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Standard Operating Procedures - Isolating and Identifying Sources of Sediment Deposition Using the Signal Activated Bottom Lander (SABL)

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Administrative Notes:
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ADMINISTRATIVE INFORMATION

The work described in this report was performed by the Energy and Environmental Sustainability branch of the Advanced Systems and Applied Sciences Division, Naval Information Warfare Center (NIWC) Pacific, San Diego, CA. The Navy Environmental Sustainability Development to Integration (NESDI) Program, Project #595 provided funding for this Basic Applied Research project.

Released by
Robert George, Branch Head
Energy and Environmental Sustainability

Under authority of
John deGrassie, Division Head
Advanced Systems and Applied Sciences

REMARKS

Editor: MGK

EXECUTIVE SUMMARY

This Standard Operating Procedure (SOP) was generated in support of project #595 “Demonstration of a Signal Activated Bottom Lander Trap” as supported by the Navy Environmental Sustainability Development to Integration (NESDI) Program. This guidance document will provide the necessary information for the operation of the Signal Activated Bottom Lander (SABL) and provide considerations for site-specific deployments.

The Bioassay Lab at the Naval Information Warfare Center (NIWC) Pacific Bayside in collaboration with McLane Research Laboratory developed the SABL technology to help site managers and stakeholders more accurately evaluate sources of particulate deposition (i.e., shore-side runoff, stormwater runoff, resuspension of sediments due to ship or dredging activities, etc.) to better evaluate potential recontamination of receiving sediments adjacent to Navy installations. The SABL is a modified sediment trap that is capable of collecting multiple samples over a pre-programmed time-series. Additionally, the SABL is capable of remote programming which allows on-demand commands by NIWC Pacific scientists for unique sample collection during critical environmental changes.

These site-specific environmental triggers (i.e., salinity and/or turbidity) are measured and communicated to NIWC Pacific scientists through co-deployed water quality sensors and telemetry equipment. The SABL operator is then able to command the SABL to collect a unique sample.

This manual will focus primarily on SABL assembly and “adaptive command-line driven” deployments. Prior to deployment, researchers and field personnel should review this manual, and relevant documentation for the technologies used in conjunction with the SABL. The procedures outlined in this SOP will ensure safe and proper use of this equipment.

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ACRONYMS

DI	Deionized Water
HNO_3	Nitric Acid
HCl	Hydrochloric Acid
IP	Internet Protocol
NIWC Pacific	Naval Information Warfare Center Pacific
SABL	Signal Activated Bottom Lander
SOP	Standard Operating Procedure
USB	Universal Serial Bus
VNC	Virtual Network Connection

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CONTENTS

FIGURES

TABLES

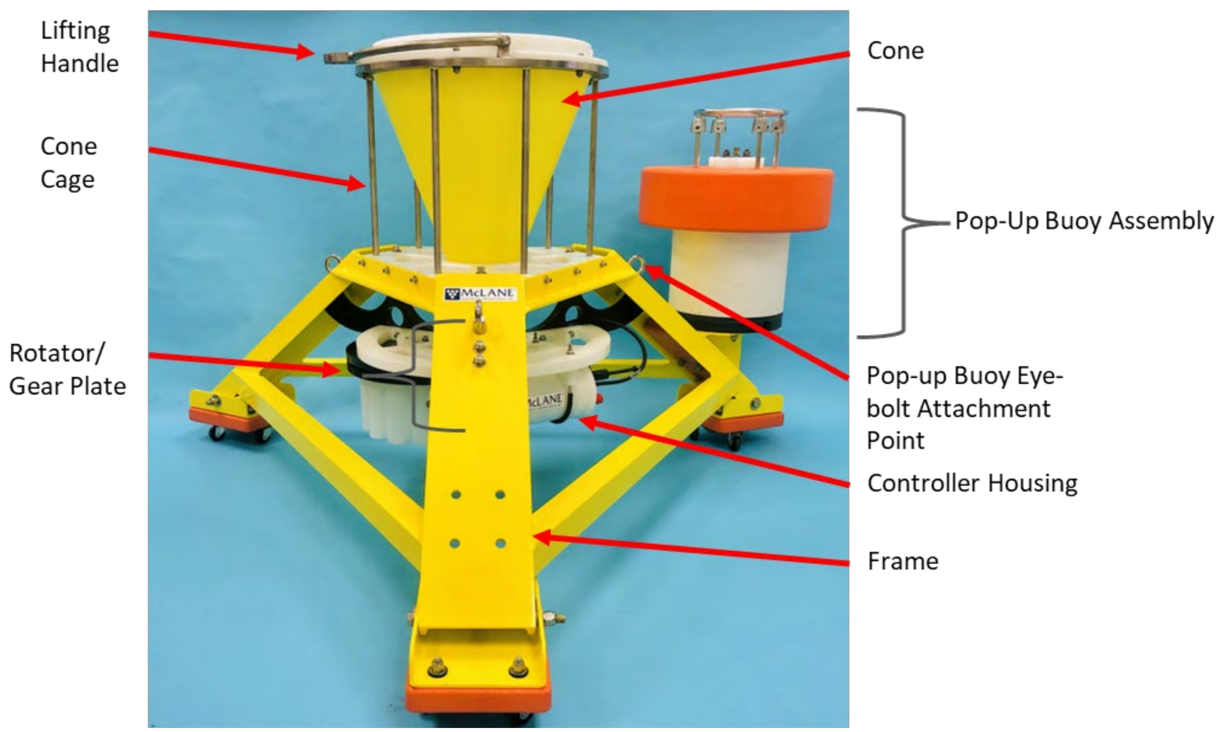
1. SIGNAL ACTIVATED BOTTOM LANDER (SABL) OVERVIEW

The SABL is a low-profile multi-sample sediment trap that is capable of collecting sinking particulate matter in individually sealed sample bottles set upon a rotator/gear plate (Figure 1). The large cone with a baffle focuses sinking matter toward the sample collection bottles. The SABL can be pre-programmed for time-series sample collection using the McLanePro Software. Alternatively, the SABL can be set-up for remote start and termination of sample collection for targeting specific deposition events (i.e., resuspension of sediments due to near-by ship activities, stormwater runoff from near-shore discharges, etc.) through a command-line interface.

The SABL has 13 sample collection bottles (250mL each) and comes with a pop-up recovery buoy that can also be pre-programmed or remotely triggered for release through the SABL communications. A SABL product fact sheet can be downloaded from the following web address:

McLane-SABL-Sediment-Trap-Datasheet.pdf (mclanelabs.com)

https://mclanelabs.com/wp-content/uploads/2023/09/McLane-SABL-Sediment-Trap-Datasheet.pdf



- Key structural components labeled.

Figure 1. SABL with associated pup-up recovery buoy (McLane 2023b).

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2. PRE-DEPLOYMENT PREPARATION

IMPORTANT: The user must ensure all watertight components are correctly assembled. A leaky controller housing can be detrimental to the project due to compounding costs associated with replacement pieces, boat rental for equipment recovery and installation of new pieces, re-deployment of SABL and lost time and data associated with this type of equipment failure.

2.1 EXTERNAL MANUALS/ GUIDANCE DOCUMENTS FOR REVIEW

2.1.1 McLane Research Laboratory – Multi-Sample Sediment Trap Standard Operating Procedure (SOP)

McLane Research Laboratory has developed a manual for the standard use of their multi-sample sediment traps including the newly designed SABL (McLane 2023). It is recommended to review and become familiar with the standard operating methods set forth by McLane Research Laboratory but noted that the operation of the SABL for the purposes of the "adaptive command-line driven." deployments will be covered in this Naval Information Warfare Center (NIWC) Pacific SOP.

Sediment Trap & McLanePro User Manual (mclanelabs.com)

https://mclanelabs.com/wp-content/uploads/2023/06/Sediment-Trap-and-McLanePro-Manual.Rev_.23.F.23.pdf

2.1.2 EdgeTech® Recovery Buoy Manual

An option of the SABL units is a pop-up recovery buoy that is activated to release through the command-line interface of the SABL or pre-programmed through the McLanePro Software if a time-series collection program is used. It is imperative to review the manual (EdgeTech 2018) and thoroughly understand the functionality and preparation of the recovery buoy prior to use to ensure release of the buoy and recovery of all field-deployed equipment.

Pop-Up Option (edgetech.com)

https://www.edgetech.com/wp-content/uploads/2019/07/0019850_Rev_B_rev.pdf

2.2 CONNECTION OPTIONS FOR SABL

The SABL is capable of both time-series sample collection or event-specific/adaptive command sample collection through remote communications. Both are described in more detail below.

2.2.1 Time-Series Programming

The SABL can be pre-programmed to collect time-series samples of depositing particulate matter by using the McLanePro software. For example, a program can be established for 2-week intervals where every two weeks, the rotator/gear plate will rotate to the next sample bottle. Following the 13th bottle, the rotator/gear plate will return to the "home" or empty position until recovery. Intervals for the SABL can vary and considerations must be made with regard to deposition rates to ensure that the sample collection bottles don't over-fill and potentially carry-over into a subsequent collection bottle. If all sample bottles are not planned for use, programming should end the deployment on an open hole. If programming ends on a sample bottle/closed hole, the cone will fill with water and make the SABL much heavier to recover.

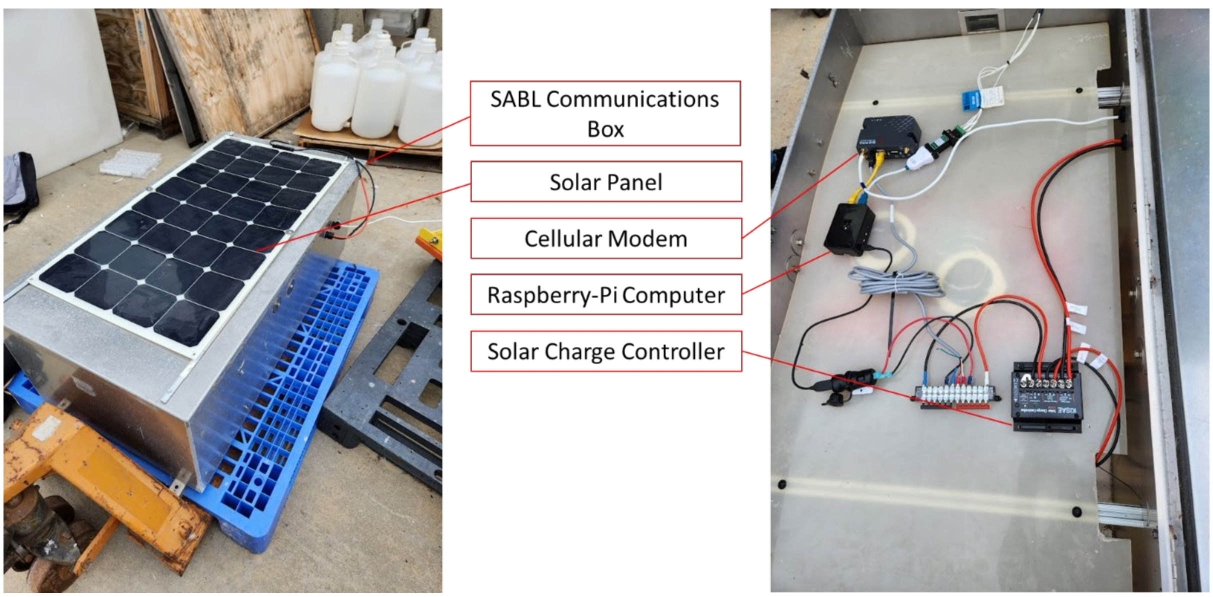
Programming for a time-series deployment requires the McLanePro software on a Windows® 7 or higher system. The connection between the McLanePro and the SABL is through universal serial bus

(USB)/RS-232 adapter (included in instrument toolkit with each unit when purchased). Refer to the McLane Sediment Trap Manual for further instructions for pre-programmed time-series deployments and use of the McLanePro software.

2.2.2 Adaptive Command Deployment

The SABL can be connected to a NIWC Pacific-built SABL Communications Box to allow for remote connectivity and user-dictated, event-base start/stop sample collection/movement of the rotator/gear plate. The SABL Communications Box connects directly to the SABL via an RS-485/RS-232/USB modified cable. The RS-485 end of the cable is plugged into the "C" 6-pin port on controller housing of the SABL and the USB end of the cable is plugged into an external computer or a microcontroller (host; i.e., Raspberry-Pi). For the purposes of this SOP, NIWC Pacific uses a Raspberry-Pi as the host.

The Raspberry-Pi is connected to a Sierra Wireless 4G router, both of which are powered by Odyssey Deep Cycle 12V batteries. Batteries are kept charged via a Kisae Technology SC1210LD Solar Charge Controller with a solar panel mounted on the top of the SABL Communications Box. Figure 2 below shows the configuration of the components inside the SABL Communications Box.



- Photos by M. Colvin.

Figure 2. SABL Communications Box and key components.

Prior to a deployment, it is imperative to ensure that the RS-485 connection to the SABL is secure to safeguard against water intrusion into the SABL controller housing. It is recommended that the RS-485 cable is secured to the SABL frame with cable ties so that no stress is placed on the controller housing connection. Once all connections are confirmed, the SABL unit can be deployed at the desired location. Care should be taken while doling out the RS-485 cable during deployment of the SABL unit.

2.3 EQUIPMENT PREPARATION

Several pieces of equipment need to be prepared prior to deployment. For the purposes of this SOP, preparations of equipment will be with the intent of an Adaptive Command Deployment. Each SABL comes with a toolkit as provided by McLane Research Laboratories. The toolkit contains proper sized tools and appropriate lubricants for use only on the SABL units for proper maintenance.

2.3.1 SABL Equipment

For the SABL unit, the following steps need to be followed to ensure proper operation (adapted from McLane 2023):

- Check and tighten all bolts and screws on SABL frame;
- Install new "C" cell alkaline batteries with correct polarity within the controller housing;
- Connect battery power to electronics (Figure 3);
- Inspect O-rings and replace if brittle or cracked;
- Close the controller housing and secure in the correct orientation;
- Remove dummy plug if necessary and connect the communications cable (RS-485/RS-232/USB modified cable);
- Connect communications cable to computer or SABL Communications Box;
- Confirm the SABL is communicating to the external computer/host;
- It is recommended at this time to set the date/time and tilt of the SABL (see section 3.3 for commands);
- Remove dummy plug if necessary and connect the motor-control cable as well as the recovery buoy cable to their appropriate ports, 'M' and 'R', respectively.

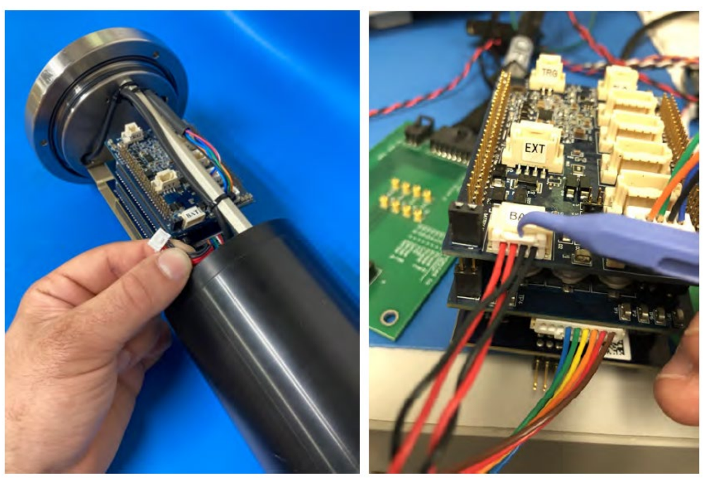


Figure 3. Battery connection within the controller housing of the SABL (McLane 2023).

2.3.2 Sample Bottle Preparation

Sample bottles must be cleaned and inspected prior to deployment. Sample bottles and O-rings should be inspected to ensure they are intact and not brittle. If so, replace bottles and O-rings as needed. The following steps should be taken:

1. Rinse with deionized water (DI) several times.
2. Soak in DI water and 10% Liquinox® or other detergent for at least 15 minutes, and then scrub with brush.

3. Rinse in DI water several times.
4. Rinse in 10% nitric acid (HNO_3) or hydrochloric acid (HCl) to remove scales, metals, and bases.
5. Rinse several times in DI water.
6. Rinse once with pesticide grade acetone in fume hood.
7. Rinse three times with DI water.
8. Dry on rack.
9. Just prior to deployment, fill each sample bottle with DI water;
10. Load bottles and hand tighten onto the rotator/gear plate (rotator can be moved to allow for better access for loading bottles);
11. Ensure that rotator is returned to the zero position (open hole under the cone opening) prior to deployment.

Sample bottles can be labeled with their respective port/sample # on the exterior with a permanent marker.

2.3.3 Water Quality Sensors

Currently, NIWC Pacific utilizes In-Situ Aquatroll 500® multiparameter data sondes in conjunction with a VuLink® cellular telemetry device (https://in-situ.com/us/). Typically, a Aquatroll 500® multiparameter sensor is secured to the SABL unit for measurements of water quality data (i.e., salinity, temperature, turbidity, etc.) at or near the sediment surface. A second Aquatroll 500® multiparameter sensor can be deployed within a rugged buoy at the water surface. Both of the multiparameter units are connected to a VuLink® cellular telemetry device. The VuLink® allows for pre-programmed thresholds of water quality measurements and when those thresholds are met, the VuLink® is capable of sending text and/or email notifications of the changes in water quality characterization.

Prior to deployment, batteries should be new (don't mix old and new batteries) and all fittings should be secure to avoid water intrusion. Water quality sensors and telemetry units should be securely fastened to the SABL unit and/or nearby structures as required. Be aware of potential tidal fluctuations when securing deployed equipment to either stationary or floating structures to avoid tension on cables or loose cables that may become entangled. NIWC Pacific utilizes stretchable dock lines (i.e., Dock Buddy or similar) to allow for the potential change in tidal heights throughout a deployment.

2.3.4 Recovery Buoy

The recover buoy is essential for success of the field operations. The buoy and associated cannister need to be check for secure attachment to the SABL. Check the four bolts/nuts located on the bottom of the cannister. Ensure that the release cable is secure and connected to the controller housing 'R' comms port. The recovery/spectra line within the cannister must have one end secured to the eye bolt on the SABL frame with a shackle. The opposite end must be connected to the pop-up buoy with an additional shackle. The line should be flaked neatly into the cannister to avoid entanglement.

Refer to the EdgeTech Manual for instructions on arming the pop-up buoy. Place the pop-up buoy on top of the canister so the threaded rod comes through the hole on the top. Secure the threaded rod with a flat washer, lock washer and two hex nuts (in that order).

3. DEPLOYMENT OPERATIONS

3.1 Deployment Considerations

Upon arrival at deployment destination, determine the approximate depth at which the SABL will be deployed to be aware of how much loose line and cable will be needed for deployment. Ensure once again that all connections are secure, and the bolts of the controller housing are snug. It is recommended to use an A-frame with winch on the boat/vessel or similar for safe, controlled deployment of the SABL. The swinging lifting handle at the top of the cone is the preferred attachment point for deployment. A line can be passed through the eye of the lifting handle and the SABL can be carefully lowered to the sediment surface. Care should be taken while doling out the RS-485 cable or any other cables/lines during deployment of the SABL.

The loose/top-side end of the RS-485 cable can be tied to permanent structures nearby the deployment site (i.e., pilons, quay way with cleat, etc.). If the communications box and RS-485 cable are located on a floating platform, be aware of potential tide height changes throughout the deployment length and that there is sufficient slack in the line to accommodate for these tidal exchanges. If sufficient slack is not provided, the communications box and/or line can be damaged or potentially pulled into the water, destroying equipment.

Connect the RS-485 to the communications box. Confirm communications to the SABL are working (i.e., commands can be delivered, and responses are returned). Query the SABL with the command "TILT" to see unit orientation (see section 3.3 for command and response syntax). SABL may need to be repositioned slightly to ensure orientation isn't too steep to capture settling material. For example, if the tilt exceeds 15%, it is recommended to attempt repositioning to achieve a tilt value of <10%. Once position is confirmed, the loose end of the deployment line can be released and the SABL will now be deployed. If communications are not confirmed, the deployment line can be used to recover the SABL immediately as needed.

It is recommended that the first 'sampling event' or positioning of the first sample bottle be delayed a few hours following deployment to avoid capture of material that may have been resuspended during the deployment activities.

3.2 REMOTE COMMUNICATIONS

Once a SABL is deployed, the unit can be commanded remotely. To engage the Raspberry-Pi, or host, the user can remotely connect to it via the cellular modem by using a virtual network connection (VNC). Several VNC applications are available to download to connect to the Raspberry-Pi:

https://www.tightvnc.com/

https://www.realvnc.com/en/connect/download/viewer/

To start a connection, open the VNC software and enter a name or an internet protocol (IP) address of the host (Figure 4). To operate at a faster speed, select the Options button (Figure 5). A new window will pop-up. Change the colors selection to '256 colors (less traffic)'; this will allow for faster remote connectivity. Keep all other setting as default and select 'OK'. The first connection screen will resume, press the 'Connect' button.

A new window will request a password (Figure 6). This will be established and provided by the Principal Investigator.

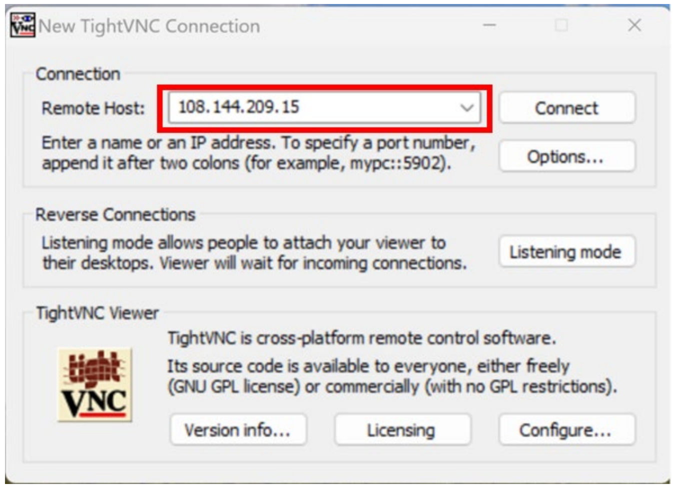


Figure 4. Example of connection via TightVNC.

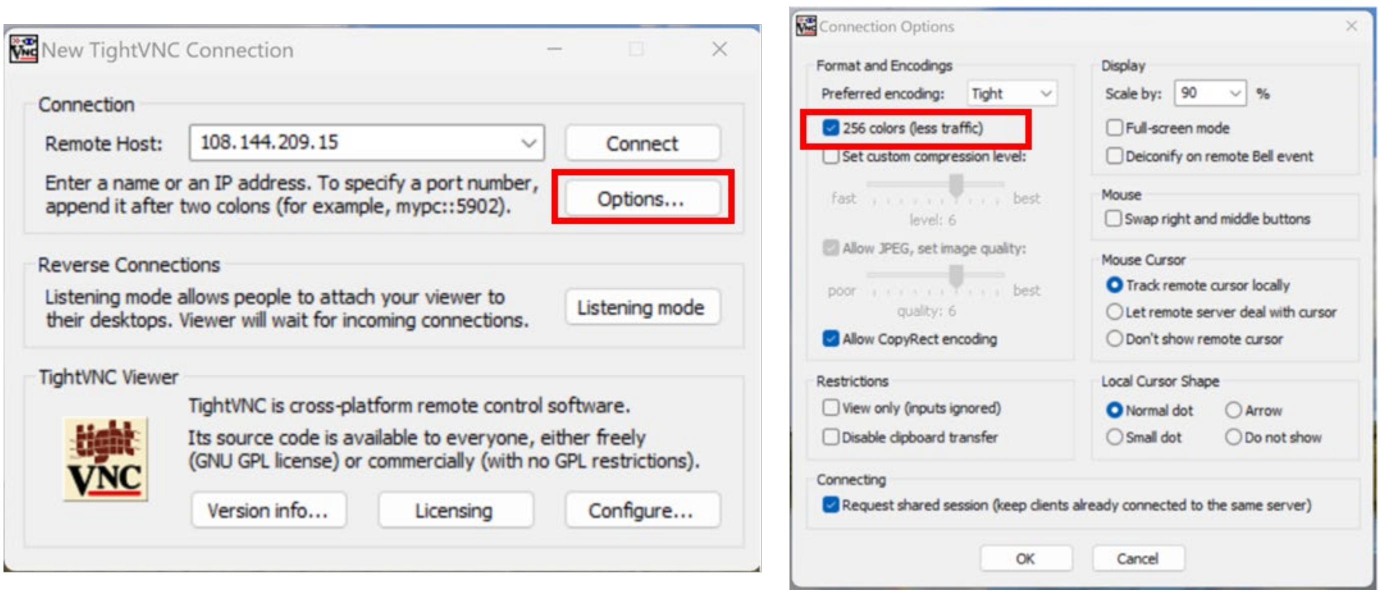


Figure 5. Options button on the connection window (left); select '256 colors (less traffic)' to allow for faster remote communications (right).

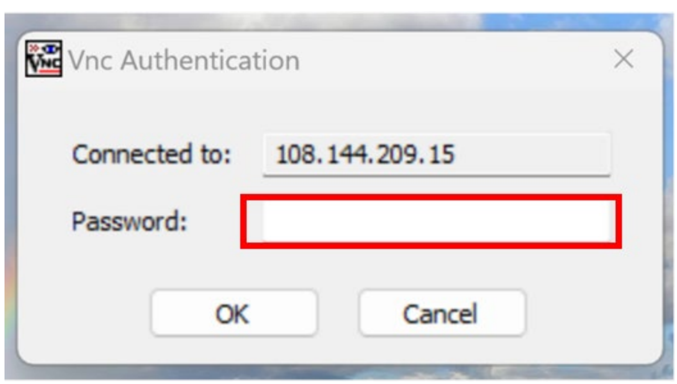


Figure 6. Password Screen within VNC Viewer.

A new screen will appear with a virtual desktop (Figure 7). Select the command-prompt icon (Figure 8) in order to open the command-line interface (Figure 9).

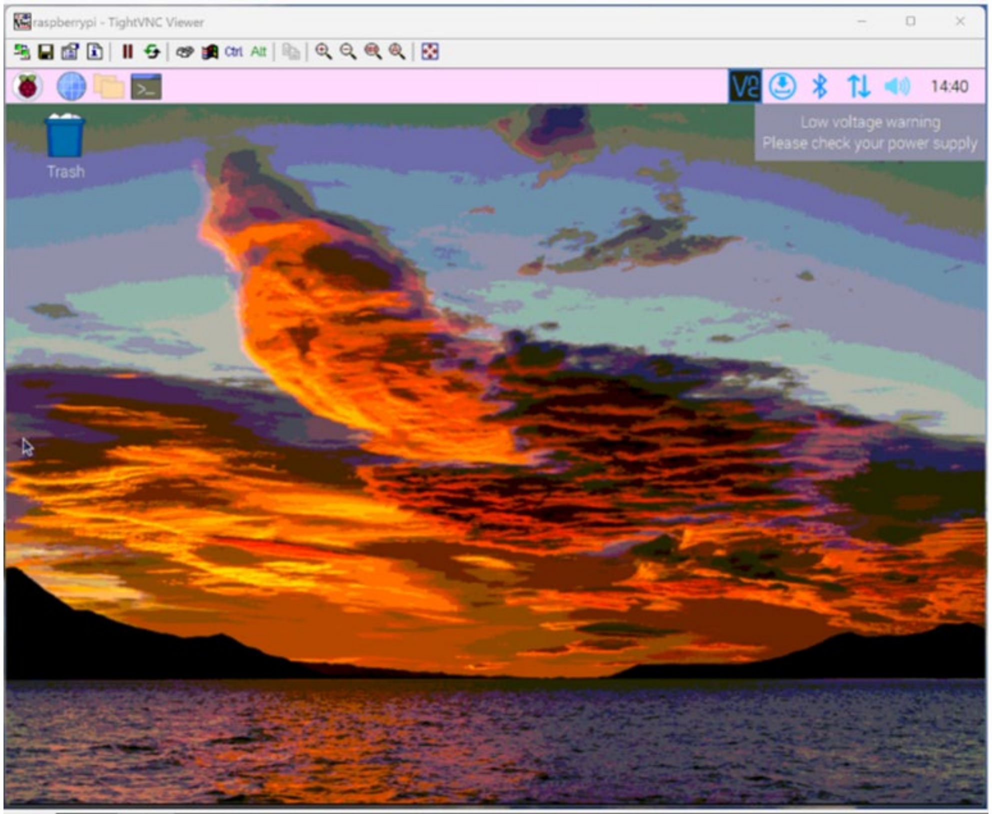


Figure 7. Virtual desktop of the Raspberry-Pi.

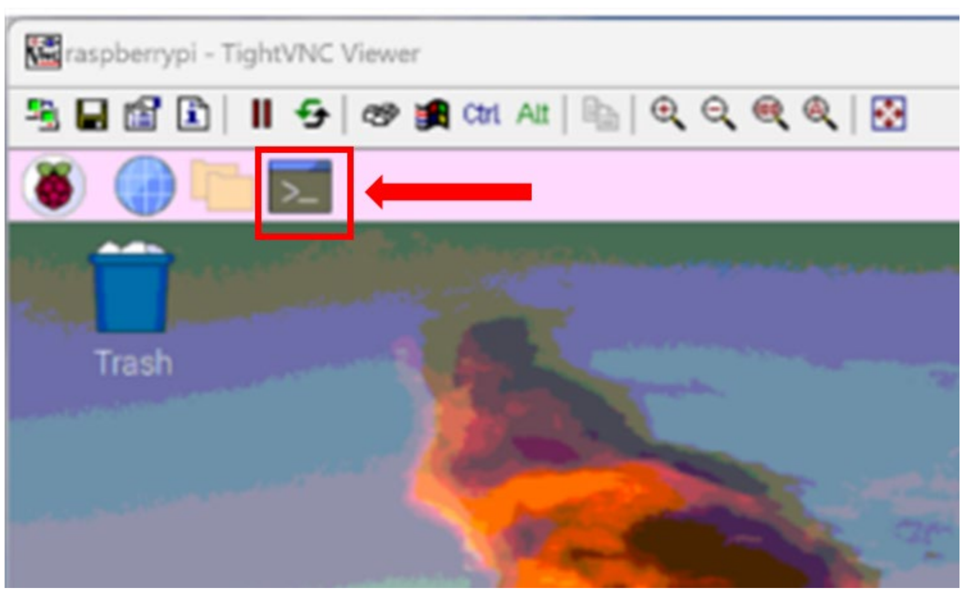


Figure 8. Icon to open the command-line interface.

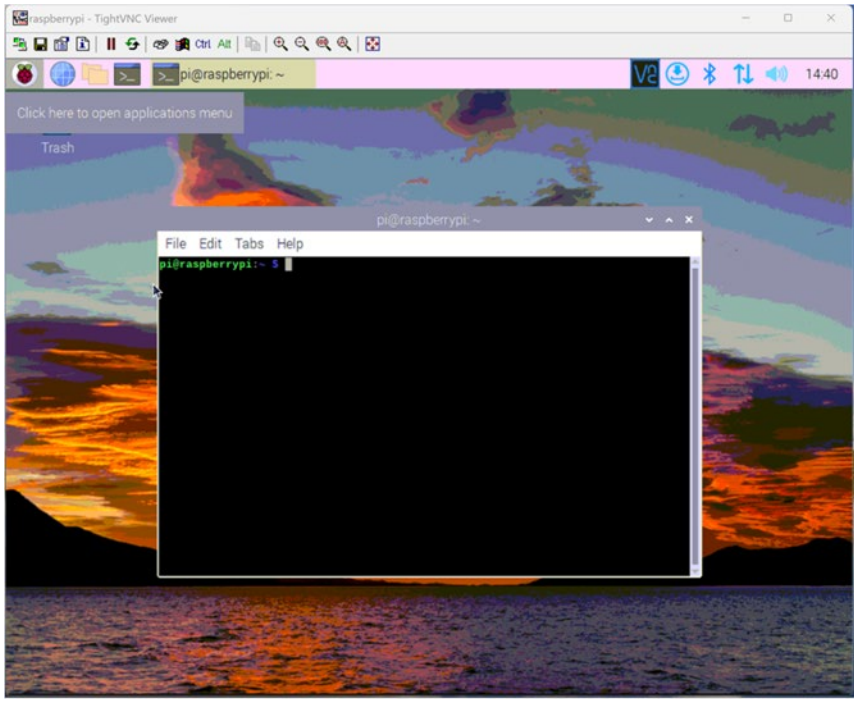


Figure 9. Command-line interface window.

Within the command-line interface window, type “gtkterm” and press “enter”. This will open a new window with a warning prompt that will appear (Figure 10). Press “OK” and then press the Configuration button at the top of the GTKTerm window (Figure 11). This will allow the user to establish the direct connection with the SABL unit. Ensure the selection in the Port window is “/dev/ttyUSB0” and the Baud Rate is “19200”. The terminal window can then be used to enter commands and communicate directly with the SABL unit.

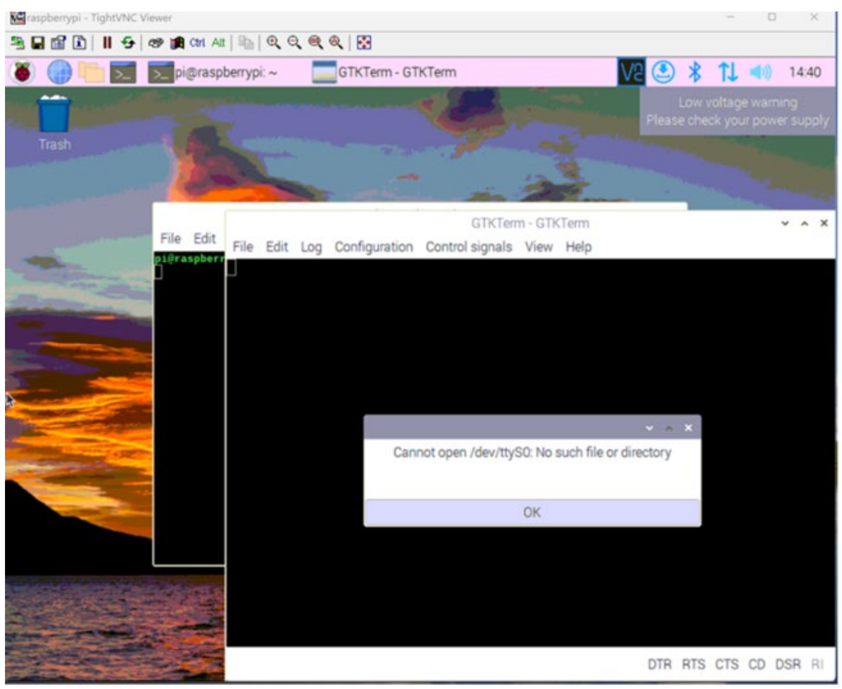


Figure 10. GTKTerm window with warning prompt.

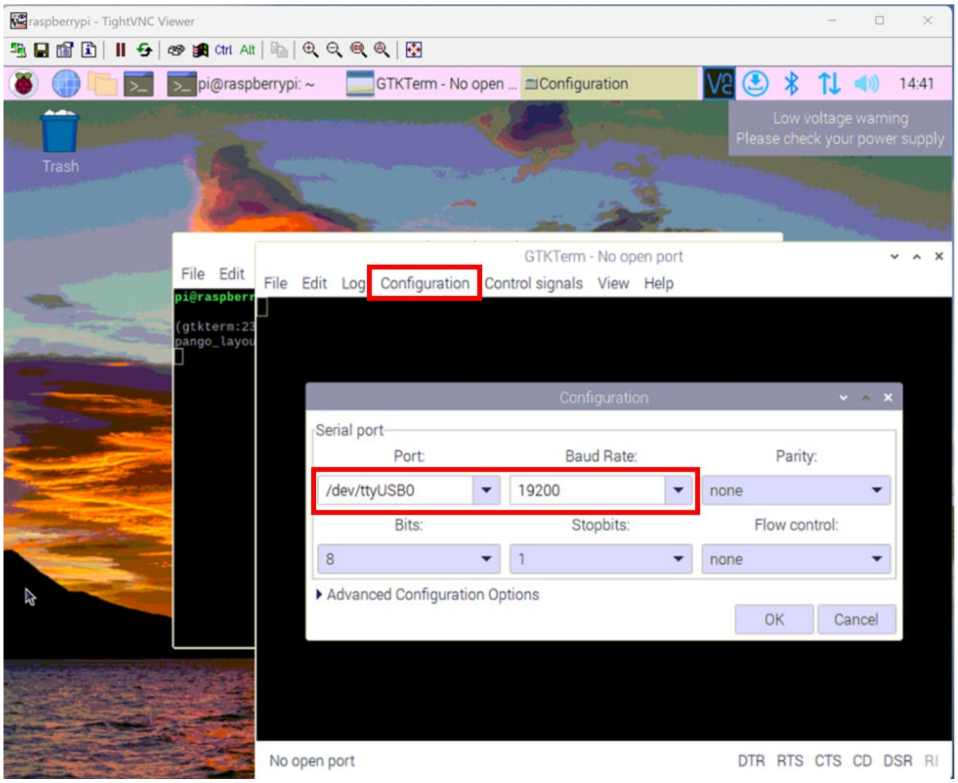


Figure 11. Connection configuration window with appropriate selections shown.

3.3 COMMON SABL COMMANDS FOR EVENT-BASE START/STOP SAMPLE COLLECTION

Upon first connection, the SABL unit will need to be woken up. Any character will wake the SABL but must be followed by the command CTRL-Z to confirm the wake. If CTRL-Z is not input, the SABL will return to sleep/low-power mode.

Once woken, first and foremost, the instrument time should be set. Once the connections to the SABL unit are established, the command line interface can be used to request information from or to direct the SABL to alter the rotator/gear plate position. Table 1 below shows the most common commands, their description and example syntax for the input and outputs.

Table 1. Adaptive Deployment Command-Line Prompts, Outputs and Example.

Description	Command/Syntax	Example/Output

Sets instrument time	`set_time [month] [day] [year] [hour] [minute] [second]`	`INPUT: set_time 01 04 2024 09 30 00`
		
		`OUTPUT: {"Time": { "System": "11/18/2020 14:55:55", "External RTC": "11/18/2020 14:55:55"}`

Provides the relative tilt of the SABL unit	`tilt`	`INPUT: tilt`
		
		`OUTPUT: {"Tilt": 0.0}`

Sets the tilt of the SABL unit to zero if not reflected correctly	`tilt zero`	`INPUT: tilt zero`
		
		`OUTPUT: NO OUTPUT`

Outputs the onboard temperature within the controller housing	`temperature`	`INPUT: temperature`
		
		`OUTPUT: {"Temperature": 26.8}`

Display battery voltage of SABL controller unit	`battery`	`INPUT: battery`
		
		`OUTPUT: { "Battery Voltage": 21.2 }`

Indicates the current position of the rotator/gear plate/bottle # relative to the collection cone (highlighted portion) as well as a description of the state of the current rotator operation	`rotator ?`	`INPUT: Rotator ?`
		
		`OUTPUT: {"Status": ["Moving", "Finding port", "Not-aligned"], "Progress": 33, "Port": 1.203812 , "Last Known Port": 1, "Total Steps": 203812, "Direction": 1, "Window": 29397, "Wall": 174046, "Switch": 0, "Abs Position": 174046, "VDC": 20.8, "Motor mA": 111.7, "Time": "08/18/2021 10:53:24"}`

Set the port # if current position is not reflected correctly	`rotator port = XX`	`INPUT: rotator port = 3`
		
		`OUTPUT: {"Status": ["Stationary", "Aligned"], "Progress": 100, "Port": 3, "Last Known Port": 3, "Total Steps": 0, "Direction": 0, "Window": -99, "Wall": -99, "Switch": 0, "Abs Position": 0, "VDC": 21.4, "Motor mA": 124.4, "Time": "08/18/2021 10:49:23"}`

Table 1. Adaptive Deployment Command-Line Prompts, Outputs and Example. (Continued)

Description	Command/Syntax	Example/Output
Move rotator/gear plate to specified bottle position; output will stream the status of movement until complete (i.e., port 3 to port 1)	`Rotator port XX`	INPUT: rotator port 2 OUTPUT: {"Rotator Operation": {"Diagnostic Data": { "Status": ["Moving", "Finding end of current port"], "Progress": 0, "Port": 3.0 , "VDC": 21.3}, { "Status": ["Moving", "Finding end of current port", "Not-aligned"], "Progress": 3, "Port": 3.18816 , "VDC": 21.4}, { "Status": ["Moving", "Not-aligned"], "Progress": 4, "Port": 3.28096 , "VDC": 20.9}, { "Status": ["Moving", "Finding port", "Not-aligned"], "Progress": 4, "Port": 3.28096 , "VDC": 21.2}, { "Status": ["Moving", "Finding port", "Not-aligned"], "Progress": 7, "Port": 3.46957 , "VDC": 21.2}, … … … { "Status": ["Stationary", "Aligned"], "Progress": 100, "Port": 1, "VDC": 21.2},], "Rotator Operation Summary": { "Starting VDC": 21.2, "Lowest VDC": 20.7, "End Time": "08/18/2021 10:50:15", "Status Flags": ["Stationary", "Aligned"]

Table 1. Adaptive Deployment Command-Line Prompts, Outputs and Example. (Continued)

Description	Command/Syntax	Example/Output
Moves the rotator forward/clockwise one position; output will stream the status of movement until complete (i.e., port 0 to port 1)	`rotator next`	INPUT: rotator next OUTPUT: {"Rotator Operation": {"Diagnostic Data": { "Status": ["Moving", "Finding end of current port"], "Progress": 0, "Port": 0.0 , "VDC": 21.2}, { "Status": ["Moving", "Finding end of current port", "Not-aligned"], "Progress": 3, "Port": 0.18829 , "VDC": 21.4}, { "Status": ["Moving", "Not-aligned"], "Progress": 4, "Port": 0.29032 , "VDC": 21.2}, { "Status": ["Moving", "Finding port", "Not-aligned"], "Progress": 4, "Port": 0.29032 , "VDC": 21.2}, … … … { "Status": ["Moving", "Not-aligned"], "Progress": 100, "Port": 0.616051 , "VDC": 21.2}, { "Status": ["Stationary", "Aligned"], "Progress": 100, "Port": 1,"VDC": 21.2},], "Rotator Operation Summary": { "Starting VDC": 21.2, "Lowest VDC": 20.7, "End Time": "08/12/2021 09:53:42", "Status Flags": ["Stationary", "Aligned"]

Table 1. Adaptive Deployment Command-Line Prompts, Outputs and Example. (Continued)

Description	Command/Syntax	Example/Output

Moves the rotator/gear plate backward/counter-clockwise one position; output will stream the status of movement until complete	`rotator previous`	`INPUT: rotator previous`
		
		`OUTPUT: SIMILAR OUTPUT TO "PREVIOUS NEXT"`

Aligns the rotator/gear plate to the open port before activating the release of the recovery buoy	`recovery_release now`	`INPUT: recovery_release now`
		
		`OUTPUT:`
		`{ "MESSAGE": " Locating open rotator port before activating recovery release..." }`
		`{ "MESSAGE": " Recovery release started" }`
		`{ "MESSAGE": " Recovery release completed." }`

3.4 RECOVERY AND STORAGE OF SABL

Recovery of the SABL should be properly planned in advance and take site-specific details into consideration (i.e., site access, tide heights, current conditions, weather, etc.). To initiate recovery of the SABL, connect to the SABL via the VNC software and type the command “recovery_release now”. This will release the recovery buoy. This evolution takes several minutes as the rotator/gear plate will first align to the open port before activating the release of the buoy. Additionally, the threaded rod turns very slowly to release the associated release link and shackle. The buoy then slowly ascends to the surface with the attached spectra line from within the cannister. Using a boat hook, the line can be caught and used to winch the SABL slowly to the surface. During recovery operations, care must be taken in recovering the associated RS-485 cables and ensuring no strain is placed on the connections to the controller housing or other sensors. Using the spectra line will bring the SABL to the surface at an angle. Once the SABL is near the surface, it is the decision of the operator to switch a connection to the swinging lifting handle for more upright recovery once out of the water.

Sample bottles can be detached from the rotator/gear plate and processed as needed. Maintenance and correct storage of the SABL following deployments is necessary for long-instrument life and proper operations. The following steps should be followed (adapted from McLane 2023):

1. Rinse and gently scrub SABL (cone, frame, controller and motor housing) and associated equipment with freshwater and soft bristle brush;
2. Offload all data from memory;
3. Open controller housing and unplug battery from the electronics;
4. Reseal all components and inspect O-rings.
5. Inspect all components (i.e., cables, spectra line, shackles, etc.) for wear and repair and/or replace as needed.

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EdgeTech. 2018. Pop-Up Option: User Hardware Manual. 0019850_Rev_B.

McLane Research Laboratories, Inc. 2023a. Sediment trap & McLanePro User Manual. Rev.23.F.23.

McLane Research Laboratories, Inc. 2023b. SABL Sediment Trap Datasheet.09/2023.

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14. ABSTRACT
This document describes standard operating procedures for use of the Signal Activate Bottom Lander (SABL) trap. This guidance document will provide the necessary information for the operation of the SABL and provide considerations for site-specific deployments.

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