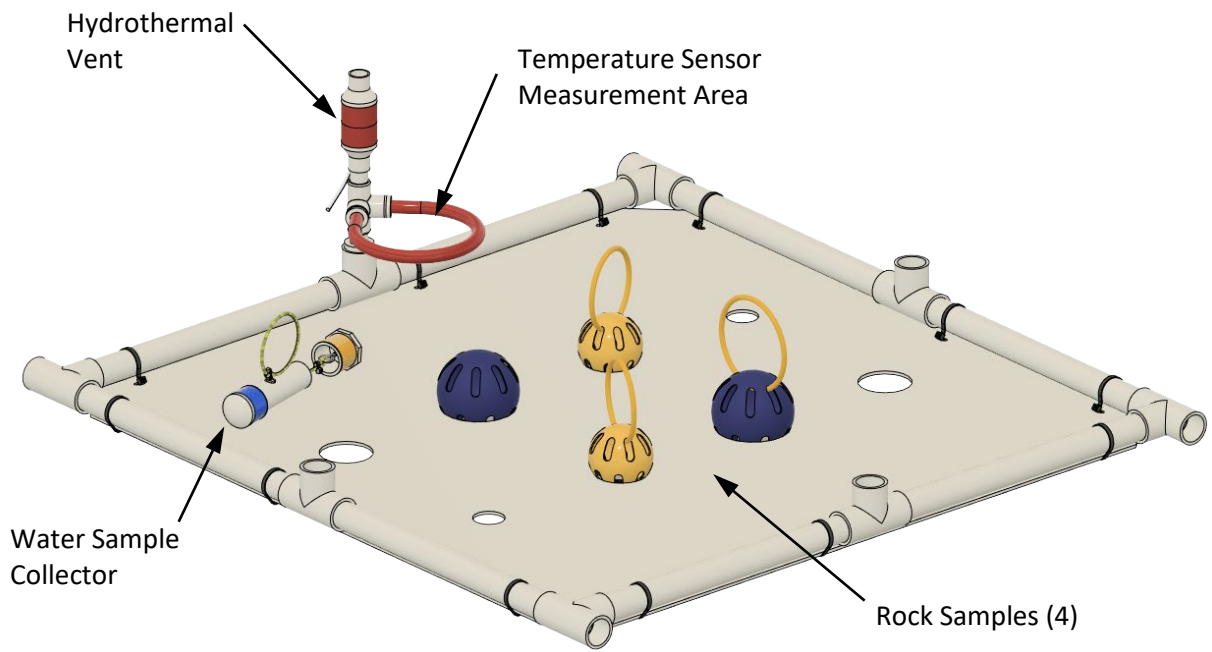
Task Frame (Quantities are for 2 frames)		
Item	Unit	Qty.
1" Sch 40 PVC Tee (DURA brand – may use other brands, but see item 3 in the <i>General Construction Notes</i> section above)	Each	16
1" Sch 40 PVC Pipe X 16.5" Long	Each	16
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	32
Polypropylene Corrugated Sheet, .157 Thick, 36" X 36" <i>(Optional for pool floor course)</i>	Each	2
8" Cable Tie <i>(Only needed if using Polypropylene sheet)</i>	Each	24

Construct the two task frames as shown.

Notch the corners of the corrugated sheet as needed. Attach the corrugated sheet to the frame using 8" cable ties.



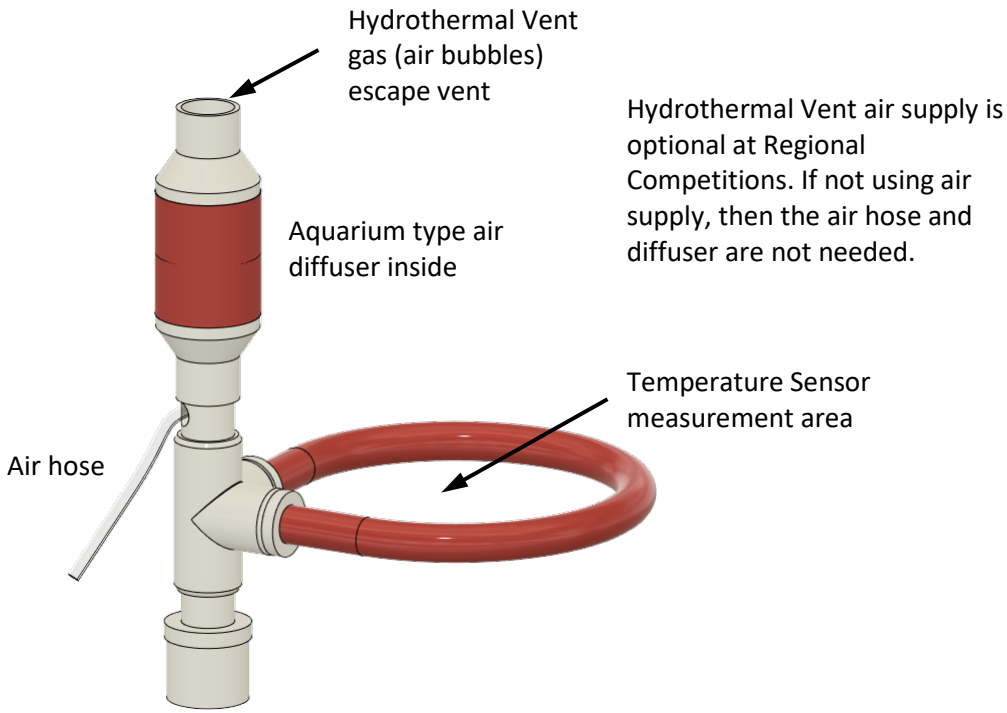
Ocean Bottom Exploration Field



Ocean Bottom Exploration Field with Task Elements

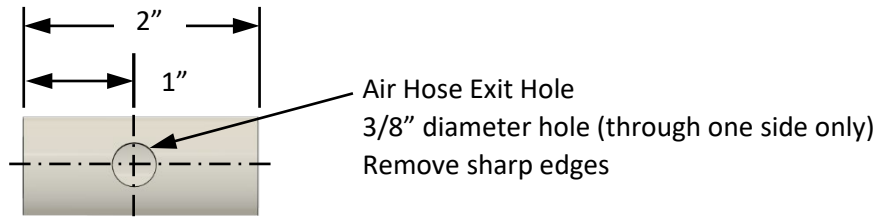


**Hydrothermal Vent**

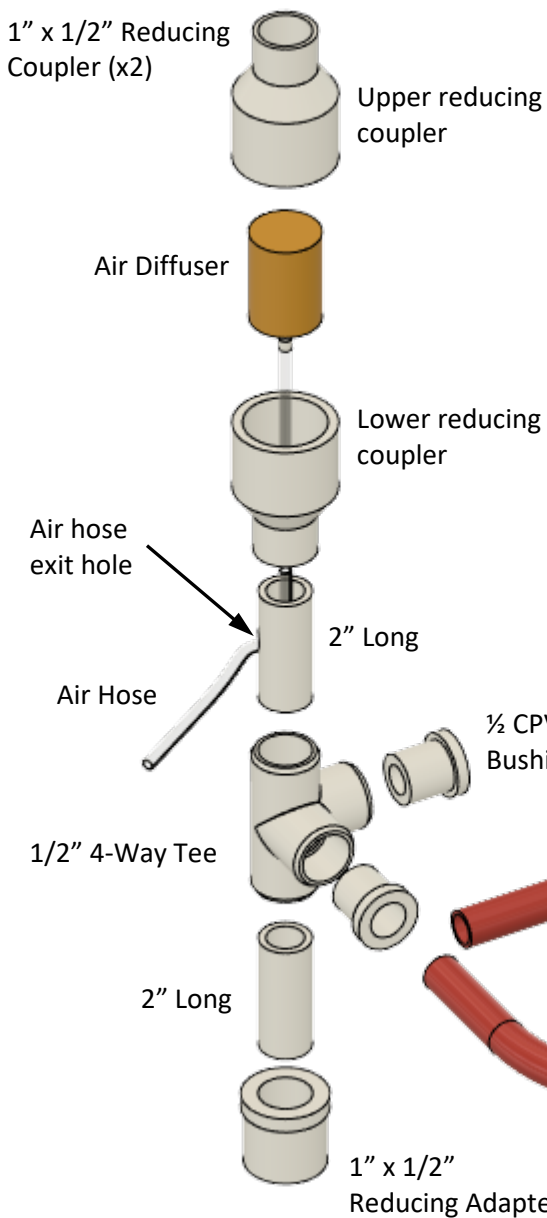


Hydrothermal Vent air supply is optional at Regional Competitions. If not using air supply, then the air hose and diffuser are not needed.

Hydrothermal Vent Parts List		
Item	Unit	Qty.
1/2" PVC Furniture Grade 4 Way Tee	Each	1
1/2" Sch 40 PVC Pipe X 2" Long	Each	2
1/2" CPVC to 1/2" PVC Bushing	Each	2
1" x 1/2" Sch 40 PVC Reducing Coupler	Each	2
1" X 1/2" Sch 40 Reducing Bushing	Each	1
High Visibility Tape	Each	1
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	5
1/2" PEX Pipe X 16" Long	Each	1
Air Diffuser, Optional for Regional competitions, see Hydrothermal Vent Air Supply section	Each	1

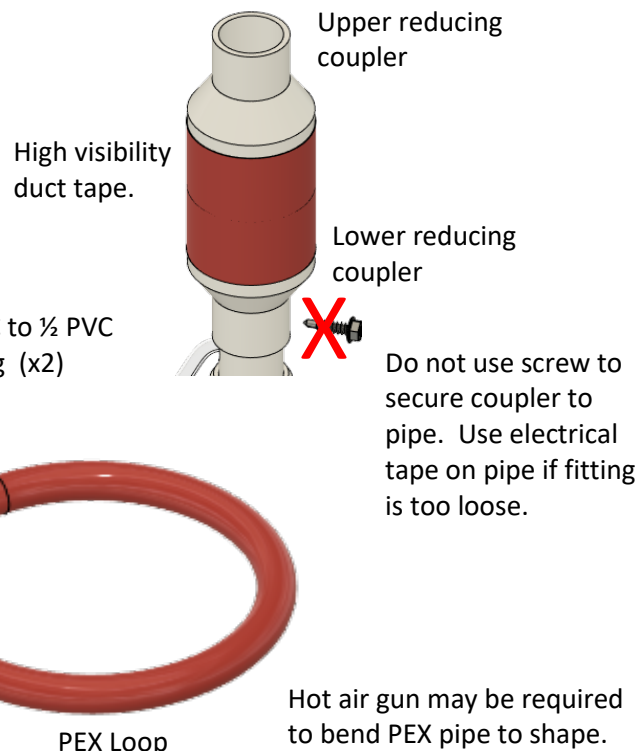


It is recommended that all pipe joints be secured with self-drilling screws.



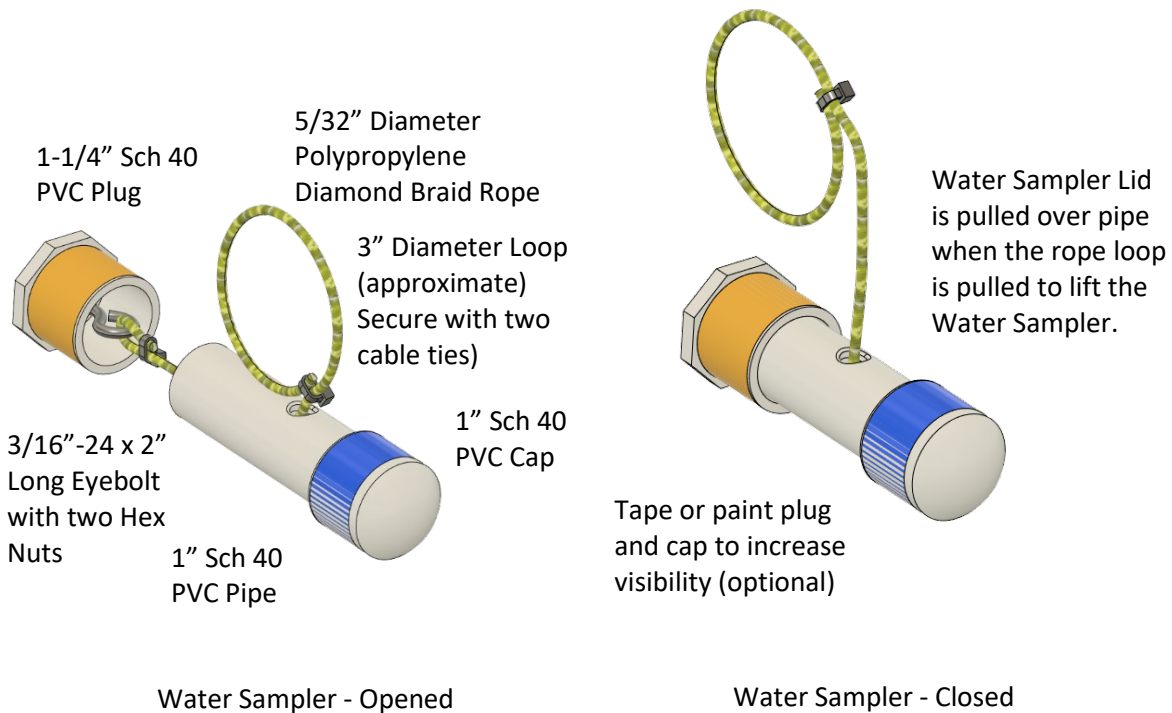
**Air Diffuser Assembly**

1. Attach lower reducing coupler to pipe with air hose exit.
2. Thread air hose through hose exit hole and attach to diffuser.
3. Hold upper and lower reducing couplers together and secure with two to three wraps of high visibility duct tape.



Exploded Assembly View

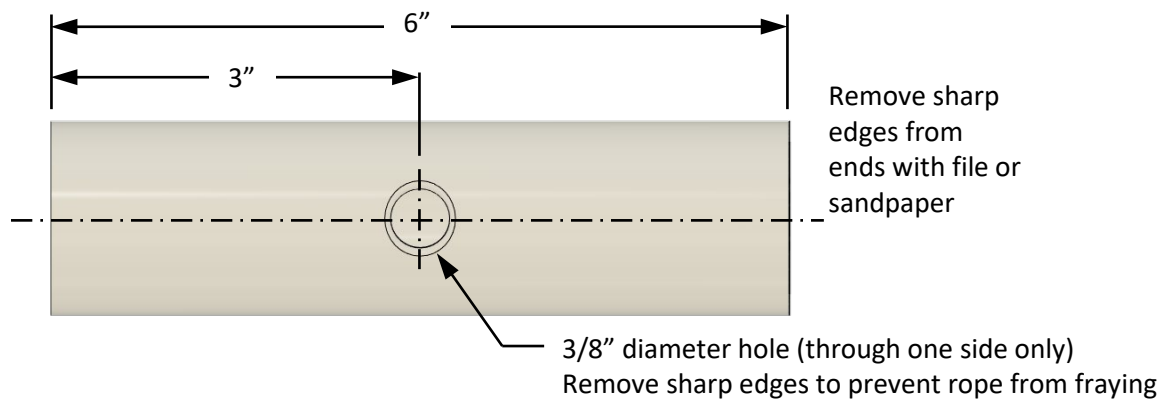
**Water Sample Collector**



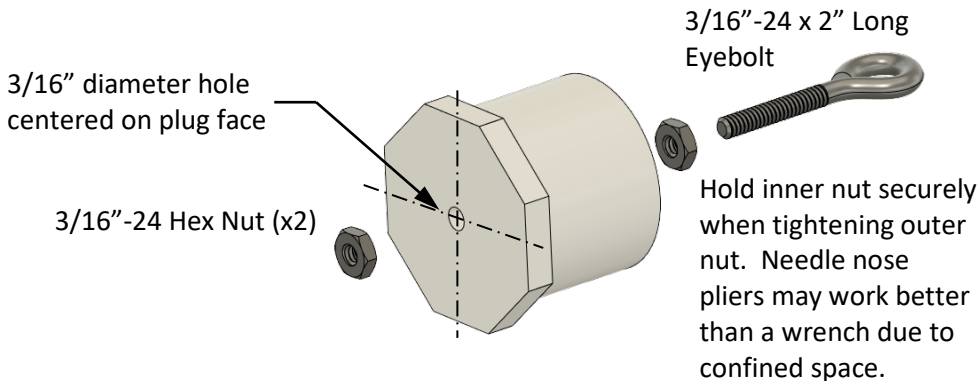
Water Sample Collector Parts List		
Item	Unit	Qty.
1-1/4" Sch 40 PVC Plug	Each	1
1" Sch 40 PVC End Cap	Each	1
1" Sch 40 PVC Pipe X 6" Long	Each	1
3/16"-24 X 2" Long Eye Bolt	Each	1
3/16"-24 Hex nut	Each	2
5/32" Polypropylene Diamond Braid Rope x 16" Long	Each	1
4" or 6" Cable Ties	Each	2
Colored Duct Tape or paint (optional)		

Weight in air = 150 grams  
 Weight in water = 45 grams

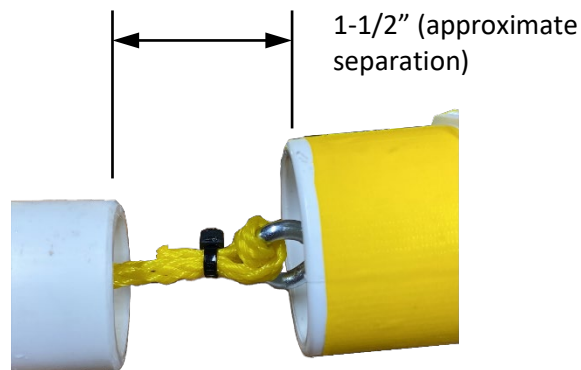
If the 1" cap does not fit securely on the pipe, then it should be glued or taped to the pipe.



Pipe Details



Lid Details



Wrap rope around eyebolt loop two times and secure with cable tie

Rope Termination Details

**Rock Samples**

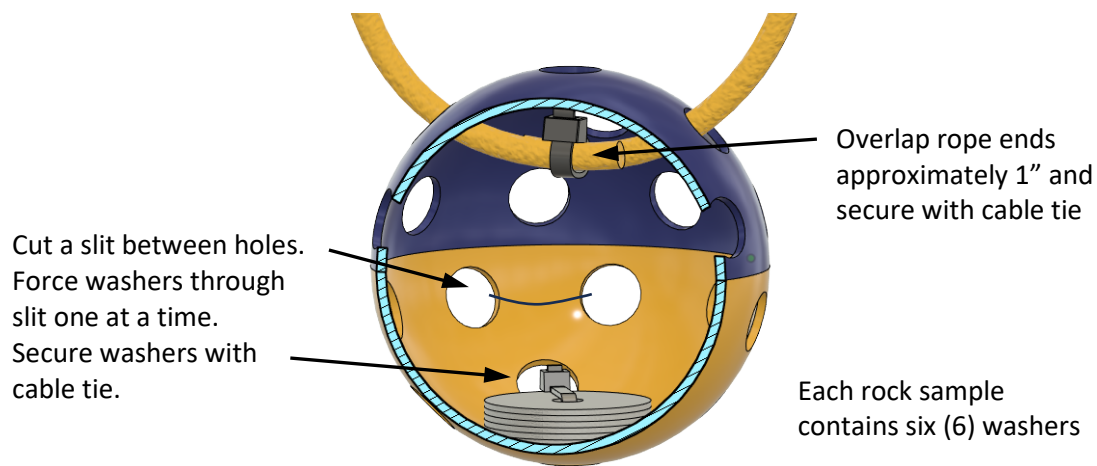
Rock Samples Parts List		
Item	Unit	Qty.
Baseball Size Plastic Practice Ball, 2.86" Diameter	Each	2
Softball Size Plastic Practice Ball, 3.6" – 3.86" Diameter	Each	2
1/4" Bolt Size X 1.5" Diameter X 0.055" Thick Stainless-Steel Fender Washer	Each	24
6" or 8" Cable Tie	Each	7
1/4" Diameter x 14" Long Polypropylene Rope	Each	3



Small Rock Samples (2 each)  
 Baseball Size Plastic Practice Ball,  
 Air weight: 100 grams  
 Water weight: 65 gram

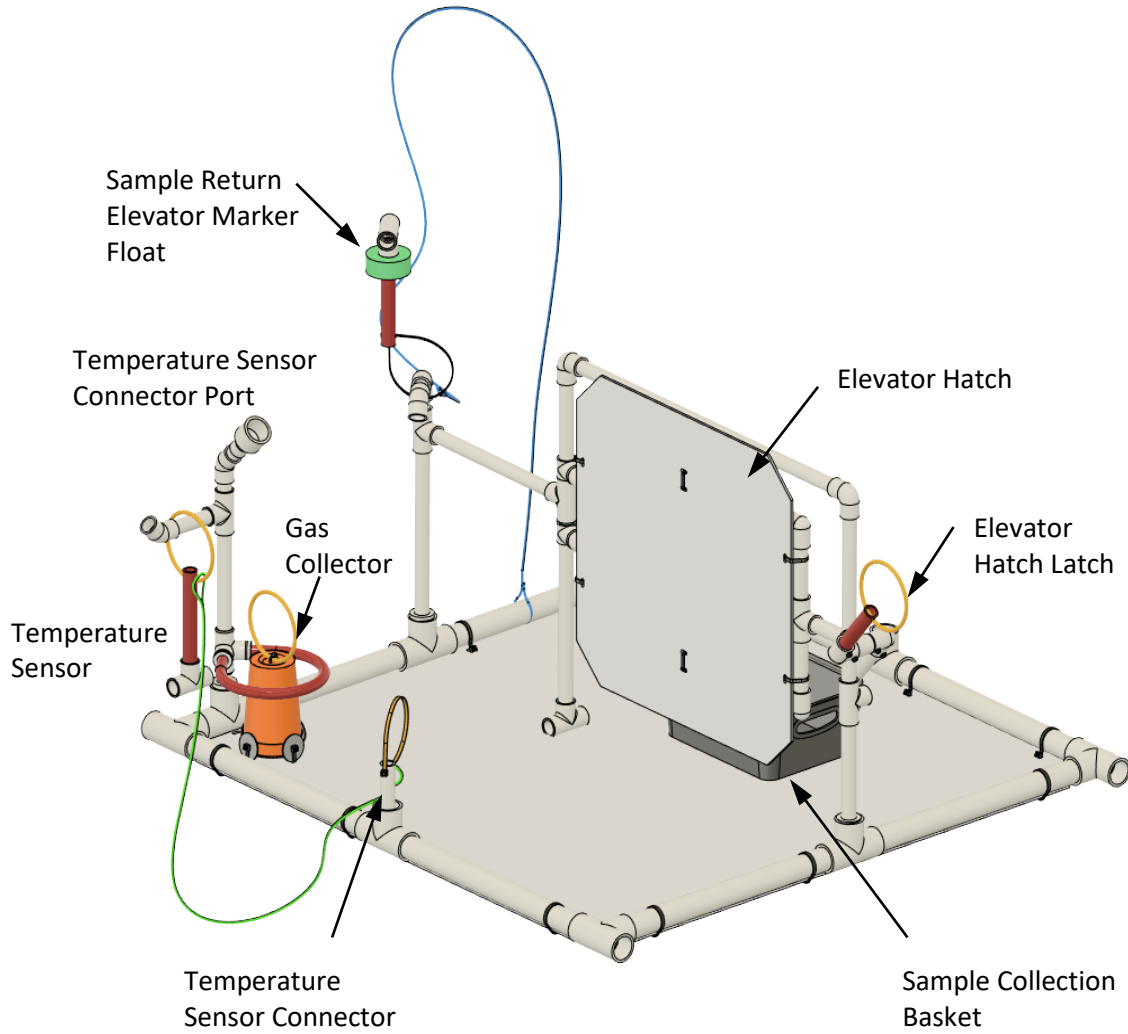
Large Rock Samples (1 with  
 rope loop, 1 without loop)  
 Softball Size Plastic Practice  
 Air weight: 126 grams  
 Water weight: 65 grams

**Rock Sample Specifications**



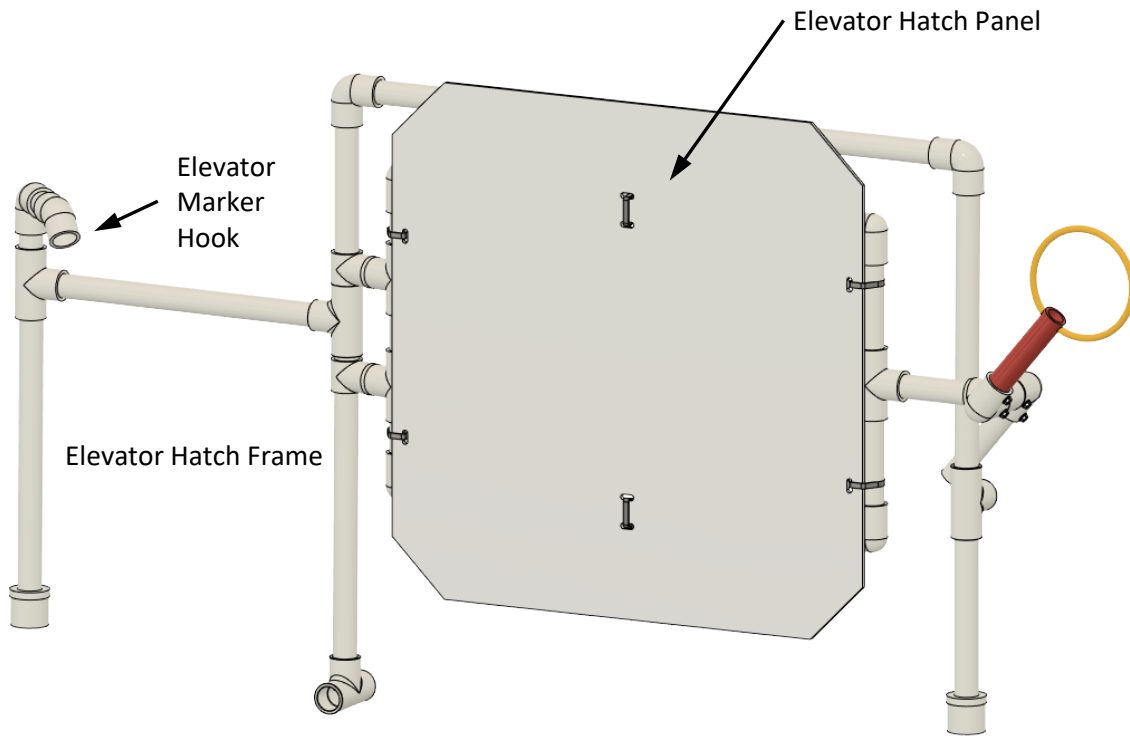
Cutaway View

### Sample Return Elevator



Sample Return Elevator with Task Elements

### Elevator Hatch Assembly



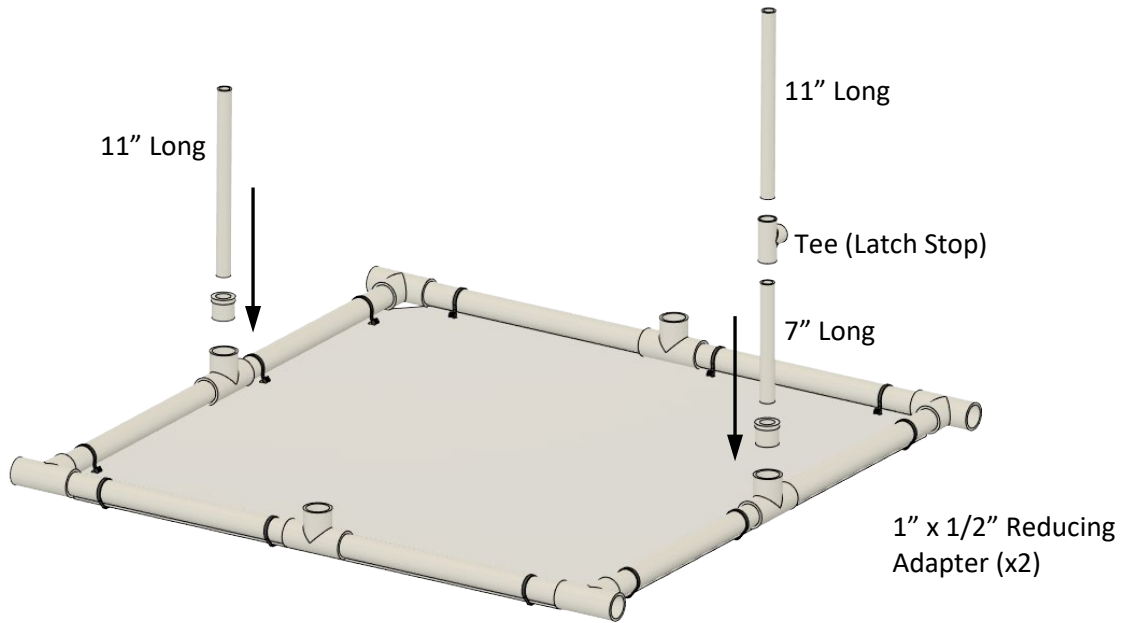
Elevator Hatch Assembly

The Elevator Hatch Panel is the “Gate” that has been used in International SeaPerch Challenge Mission Courses since 2019.

Elevator Hatch Frame Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Elbow	Each	3
1/2" Sch 40 PVC 45° Elbow	Each	1
1/2" Sch 40 PVC Tee	Each	4
1/2" Sch 40 PVC Pipe X 2" Long	Each	2
1/2" Sch 40 PVC Pipe X 7" Long	Each	2
1/2" Sch 40 PVC Pipe X 11" Long	Each	3
1/2" Sch 40 PVC Pipe X 12" Long	Each	1
1/2" Sch 40 PVC Pipe X 22.75" Long	Each	1
1" X 1/2" Sch 40 Reducing Bushing	Each	2
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	18

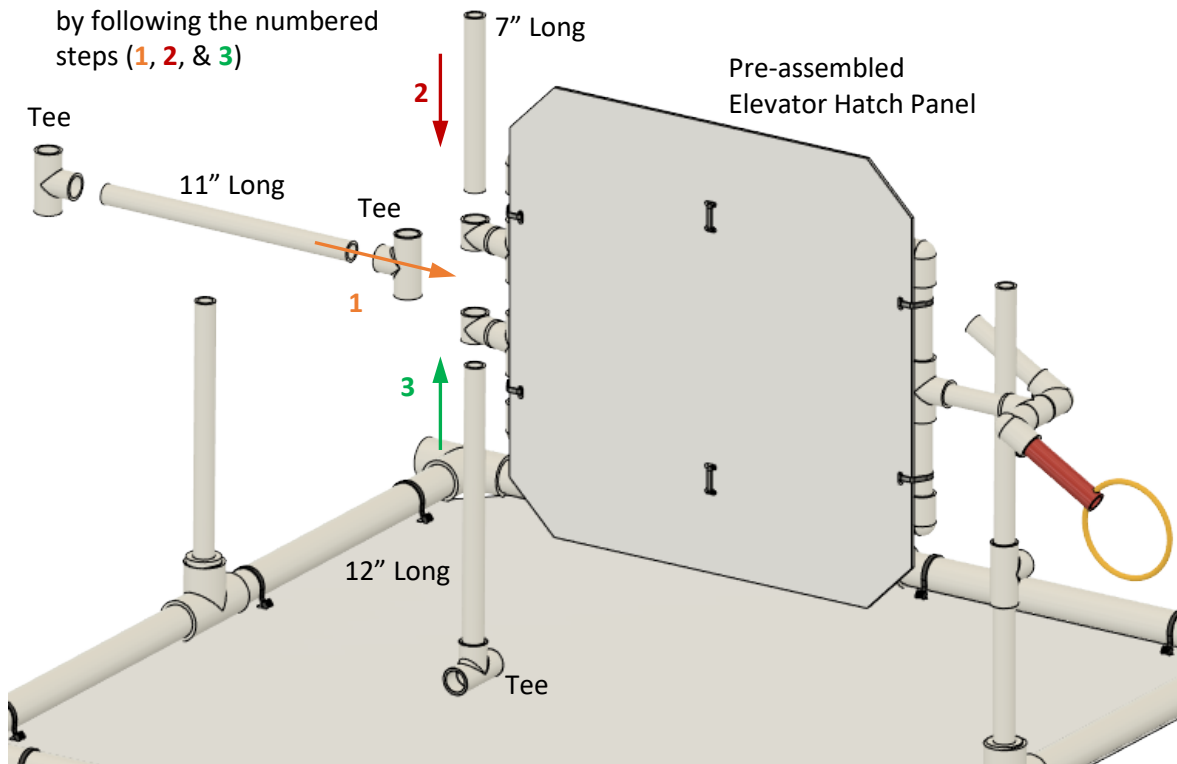
### Elevator Hatch Frame

Assemble the Elevator Hatch on the Sample Return Elevator platform.



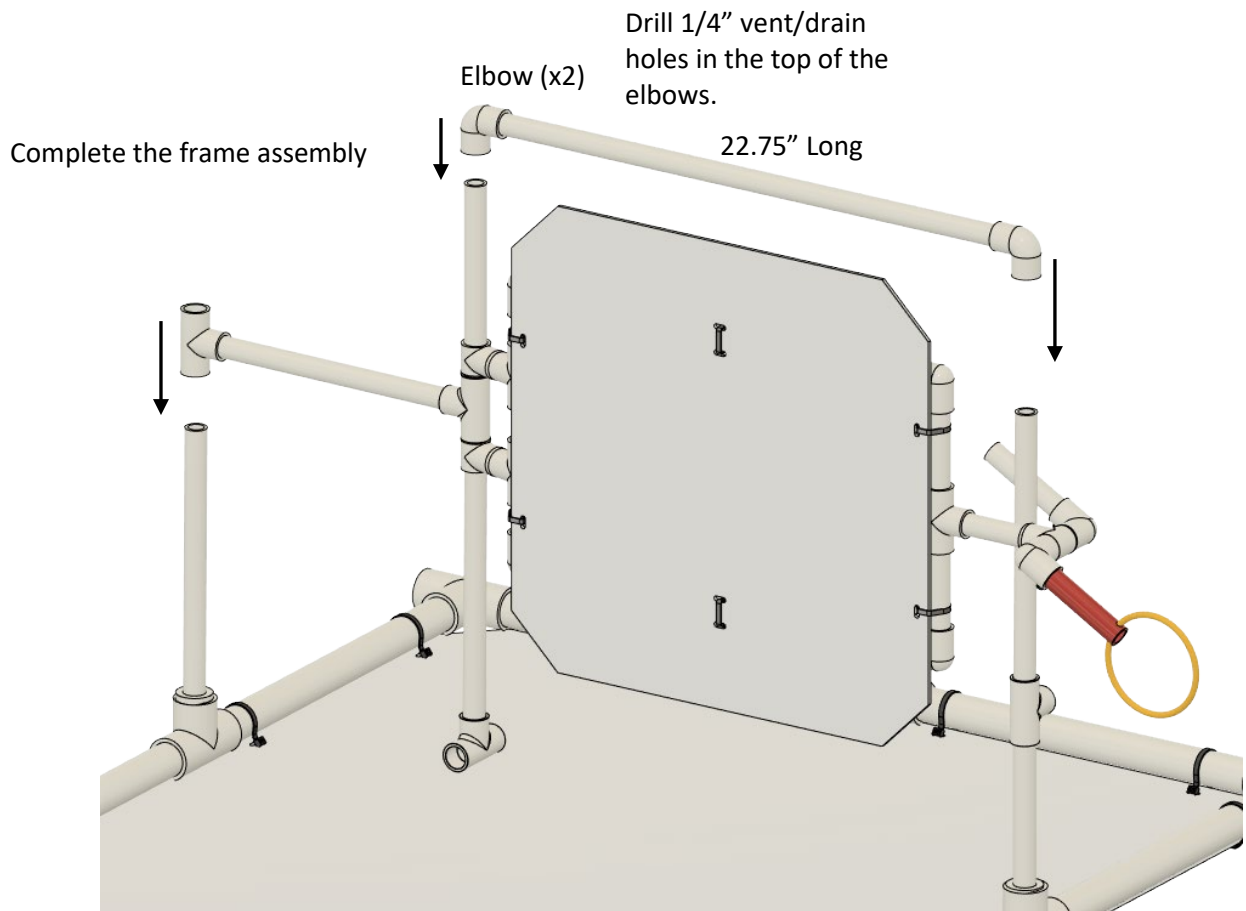
Elevator Hatch Frame Assembly – Step 1

Assemble the hinge parts by following the numbered steps (1, 2, & 3)

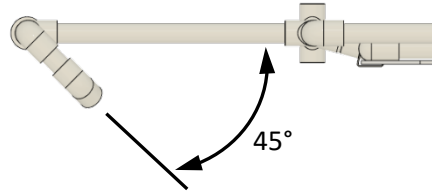


Elevator Hatch Frame Assembly – Step 2

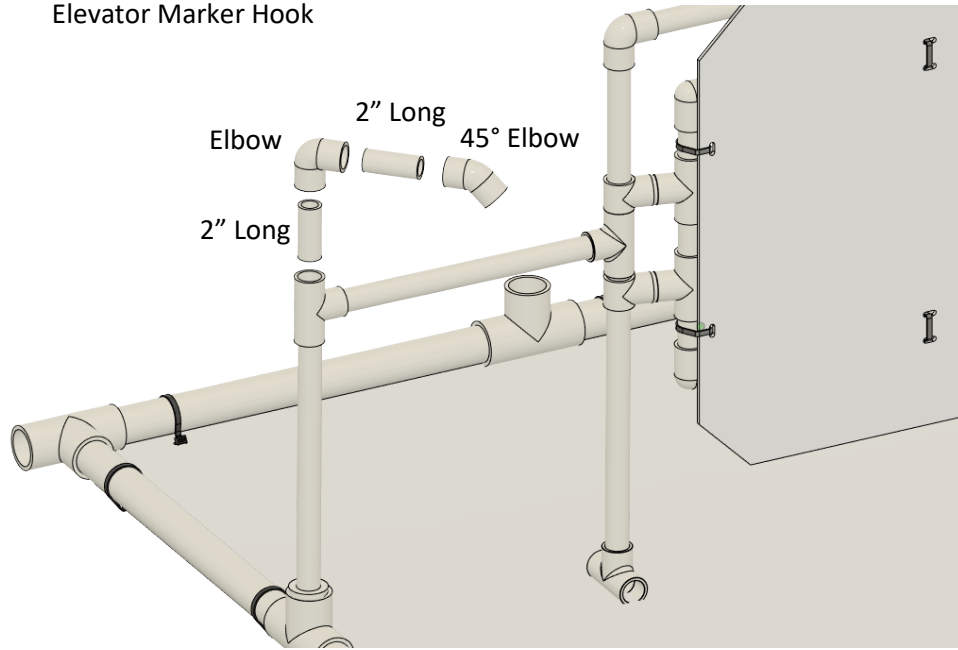




Elevator Hatch Frame Assembly – Step 3



Top View  
Elevator Marker Hook



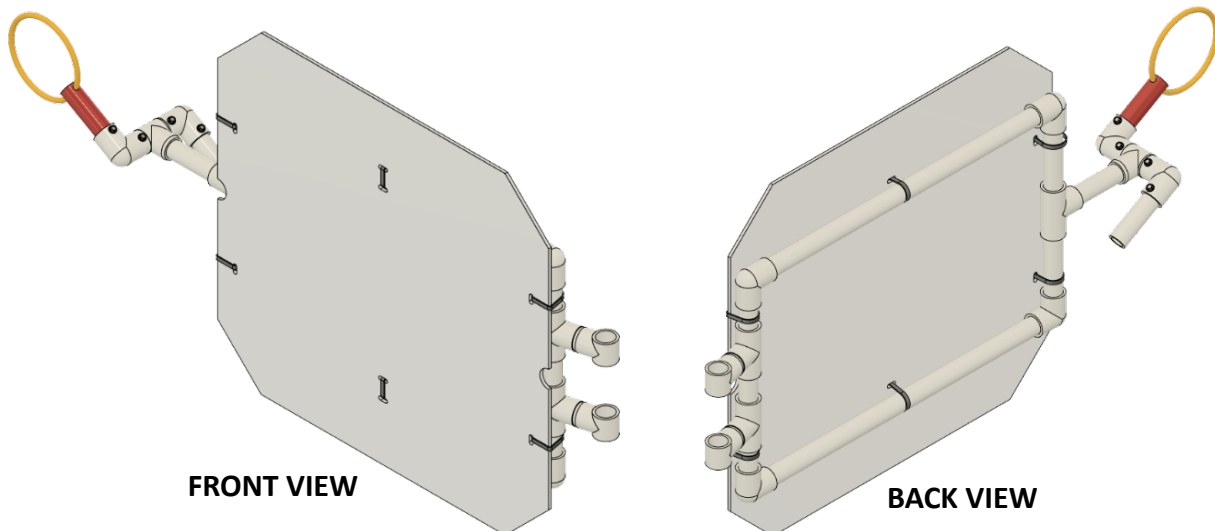
Elevator Marker Hook Assembly

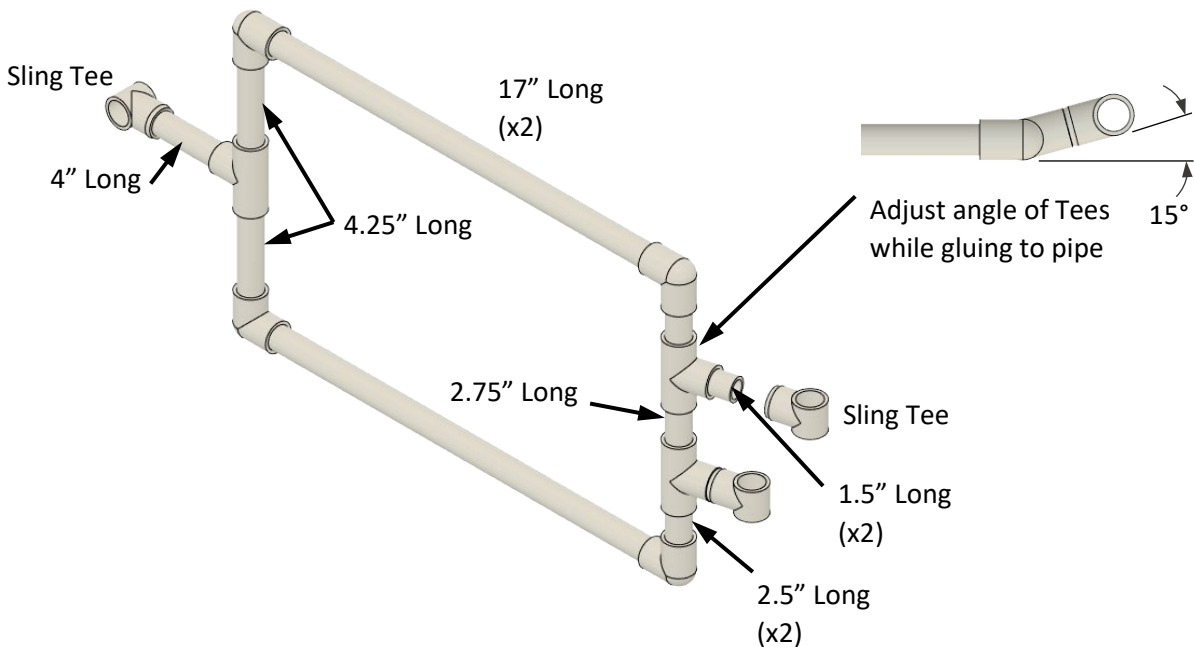
After completing the hatch assembly, secure all pipe joints with self-drilling screws.  
Do not use screws on hatch sling tees.

### Elevator Hatch Panel Assembly

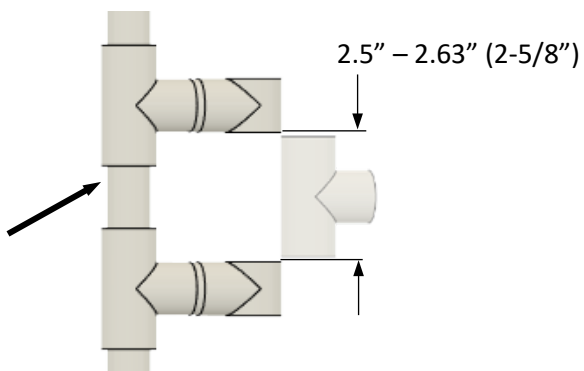
It is recommended that the frame be glued using PVC solvent cement following the manufacturer’s safety and usage instructions. Gluing the frame will make it positively buoyant eliminating the need for additional flotation.

Elevator Hatch Panel Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Elbow	Each	6
1/2" Sch 40 PVC Tee	Each	3
1/2" PVC Furniture Grade Sling Tee	Each	3
1/2" Sch 40 PVC Pipe X 1.5" Long	Each	2
1/2" Sch 40 PVC Pipe X 2.5" Long	Each	3
1/2" Sch 40 PVC Pipe X 2.75" Long	Each	1
1/2" Sch 40 PVC Pipe X 4" Long	Each	3
1/2" Sch 40 PVC Pipe X 4.25" Long	Each	2
1/2" Sch 40 PVC Pipe X 17" Long	Each	2
1/2" Sch 40 PVC Pipe X 4" Long (Red) <i>(or use plain pipe and paint or tape)</i>	Each	1
Polypropylene Sheet, .157 Thick, 18" X 18"	Each	1
8" Cable Tie <i>(may be substituted with other sizes)</i>	Each	6
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw <i>(Only needed for latch)</i>	Each	4

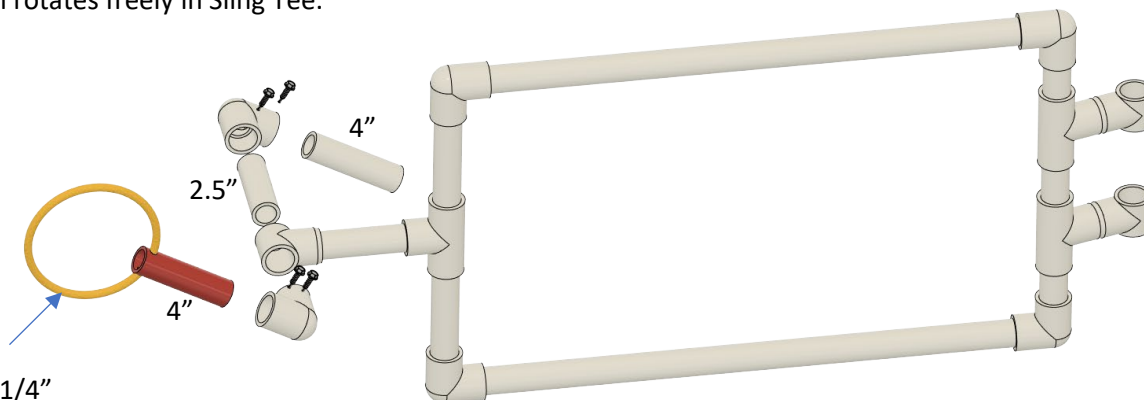




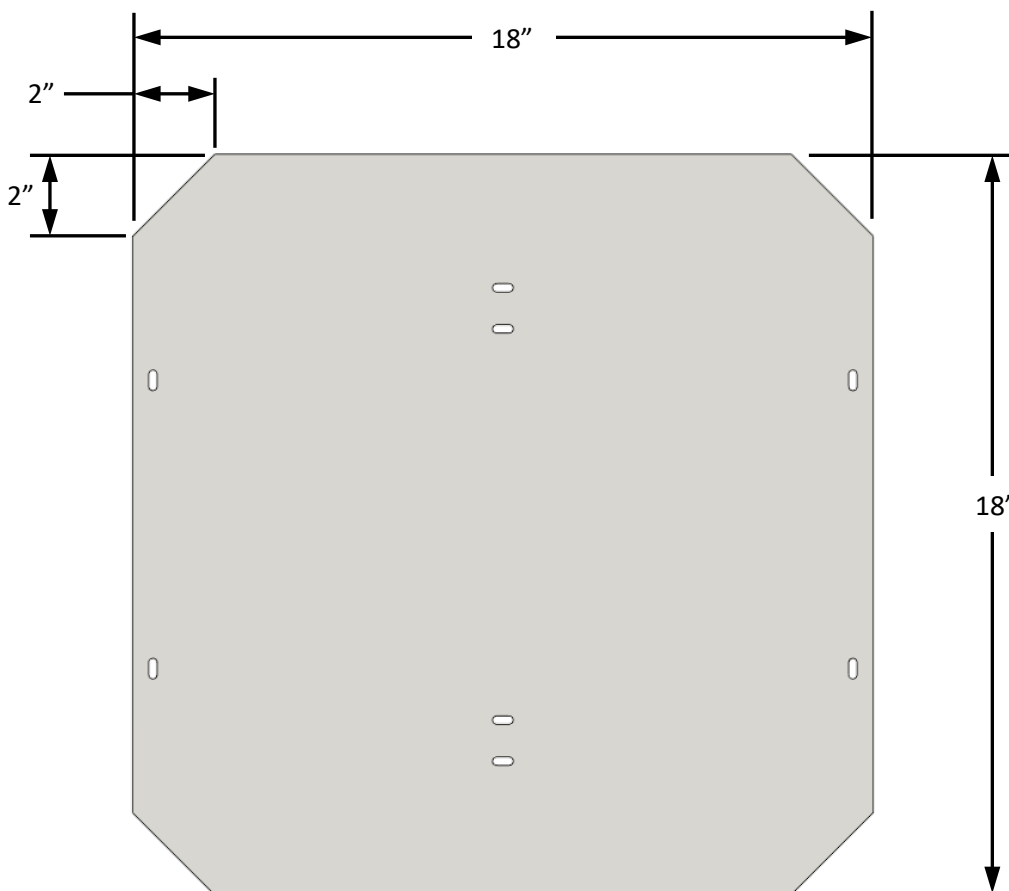
Spacing between Sling Tees must be wide enough to accommodate a standard Tee.  
Adjust length of 2.75\" long pipe as required to set spacing.



Secure pipes to elbow using screws (listed in parts list). Do not secure to Sling Tee. Assure latch rotates freely in Sling Tee.



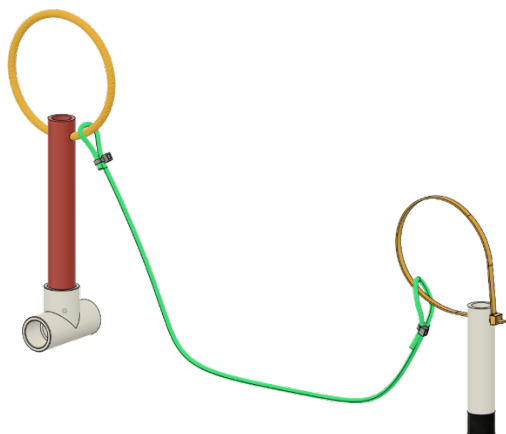
12" long 1/4" Polypropylene rope. Fasten ends using cable ties or suitable means.



Place cover plate on frame, mark location of cable tie slots. 1/4" wide flat blade screwdriver works well to cut slots.

Hatch Cover Details

### Temperature Sensor



Temperature Sensor Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Tee	Each	1
1/2" Sch 40 PVC Pipe X 4" Long (connector)	Each	1
1/2" Sch 40 PVC Pipe X 6" Long (sensor)	Each	1
5/32" Polypropylene Diamond Braid Rope x 60" Long	Each	1
1/4" Polypropylene Rope x 12" Long	Each	1
4" or 6" Cable Tie	Each	3
12" High Visibility Cable Tie	Each	1
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw (optional if pipes fit tightly into pipe fittings)	Each	1
5/16" Nominal Inside Diameter x 7/8" Outside Diameter x 1/16" thick, Zinc Flat Washer [optional to attach to magnet in the Temperature Sensor Connector Port]	Each	1
Electrical tape [optional to attach magnet to temperature sensor connector]		
Options for coloring pipe: use colored PVC pipe, colored duct tape, or waterproof paint		

Temperature sensor

Weight in air = 80 grams

Weight in water = 19 grams

Connector without washer

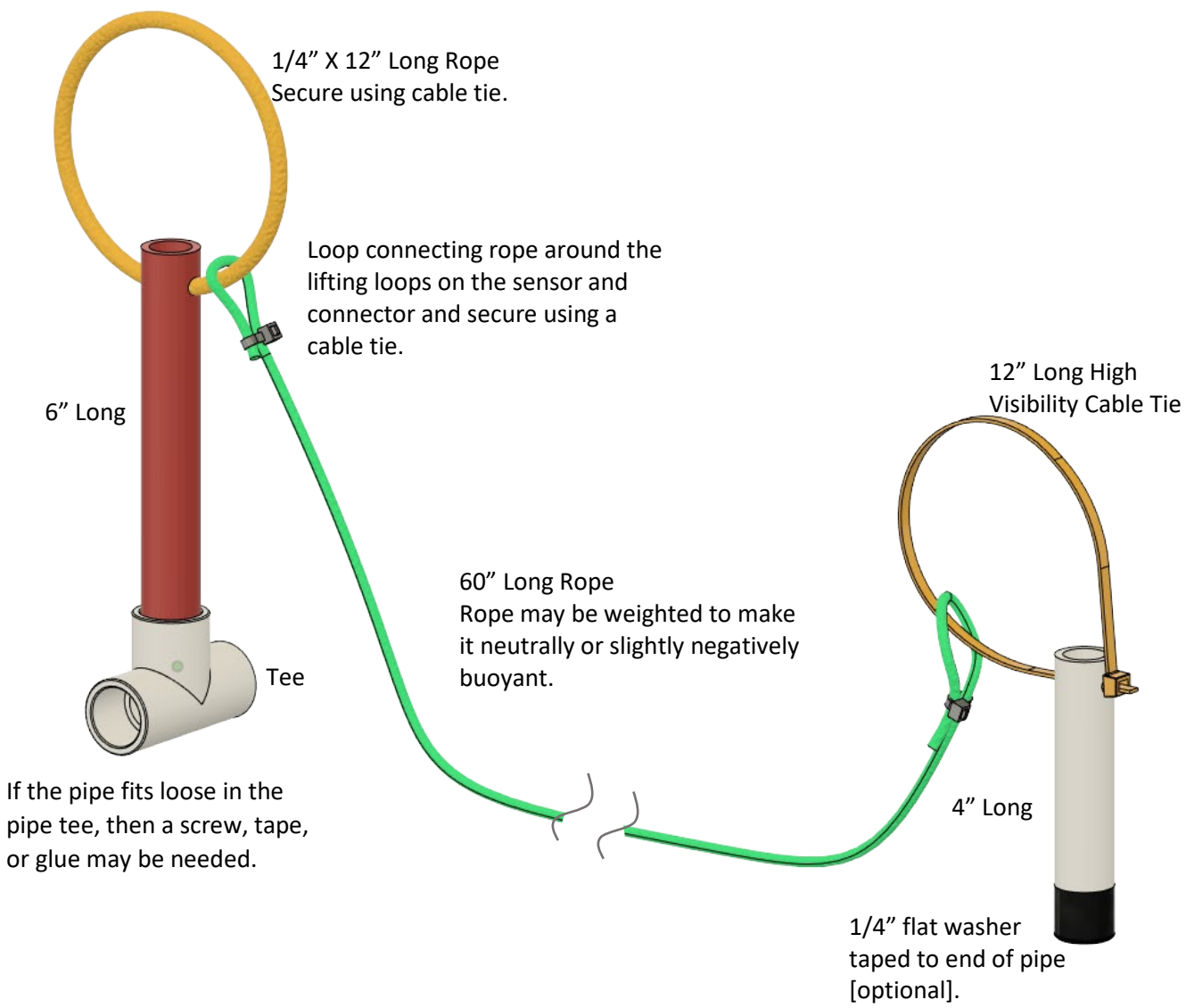
Weight in air = 28 grams

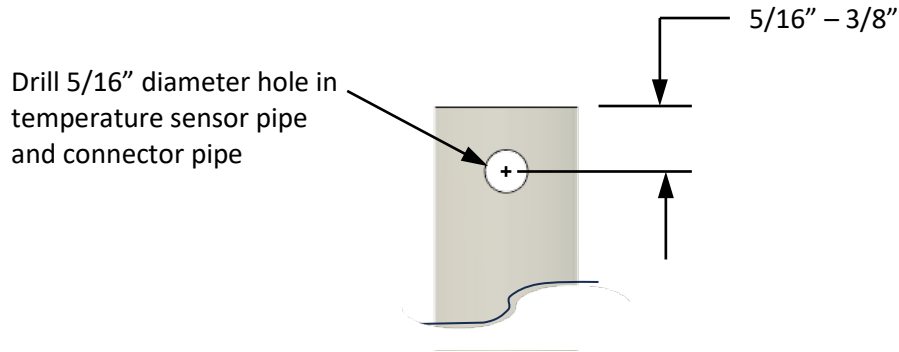
Weight in water = 8 Grams

Connector with washer

Weight in air = 33 grams

Weight in water = 10 grams





Place washer connector pipe



Place electrical tape over washer and over pipe

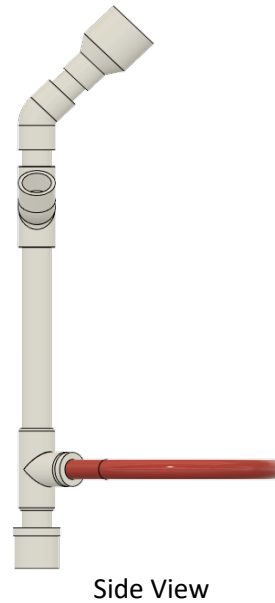
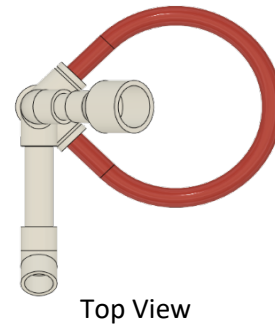
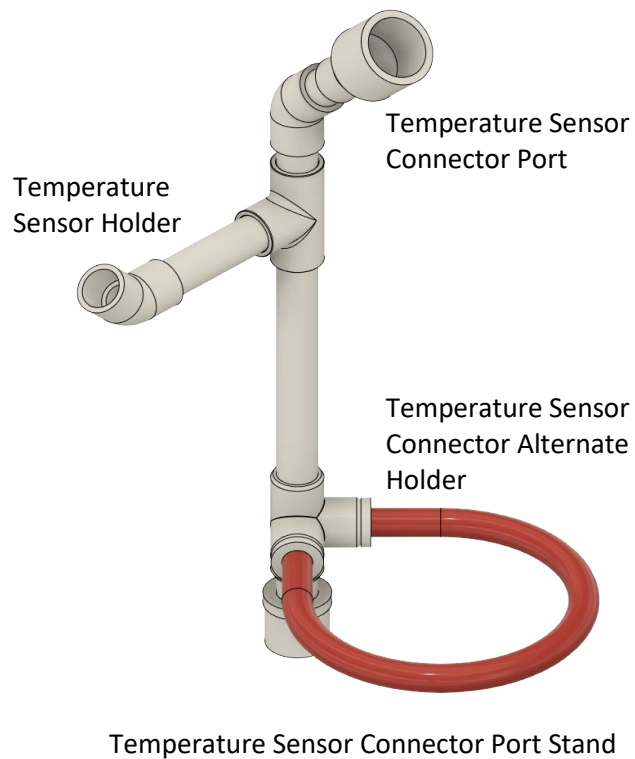


Wrap a two layers of electrical tape around the taped end of the pipe to help hold the tape and washer on the pipe.



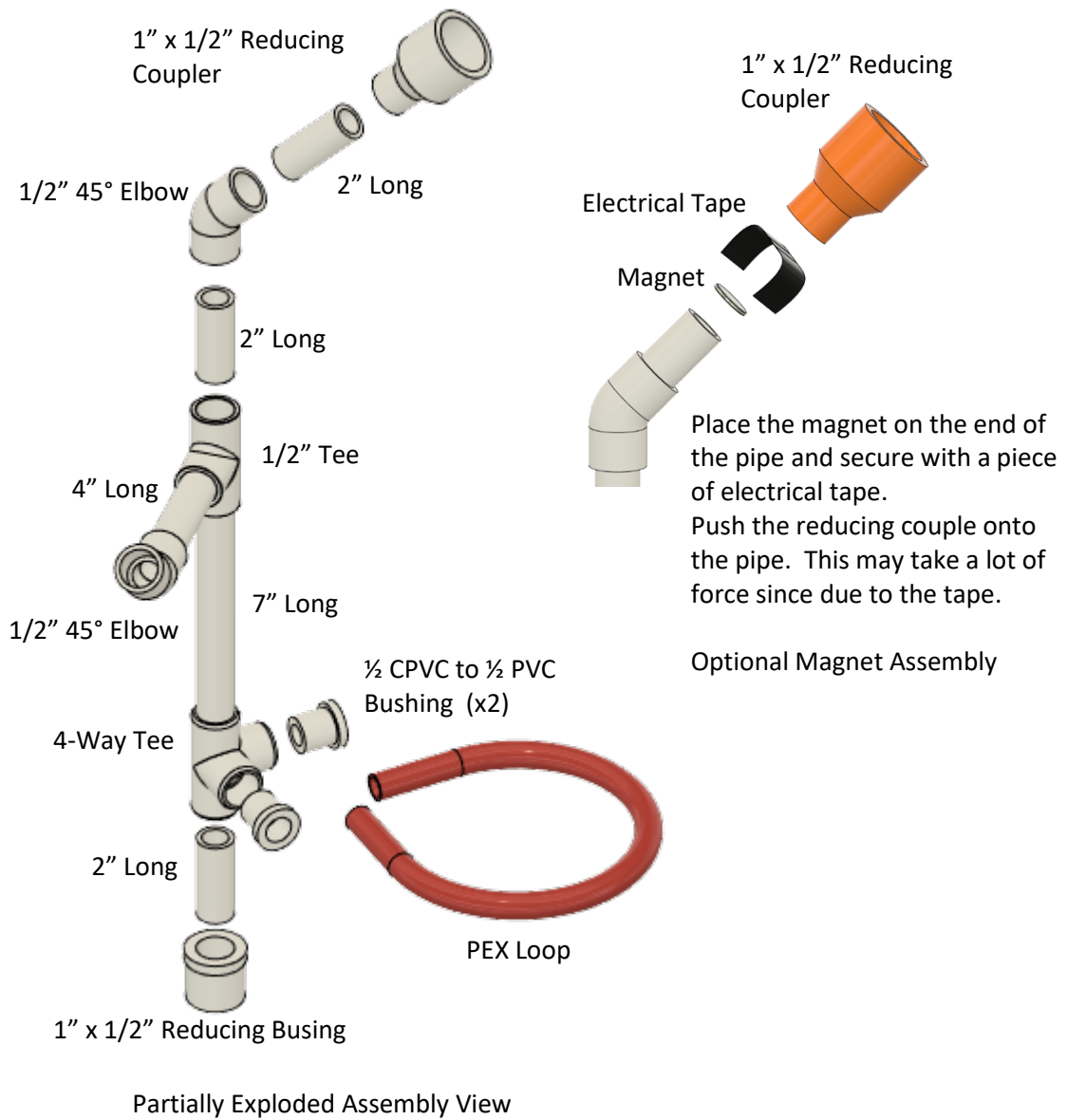
Installation of Optional Washer





**Temperature Sensor Connector Port**

Temperature Sensor Connector Port Stand Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Tee	Each	1
1/2" Sch 40 PVC 45° Elbow	Each	2
1/2" CPVC to 1/2" PVC Bushing	Each	2
1/2" PVC Furniture Grade 4 Way Tee	Each	1
1/2" Sch 40 PVC Pipe X 2" Long	Each	3
1/2" Sch 40 PVC Pipe X 4" Long	Each	1
1/2" Sch 40 PVC Pipe X 7" Long	Each	1
1" X 1/2" Sch 40 Reducing Bushing	Each	1
1" x 1/2" Sch 40 PVC Reducing Coupler	Each	1
1" PVC Snap-on Saddle Tee (shown in final assembly drawing)	Each	1
1/2" PEX Pipe X 16" Long	Each	1
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	12
20mm Diameter x 2mm Neodymium Magnets Disc [optional]	Each	1
Electrical Tape (as required if using magnet)		



**Gas Collector**

Gas Collection Cup Parts List		
Item	Unit	Qty.
16 Ounce Plastic Cup	Each	1
1/4" Polypropylene Rope X 12" long	Each	1
1/4" Bolt Size X 1.5" Diameter X 0.055" Thick Stainless-Steel Fender Washer	Each	4
4" Cable Tie	Each	5

Weight in air = 82 grams

Weight in water = 37 grams



Gas Collection Cup Assembly



Drill four 3/16" diameter holes equally spaced as shown. Can cut slits instead of drilling if preferred. Attach washers using cable ties as shown.

Washer Attachment Details



Outside Bottom of Cup

Cut small slits in the bottom of the cup to attach the cable tie. The slits should be just large enough to allow the cable tie to thread through. Larger holes will allow air to leak from the cup when collecting the gas (air).



Cable Tie Inside of Cup

Needle nose pliers are helpful to thread the cable tie through the slit when threading the cable tie end from inside the cup.

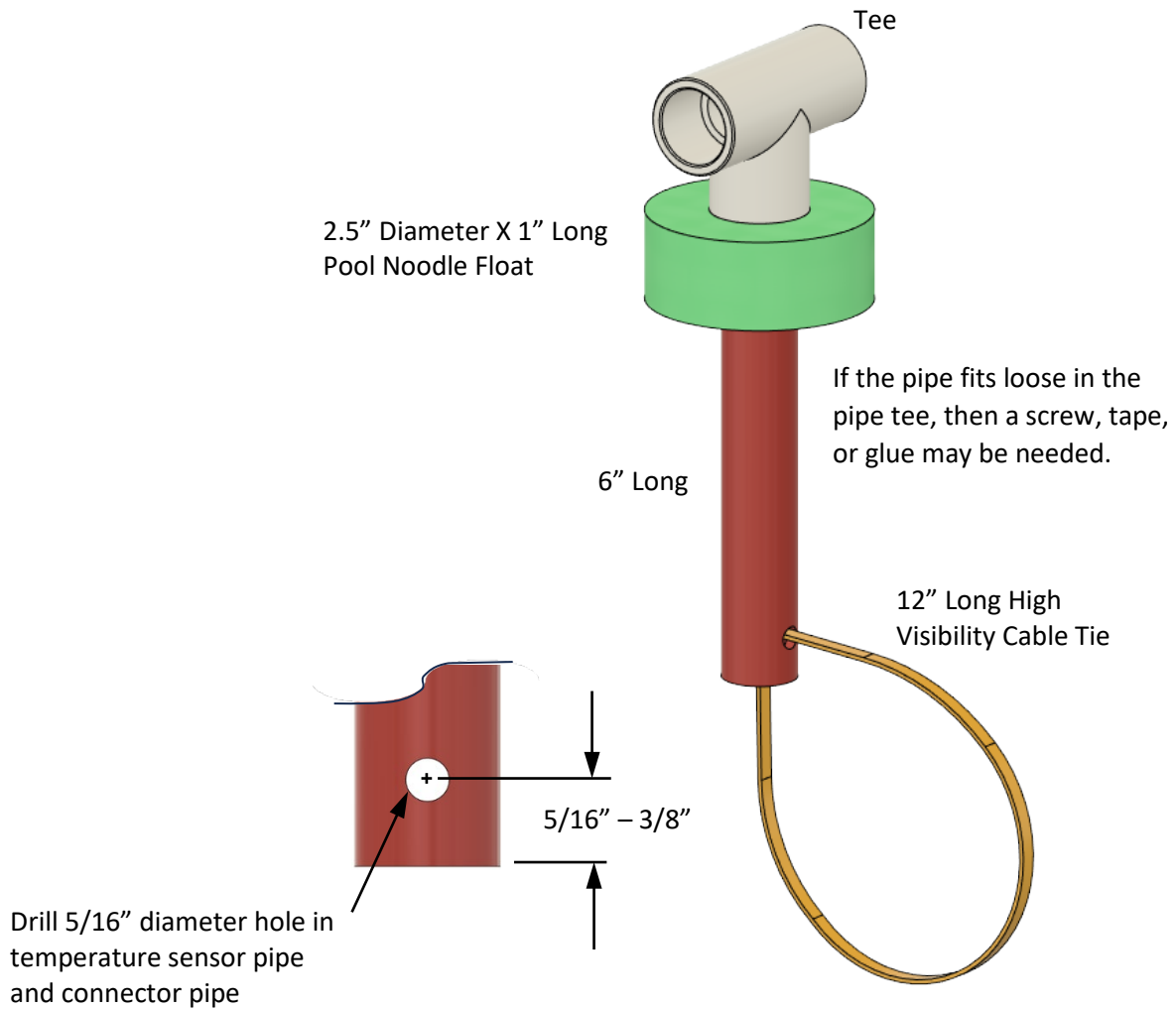


Rope Loop Termination Details

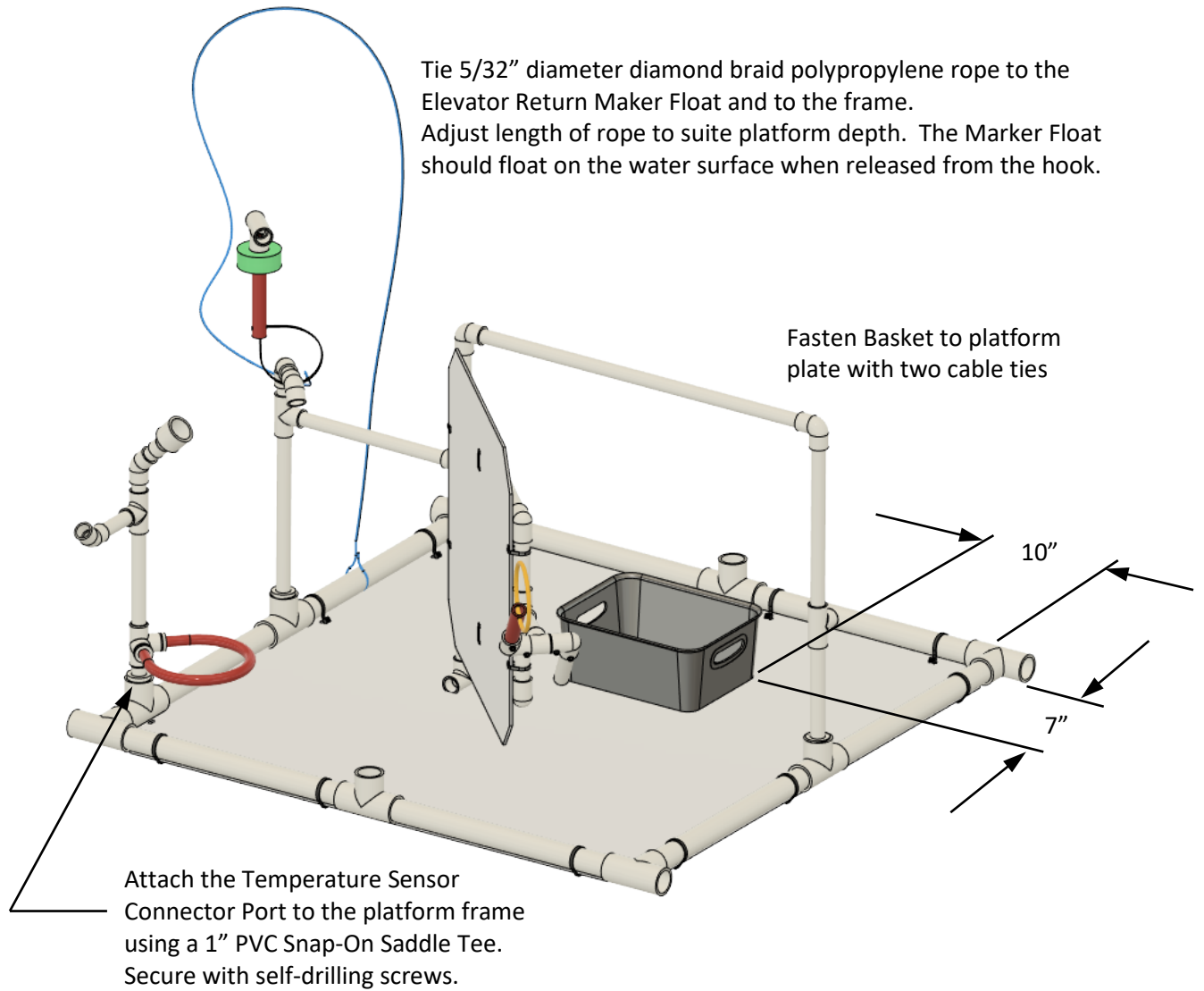
Overlap rope ends and secure with cable tie

Sample Return Elevator Marker

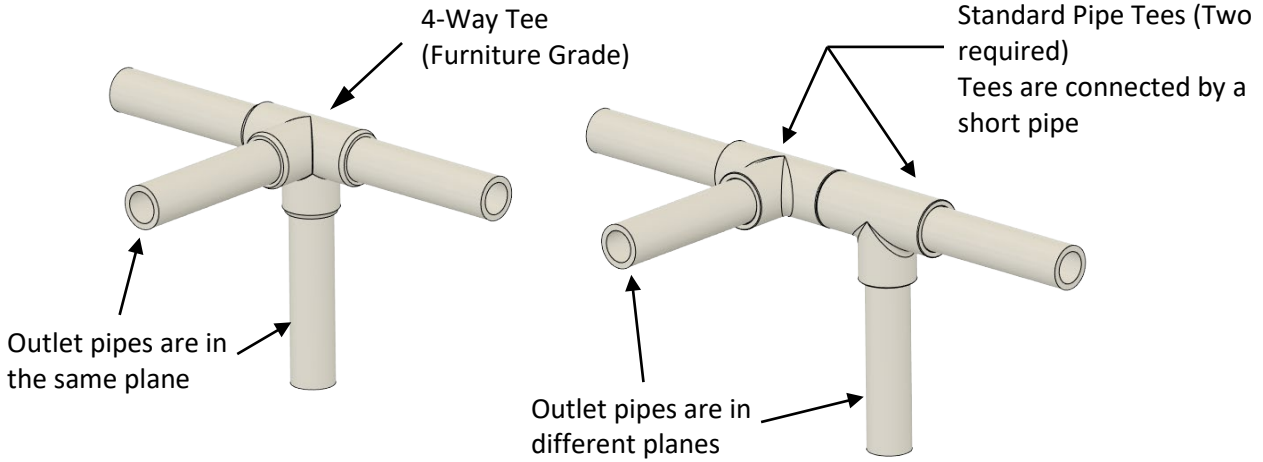
Sample Return Elevator Marker Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Tee	Each	1
1/2" Sch 40 PVC Pipe X 6" Long (Red – see options note below)	Each	1
5/32" Polypropylene Diamond Braid Rope x 72" Long	Each	1
4" Cable Tie (to secure rope)	Each	2
12" High Visibility Cable Tie	Each	1
2.5" Outside Diameter x 3/4" Inside Diameter x 1" Long Pool Noodle	Each	1
Options for coloring pipe: use colored PVC pipe, colored duct tape, or waterproof paint		



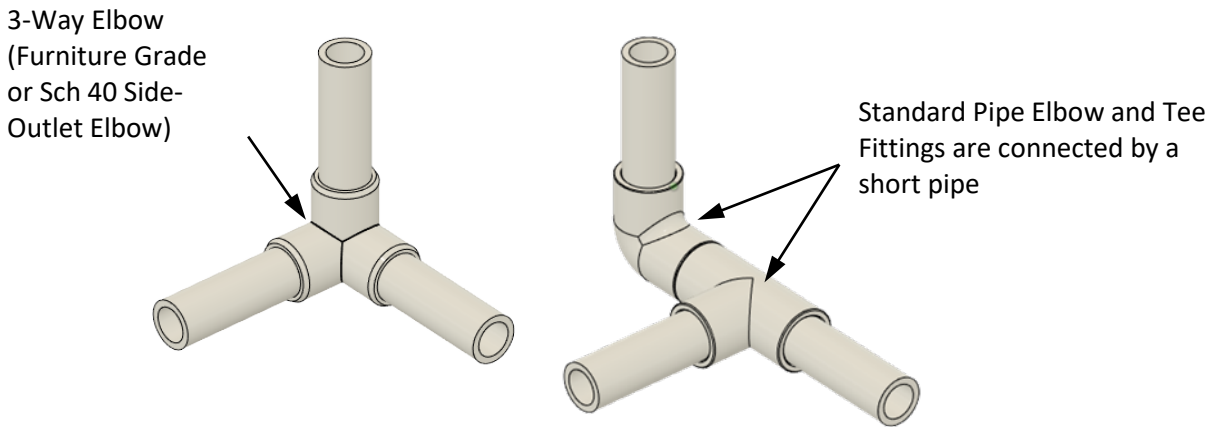
Attaching Task Components to the Sample Return Evaluator



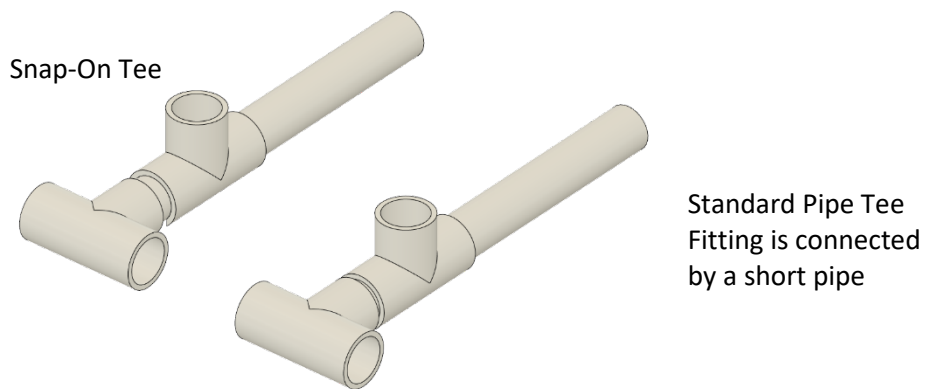
Alternatives to Using Special Fittings



4-Way Tee Alternative



3-Way Elbow Alternative



Snap-On Tee Alternative

# 2024 International Challenge Mission Course

## Hydrothermal Vent Air Supply

2024 SeaPerch Season

[www.seaperch.org](http://www.seaperch.org)

Air will be supplied to the hydrothermal vent using an aquarium air pump. The air pump has a rechargeable battery and can be used on the pool deck without being plugged into 110-volt facility power.

Air pump reference information: <https://www.amazon.com/gp/product/B0C2YYYM9N>

The air pump being used at the International Challenge is the 18-watt model. Two air pumps will be used to supply air to eight (8) mission course simultaneously.

The 10-watt model is sufficient for up to four (4) mission courses at a water depth less than five feet deep. If the pump is being used at a regional competition it should be tested in the pool to assure it will supply air at the depth required. Please refer to the link provided for additional product information.

