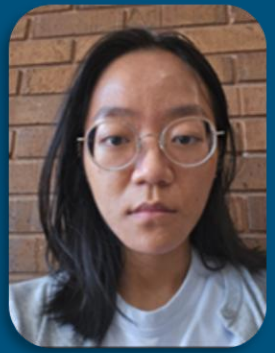
PoolWatch

Optical Chlorine and Phosphate Concentration Analyzer with Particle Imaging for Classification

Group 4

Austin Naugle
Dylan Hughes
Jason Ser
Ning Dim

Team Members



Ning Dim

Computer Engineer

Dylan Hughes

Computer Engineer

Austin Naugle

Photonic Science and Engineering

Jason Ser

Photonic Science and Engineering

Motivation

- Many people own pools across the United States
- Pool maintenances is a time consuming process
- A monitoring system could improve the overall health of a pool and even automate several aspects of its maintenance

Hardware Goals

Goals:

- Interchangeable PCB Parts
- Temperature Sensor
- Chlorine Sensor
- Phosphate Sensor
- Particulate Sensor
- Wi-Fi Communications
- Monitors Device Health
- Water Pump
- Debug Panel
- A Long-Lasting Power Supply

Stretch Goals:

- Automatic Chemical Inputs
- Automatic Waste Disposal
- Keyboard / Input System
- Display System

Software Goals

Goals:

- 2-Way Communication between Device & Server
- Account System
- Notification System
- Report Storage
- Containerized
- Displays Results

Stretch Goals:

- Secure Commination
- Weather Monitoring System
- Phone Compatible

Optical Goals

Goals:

- Orthophosphate Sensor
- Chlorine Sensor
- Particulate Imaging

Stretch Goals:

- pH Sensor
- Bromine Sensor
- Cyanuric Acid Sensor

Mechanical Goals

Goals:

- Reasonable Sized
- Supports Pumping Water

Stretch Goals:

- Water Resistant
- Waste Container
- Heat Resistant

Hardware Objectives

- A power supply that lasts at least a month while running tests at least once a day.
- A pump system to draw pool water into the two test cuvettes, where it will mix with preloaded reagents in each cuvette.
- The device will include status LEDs for each major system and these LEDs will remain off until a switch is flipped.
- Sensors, regulators, and other major systems should be interchangeable to allow for easy maintenance on the device.
- The MCU will need to be able to communicate with all photodiodes in the system.
- The device’s MCU will need to be capable of completing every test calculation within a small time interval.
- The MCU will require Wi-Fi capabilities in order to communicate with the web server.

Software Objectives

- The system will need to have a web server on a cloud provider
- The system will require a database to store user credentials and data collected from the device
- The web server will need a front end website that will allow the user to communicate with the device
- The website will allow the user to create a new account and login to that account.
- The website will allow the user to add devices to their account based off the device’s serial number
- The website will display the device's current battery charge, time from last test, and if any non-power systems are down.
- The website will display the results from the free chlorine detection system, phosphate detection system, depth test, and temperature test, with timestamps.
- The website will display the results of the previous tests.
- The website will allow the user to change the sampling rate of the device.
- The website will allow the user to request tests to be run on the device.
- The website will allow the user to change how long back tests will be stored.
- Measurements on the website will be displayed in common American units.
- The website will have a domain name to facilitate easy access.

Software Objectives Cont.

- The website will allow the user to set up automatic notifications for email and other servers, based on thresholds being crossed, such as the depth drops below 6 feet.
- The web server will need to be fully containerized to allow for immediate deployment on other computers.
- The webserver will need to be hosted on a kubernetes cluster and configurable using environment variables to allow modification in future deployments.The device will generate HTTP messages to the web server to facilitate outbound communication.
- The device will be able to parse HTTP messages to facilitate inbound messages.
- The device will control when a test is run and will be able to compute the outcome of the test into common American units.
- The device will manage the water drawing system.
- The device will listen for button presses that indicate a test to be performed.
- The device will monitor the battery level and update the site on the charge.
- The device will have a hard coded serial number.

Optical Objectives

- Design a simple optical system that will detect phosphate and chlorine concentrations in a micro-cuvette.
- Design a magnifying lens system using singlet lenses with a camera to image particulate.
- Use Achromatic lenses to minimize comatic aberration in order to capture a larger field of view.
- Use a multi lens system to minimize spherical aberration and collimate the light.
- Optimize the alignment so the optical path length increases.

Mechanical Objectives

- The device will fit within a non disruptive space by the side of the pool.
- The device will support drawing operations
- Accessing components of the device and changing them out will be manageable with a common multitool, such as a Leatherman.
- The device will have a debug section displaying the LEDs indicating the working systems.
- The device will have hand changeable molybdophosphoric acid and chlorine testing chambers.
- The device's power source will be hand changeable if the power source is a battery.
- The device will have an on switch and a debug switch section.

Engineering Specifications 1

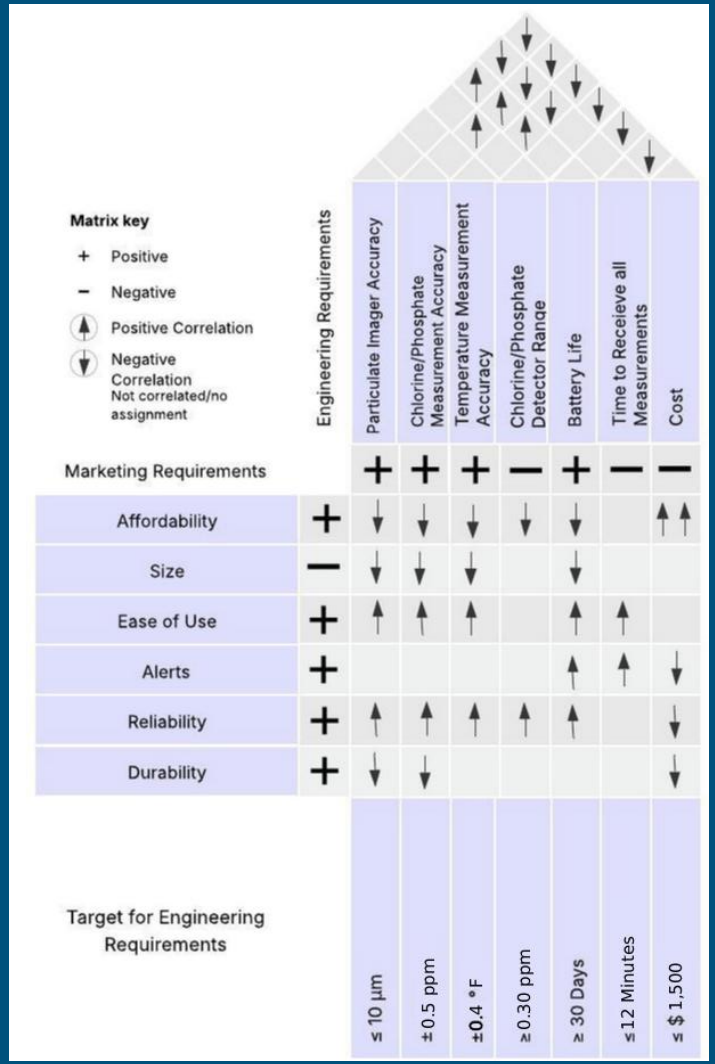
Component(s)	Parameter	Specification
Particulate Imager	Resolution	≤ 10 µm
Chlorine mass Concentration	Accuracy	± 0.60 ppm
Thermometer	Accuracy	± 0.4 °F
Particulate Imager	Field of View	5 mm x 5 mm
Chlorine mass Concentration	Measurement Range	≥ 0.30 ppm
Chlorine LED Emission	Wavelength Range	515 nm ± 2 nm
Chlorine Optical Narrow Bandpass Filter	Central Wavelength	515 nm
Chlorine Concentration Analysis	Response Time	≤ 1 minutes 30 seconds
Phosphate Mass Concentration	Accuracy	± 0.50 ppm

Engineering Specifications 2

Component(s)	Parameter	Specification
Phosphate Mass Concentration	Accuracy	± 0.05 ppm
Phosphate Mass Concentration	Measurement Range	≥ 0.30 ppm
Phosphate LED Emission	Wavelength Range	880 nm ± 2 nm
Phosphate Optical Narrow Bandpass Filter	Central Wavelength	880 nm
Phosphate Concentration Analysis	Response Time	≤ 5 Minutes
Battery	Capacity	≥ 5000 mAh
Particulate Imager	Response Time	≤ 1.5 minute
UV Quartz Cuvette	Transmittance	90%
UV Quartz Cuvette	Allowable Volume Content	≤ 3.5 mL

Component(s)	Parameter	Specification
Thermometer	Response Time	≤ 15 seconds
Container	Dimensions	≤ 18” x 12” x 6”
Power Unit	Max Power Consumption	≤ 24 Watts
Power Unit	Average Power Consumption	≤ 1 Watt
System	Battery Life	≥ 30 Days
System	Cost	≤ $1,500

House of Quality

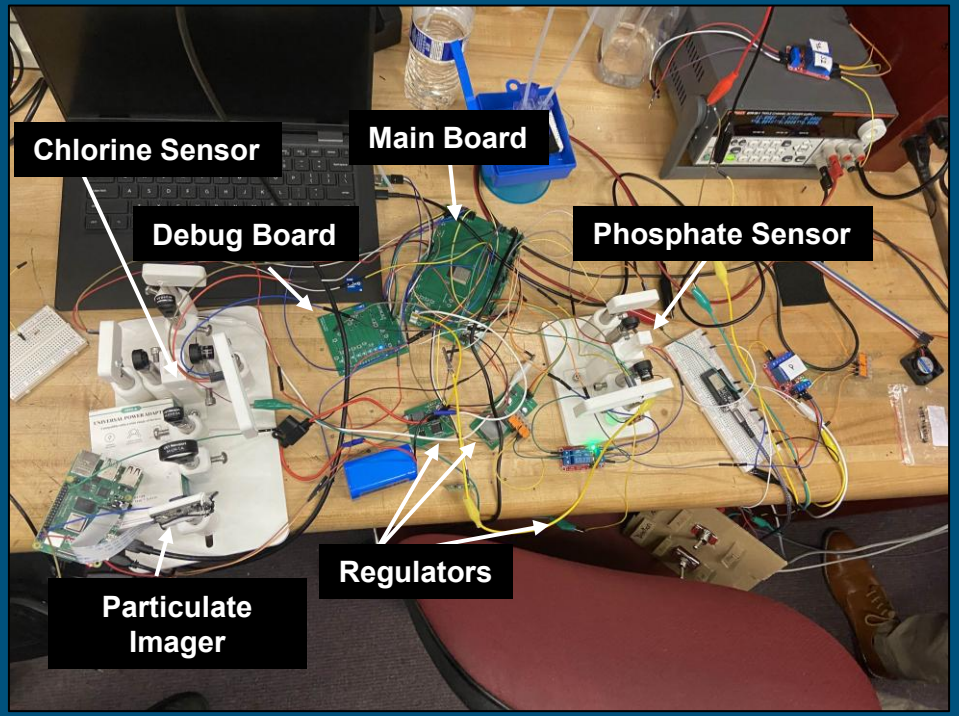


Matrix key

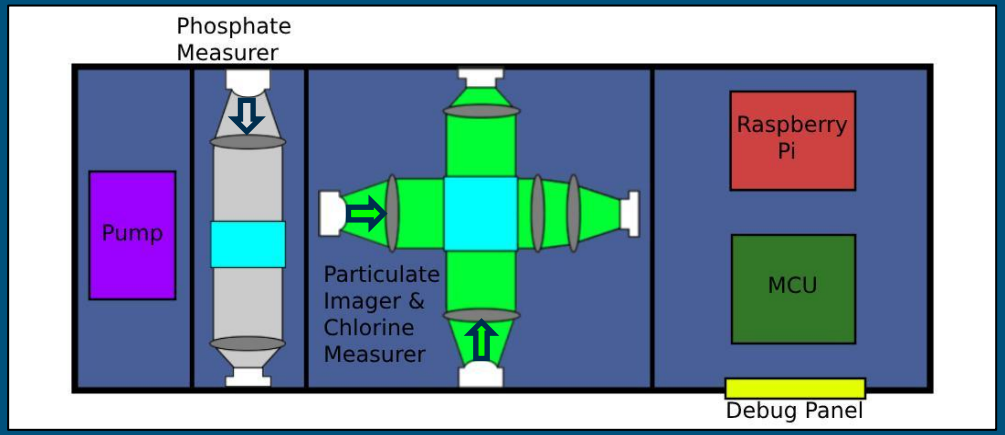
+ Positive
− Negative
Positive Correlation
Negative Correlation
Not correlated/no assignment

Engineering Requirements	Particulate Imager Accuracy	Chlorine/Phosphate Measurement Accuracy	Temperature Measurement Accuracy	Chlorine/Phosphate Detector Range	Battery Life	Time to Receieve all Measurements	Cost
Marketing Requirements	+	+	+	−	+	−	−
Affordability	+	↓	↓	↓	↓	↓		↑↑
Size	−	↓	↓	↓		↓		
Ease of Use	+	↑	↑	↑		↑	↑	
Alerts	+					↑	↑	↓
Reliability	+	↑	↑	↑	↑	↑		↓
Durability	+	↓	↓					↓
Target for Engineering Requirements		≤ 10 µm	±0.5 ppm	±0.4 °F	≥0.30 ppm	≥ 30 Days	≤12 Minutes	≤ $1,500

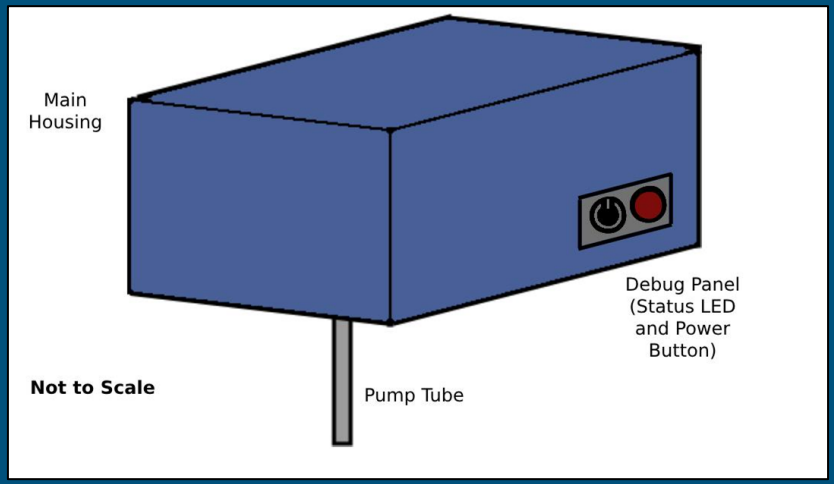
Poolwatch Device



Prototype Illustration



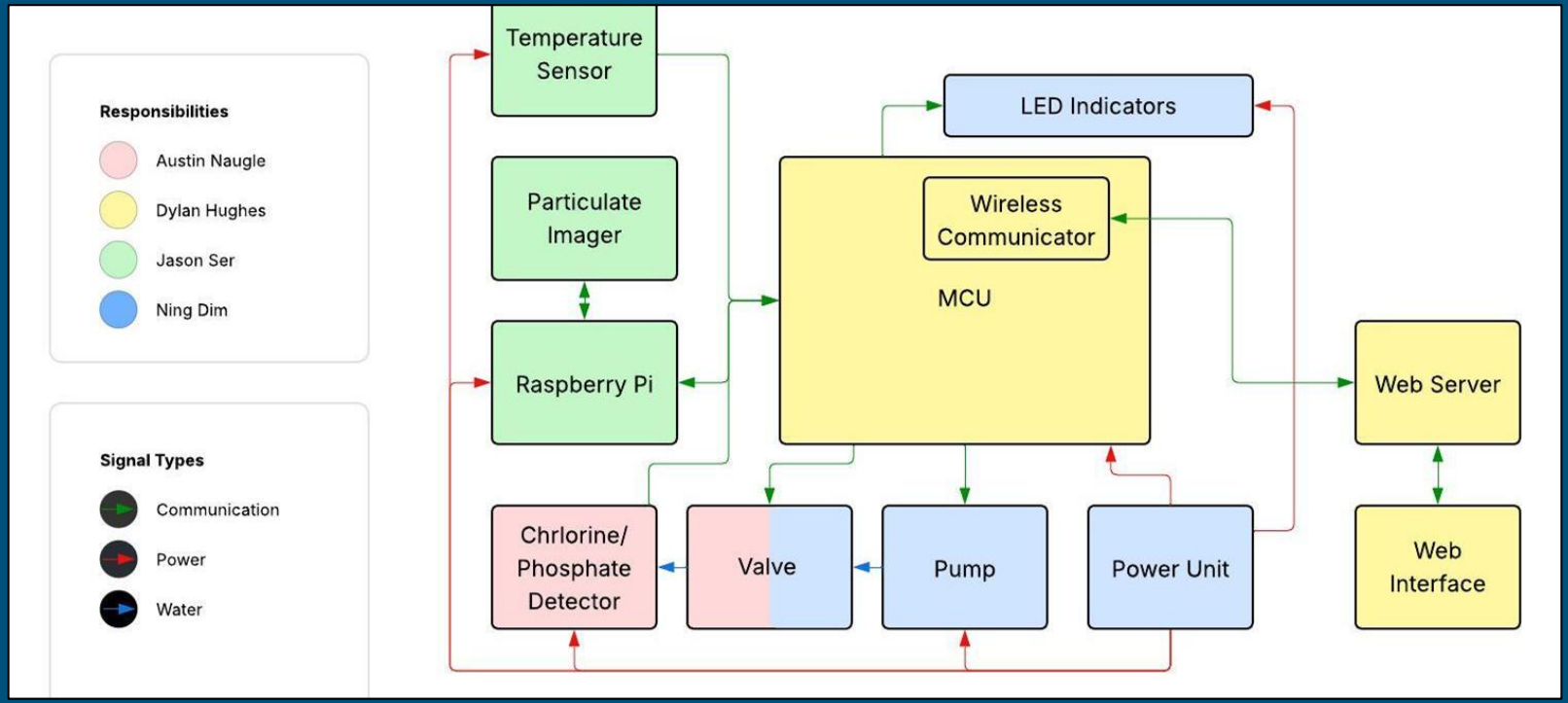
Top View



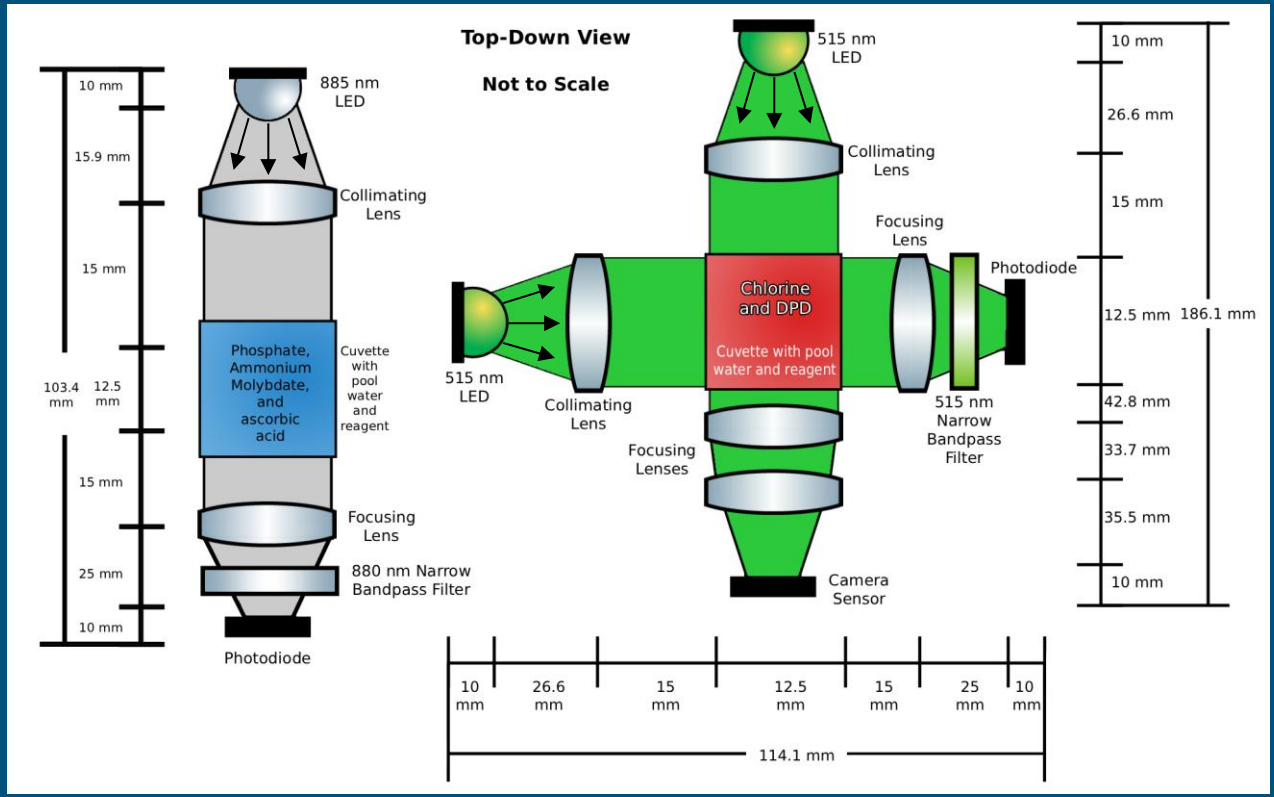
Isometric View

Hardware System

Hardware Block Diagram



Optical Design Illustration



MCU Selection

Features	Arduino Uno Rev3	Arduino Uno R4 WiFi	Adafruit HUZZAH32 ESP32
Operating Voltage	5V operating, 7-12 V (rec'd)	5V operating, 6-24 V (rec'd)	3.0-3.3 V
Chip	Atmega328P	Renesas RA4M1	Tensilica LX6
Memory	32 kB Flash, 2KB SRAM	256 kB Flash, 36 kB SRAM	4 MB Flash ,520 kB SRAM
Interfaces	I2C, SPI, UART, USB	I2C, SPI, UART, CAN, DAC	3 UART, 3 SPI, 2I2C, 2 DAC, 12 ADC
GPIO pins	14	14	21
Wi-Fi	No	Yes	Yes

We chose the ESP32 because it has built-in Wi-Fi, offers high performance at a low cost, has plenty of memory, and provides the I²C and ADC peripherals required by our system.

Image Processor Selection

Raspberry Pi 5	Raspberry Pi 4	Raspberry Pi Zero
- Cost + + Processing Power + Connection - - Power Consumption	+ Cost + Processing Power + Connection - Power Consumption	+ + Cost - - Processing Power - Connection + Power Consumption

Pump Selection

Features	Gikfun Peristaltic Pump	Kamoer Peristaltic Pump	Micro Peristaltic Pump
Voltage Requirement	12 V	12 V	6V-12V
Max Current	0.220 A	0.42A	0.5A
Flow Rate	max 0.5 L/min	0.7 L/min	30mL/min-100mL/min
Max Head Height	5m (16.5 ft)	5m (16.5 ft)	N/A (reviews say 5-6.5ft)
Tubing Dimensions	2mm ID and 4mm OD	3mm ID and 5mm OD	2.5mm ID and 4.5mm OD
Cost	$11.98 (Amazon)	$10 (Amazon)	$1.40(Aliexpress)

We chose a peristaltic pump because it's able to deliver fluid into both cuvettes at a low speed. This type of pump is also easy to disassemble and because the fluid only touches the inner tubing and not the pump's internal mechanisms, it prevents contamination and helps ensure more accurate test results.

Reagent Dispensing Selection

Features	AOMG 12V ¼" Solenoid Valve	Beduan 12V ¼" Inlet Solenoid Valve	Adafruit Solenoid Valve
Input Voltage	12V	12V	12 V
Current Load	0.4A	460mA	320 mA
Min. Operating Pressure	0.02Mpa	0.02Mpa	0.02Mpa
Dimensions	2.25 × 0.8 × 1.25 inches	8.46 x 2.36 x 1.34 inches	3.3 x 1.69x 2.24 inches
Cost	$13.79	$9.57	$6.95

We chose solenoid valves to dispense our reagents because they can open and close quickly, allowing for accurate and controlled reagent delivery. Since they do not require tubing, they provide a simple, reliable solution with minimal parts.

Reagent Mixer Selection

Features	DC Motor	PC Fan	Pancake DC Motor
Sourcing and Integration	High -reuse old parts -bulkier -customization needed	High -reuse old parts -plug and play -wide variety	Low -limited options -plug and play -harder to obtain
Cost	Low	Low	Higher

We chose a brushless PC fan because of its small size, low cost, and ability to be customized. The blades can be removed or trimmed to help it fit into tighter spaces. It integrates easily into the pre-built system and requires very few additional parts.

Control Selection

Features	Electrochemical (EMR)	Solid-State (SSR)
Switching Mechanism	Mechanical Contact +coil	Semiconductor
Response Time	Slower	Fast
Moving Parts	Yes	No
Power Consumption	High(coil)	Lower (optical trigger)
Electrical Noise	Higher; mechanical clicking	Lower; silent operation
Lifespan	Shorter; mechanical wear	Longer; no moving parts
Cost	Generally lower	Generally Higher

We used electromechanical relays by integrating prebuilt relay modules into the system This option was ideal because the modules provides visual and audio indicators showing when each relay is activated, which helps with troubleshooting and testing.

Chlorine LED Selection

Light Emitting Diode (LED) Comparison Chart				
Part No.	**Cost**	**Peak Wavelength (nm)**	**Output Power (mW)**	**In stock?**
WP7113ZGC	$9.68	515	3.23	✓
XSDG43MB	$8.35	515	2.47	✓
2231507	$15.11	515	2.76	✓

Chlorine Optical Lens Selection

Plano-Convex Collimating Lens Comparison Chart						
Part No.	Total Cost	Material	AR Coatings	Focal length (mm)	Optic Diameter (in)	In stock?
LA1289-AB	$41.11	N-BK7	AB	30	0.5	✓
LA1608-AB	$66.50	N-BK7	AB	75	1	✓
LA1422-AB	$70.26	N-BK7	AB	40	1	✓

Plano-Convex Focusing Lens Comparison Chart						
Part No.	Total Cost	Material	AR Coatings	Focal length (mm)	Optic Diameter (in)	In stock?
LA1560-AB	$56.07	N-BK7	AB	25	0.5	✓
LA1560-AB	$61.52	N-BK7	AB	25	0.5	✓
LA1540-AB	$60.25	N-BK7	AB	15	0.5	X

Chlorine Photodiode Selection

Photodiodes Comparison Chart				
Part No.	**Total Cost**	**Responsivity (@ 515 nm)**	**NEP ($W/Hz^{1/2}$)**	**In stock?**
S1223-01	$28.70	0.32-0.34	$1.3\ 10^{-14}$	✓
FDS1010	$86.18	0.20-0.22	$2.1\ 10^{-13}$	✓
S5973	$29.63	0.26-0.28	$1.1\ 10^{-15}$	✓

Phosphate LED Selection

Light Emitting Diode (LED) Comparison Chart				
Part No.	**Cost**	**Dominant Wavelength (nm)**	**Output Power (mW)**	**In stock?**
XTHI30W	$8.59	880	8.83	✓
XTHI12BF	$8.29	880	2.29	✓
XZTHI54W	$8.88	880	6.75	✓

Phosphate Lens Selection

Plano-Convex Collimating Lens Comparison Chart						
Part No.	**Total Cost**	**Material**	**AR Coatings**	**Focal length (mm)**	**Optic Diameter (in)**	**In stock?**
LA1074-B	$58.11	N-BK7	B	20	0.5	✓
LA1608-AB	$66.50	N-BK7	AB	75	1	✓
LA1422-AB	$70.26	N-BK7	AB	40	1	✓

Plano-Convex Focusing Lens Comparison Chart						
Part No.	**Total Cost**	**Material**	**AR Coatings**	**Focal length (mm)**	**Optic Diameter (in)**	**In stock?**
LA1560-B	$56.07	N-BK7	B	25	0.5	✓
LA1560-AB	$61.52	N-BK7	AB	25	0.5	✓
LA1540-AB	$60.25	N-BK7	AB	15	0.5	**X**

Phosphate Photodiode Selection

Photodiodes Comparison Chart				
Part No.	**Total Cost**	**Responsivity (@ 880 nm)**	**NEP ($W/Hz^{1/2}$)**	**In stock?**
S1223-01	$28.70	0.52-0.54	$1.3\ 10^{-14}$	✓
FD11A	$52.94	0.53-0.54	$6.80\ 10^{-16}$	✓
FDS015	$150.72	0.31-0.32	$8.60\ 10^{-15}$	✓

Particulate Lens Selection

Thorlabs LA1289	Thorlabs LB1258	Thorlabs LA1289-AB
+ Cost + Aberration - Transmission	+ Cost - Aberration - Transmission	- Cost + Aberration + Transmission

LED Collimating Lens

Newport PAC025	Thorlabs AC127-050-A	Newport PAC024AR.14
- Cost + Aberration - Transmission	+ Cost - - Aberration + Transmission	- - Cost + Aberration + Transmission

Front Lens

Newport PAC040	Thorlabs AC254-050-A	Thorlabs AC254-050-AB
+ Cost + Aberration - Transmission	- Cost - Aberration + Transmission	- - Cost - Aberration + + Transmission

Rear Lens

Particulate Camera Selection

CAM-IMX296Mono-GS	Arducam OV9281 1MP Monochrome Global Shutter Camera	Arducam 5MP OV5647 Camera Module
+ + Sensor Size + Global Shutter + Resolution + Monochrome - Documentation - Cost - Pixel Size	+ Documentation + Pixel Size + Global Shutter + Monochrome - Resolution - Cost - - Sensor Size	+ + Cost + + Resolution + + Pixel Size + Sensor Size + Documentation - - Rolling Shutter - - Color

Debug Panel Design Selection

Design	MCU Pins	Component Spread	Components
BJT	0-1	3	7
MOSFET	0-1	4	8
MCU	1-2	2	2

Temperature Sensor Selection

Waterproof DS18B20	LM35DZ	RTD PT100
++ Connectivity + Accuracy - Cost	+ Connectivity - Accuracy + + Cost	- - Connectivity + + Accuracy - - Cost

Power Distribution Table

	Voltage(V)	Current (mA)	Power
MCU	3.3V	250mA	0.825 W
Raspberry Pi 4 Model B	5.2V	250mA/400mA(startup)	2.08 W (max)
TLV3541IDBVR op-Amp(x4)	+ /- 5V	5mA	0.05 W
150080BS75000 LEDs (x8)	3.3V	0.2mA	0.00066 W
WP7113ZGC /XTHI30W LEDs	3.3V	20mA	0.066 W
Water Pump	12V	223mA	2.676 W
Solenoid Valves(x2)	12V	500mA	6.60 W
Brushless Fan(stirrer)(x2)	5V	80mA	0.40 W
Relay Module 1 (x2)	12V	40mA	0.48 W
Relay Module 2	5.2V	5mA	0.026 W
Temperature Sensor	5.2V	20mA	0.104 W
Total			~13.31 W

Battery Selection

Features	Liion Wholesale	GlobTek	Sparkole
Capacity	3500 mAh	5000 mAh	2600 mAh
Watt-Hour Rating (Wh)	50.4 Wh	72 Wh	37.44 Wh
Max Continuous Discharge Current	10A	5A	N/A
Size	75 × 38 × 38 mm	90 × 75 × 31 mm	71 × 37.5 × 36.5 mm
Connector Type	Wire Leads	Wire Leads	JST-VH connector
Certification	IEC 62133, UL 1642	UL2054, IEC62133-2, UN38.3	CE RoHs UN38.3 MSDS
Cost	$36.99	$46	$18.99

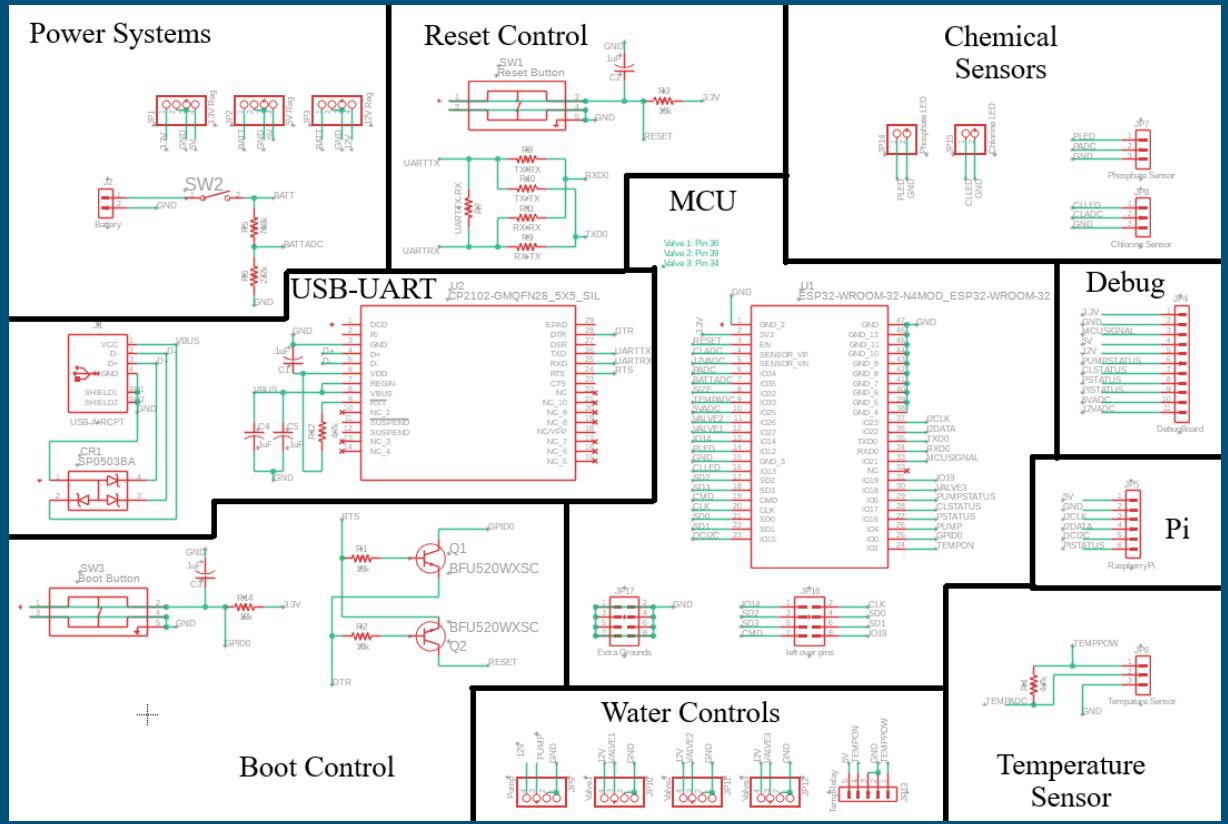
Regulator Selection

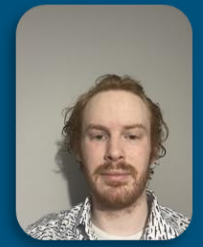
3.3V Buck Regulator (LM2576S)	5.2V Buck Regulator (LM2679)	12V Buck Regulator (TPS621361)
-ESP32 -Phosphate Detection System -Chlorine Detection System -LEDs	-Raspberry Pi for Particulate Imager -Magnetic Stirrer	- Water Pump -Solenoid Valves -Relay Modules

We needed three different buck regulators in order to buck down our Lithium-Ion battery pack from 14.4V nominal voltage to the required rails needed for our system.

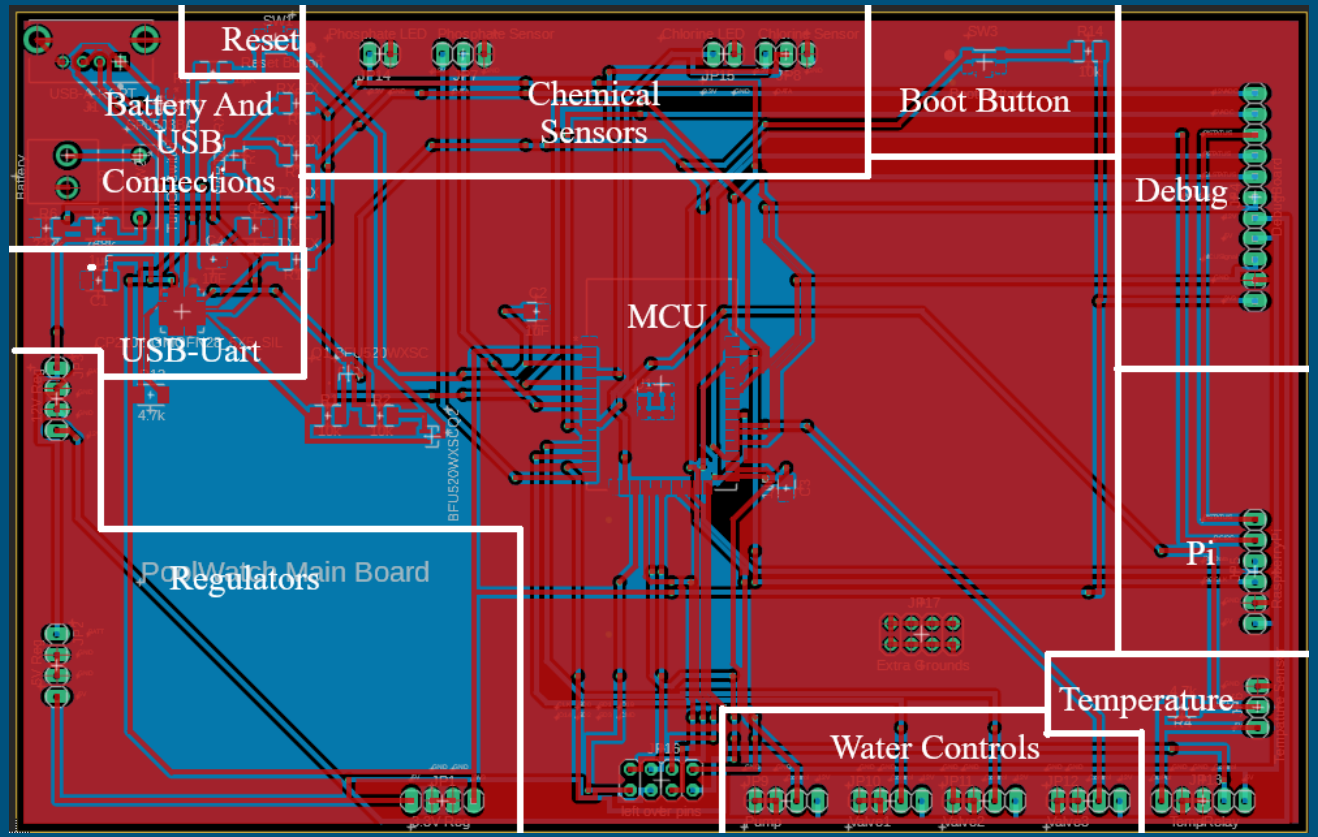
PCB Design

Mainboard Schematic

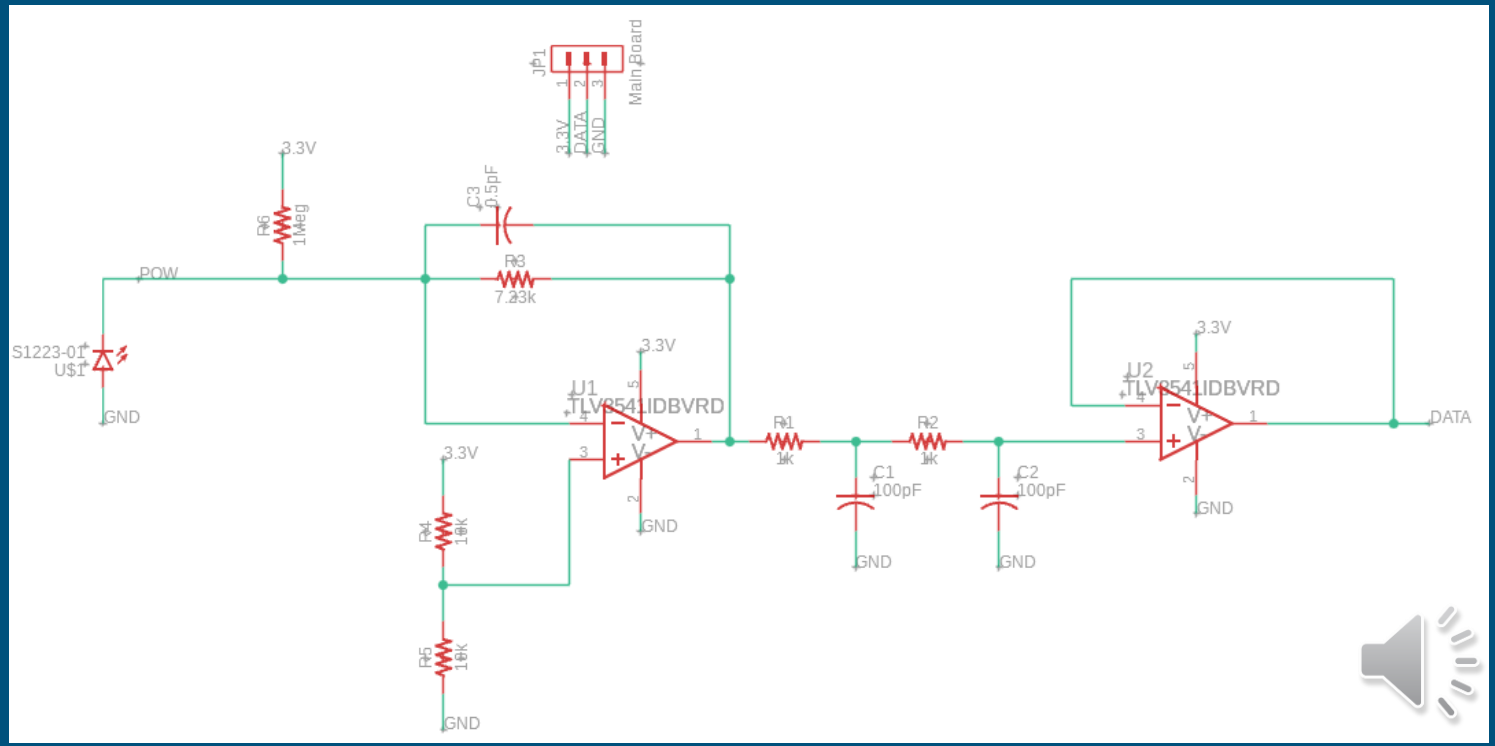




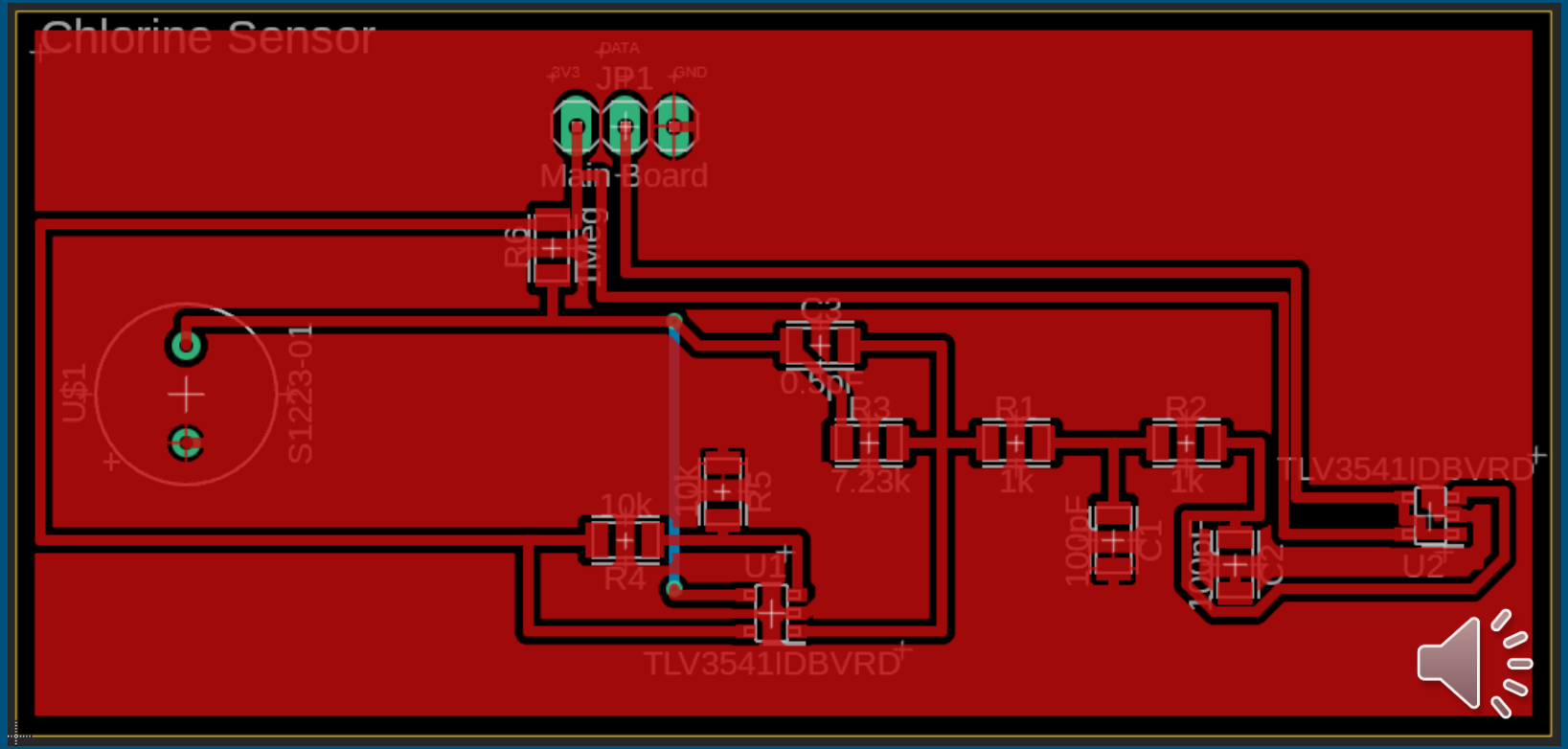
Mainboard Layout



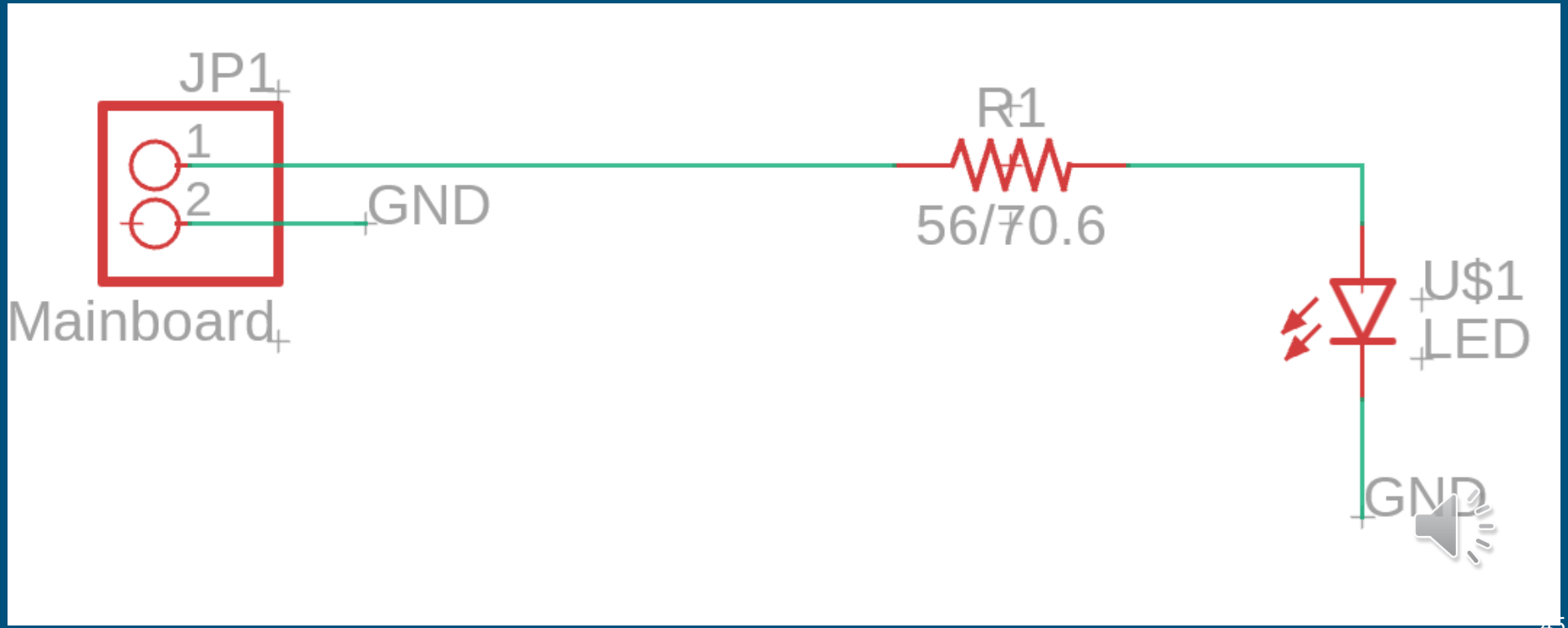
Chlorine and Phosphate Sensor Schematic



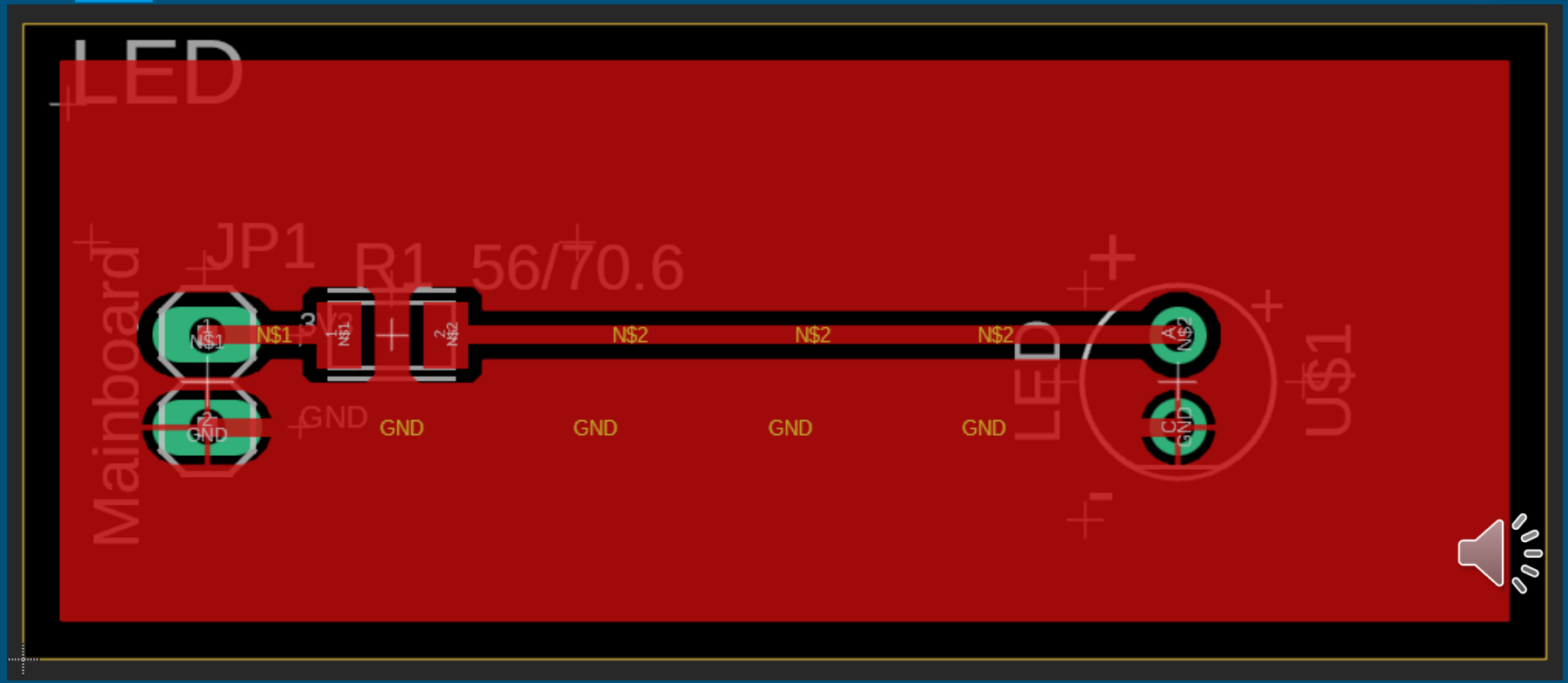
Chlorine and Phosphate Sensor Layout



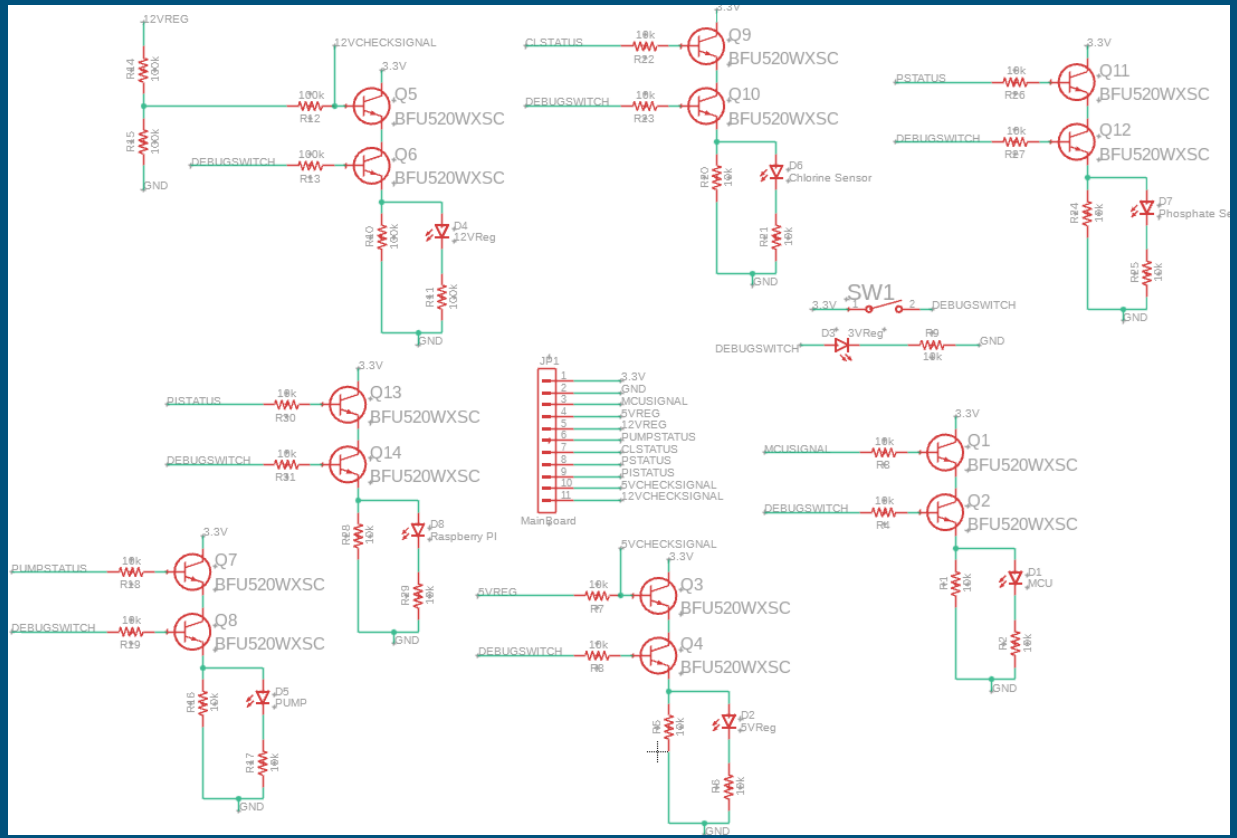
LED Schematic



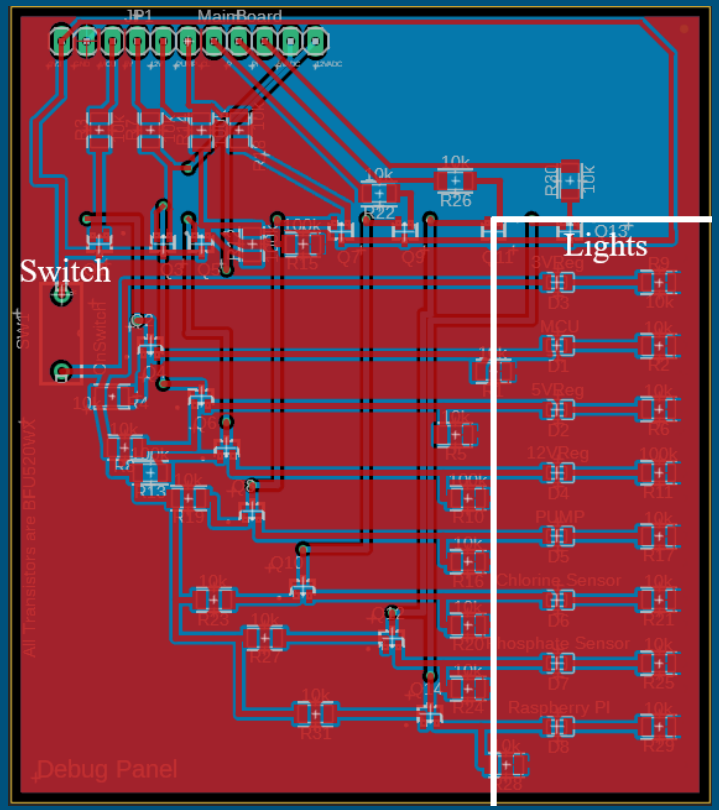
LED Layout



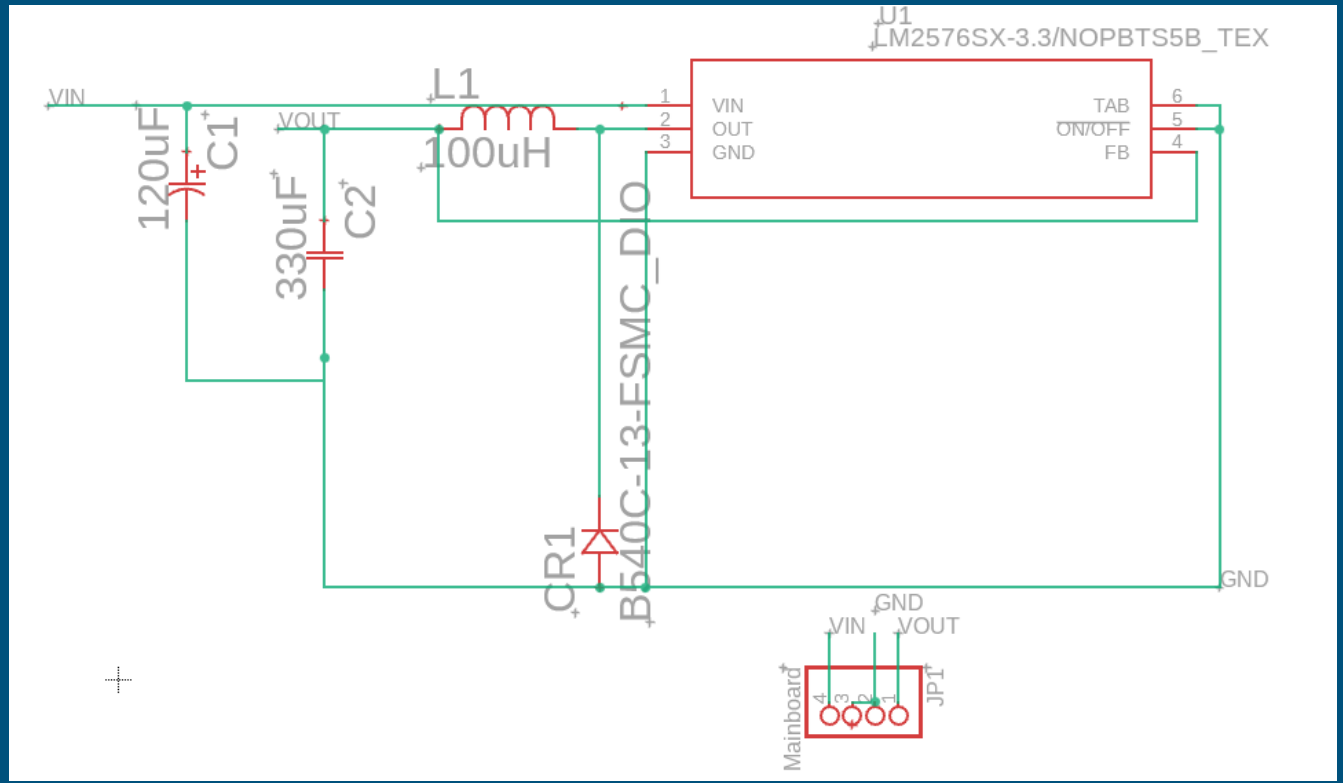
Debug Panel Schematic



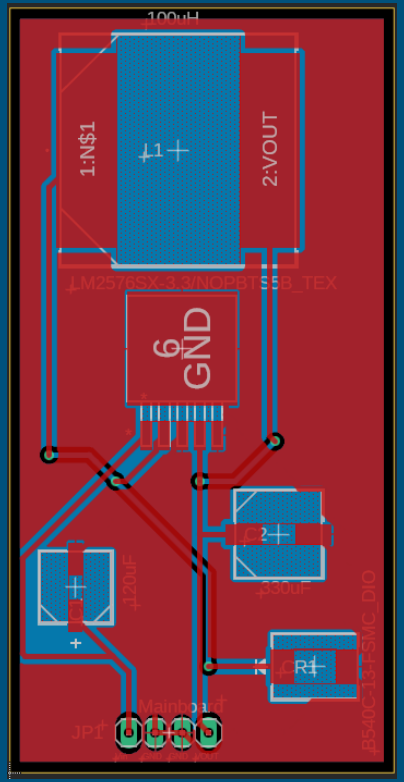
Debug Panel Layout



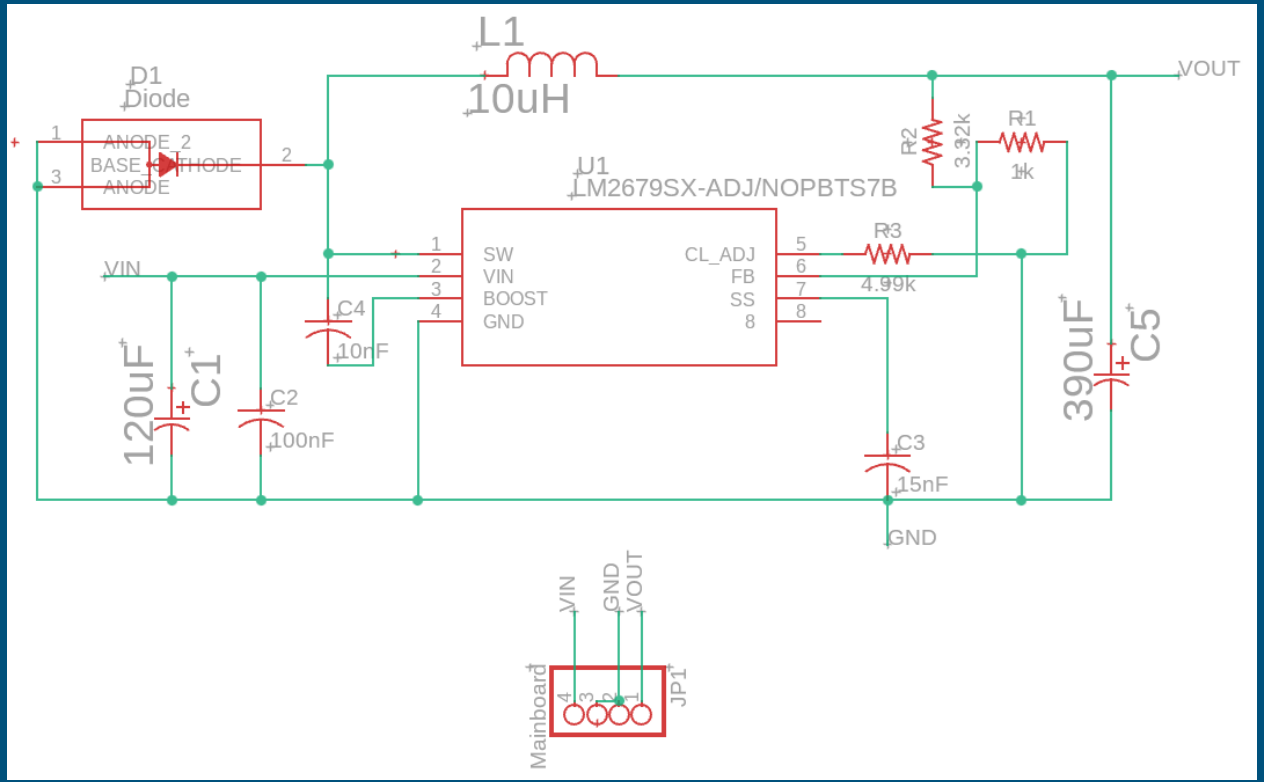
3V3 Regulator Schematic



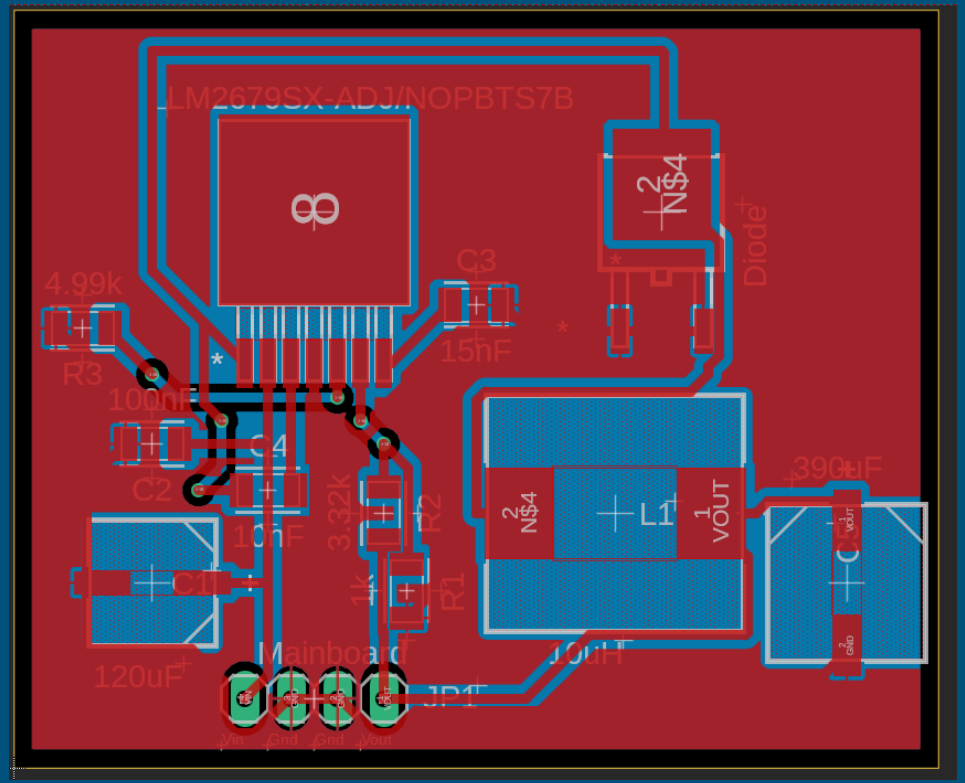
3V3 Regulator Layout

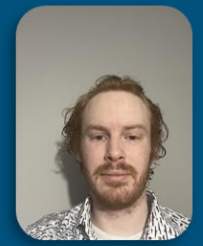


5V Regulator Schematic

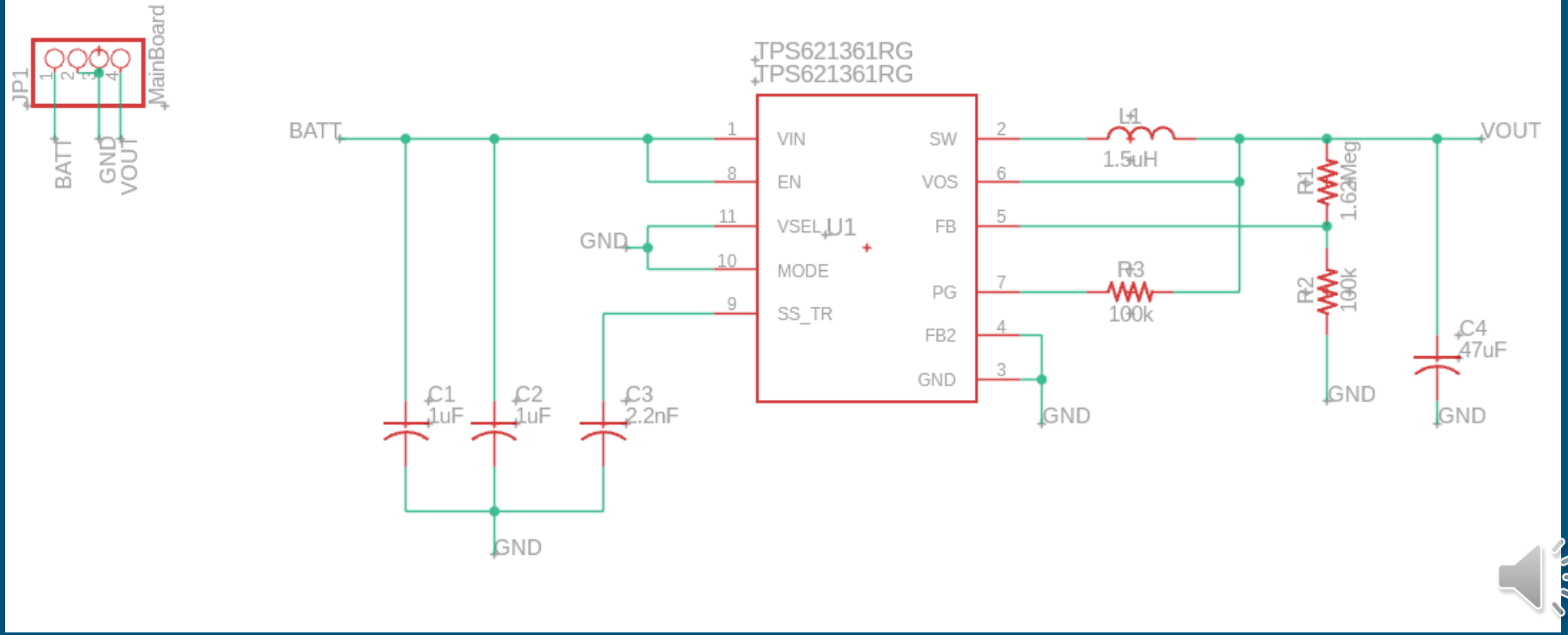


5V Regulator Layout

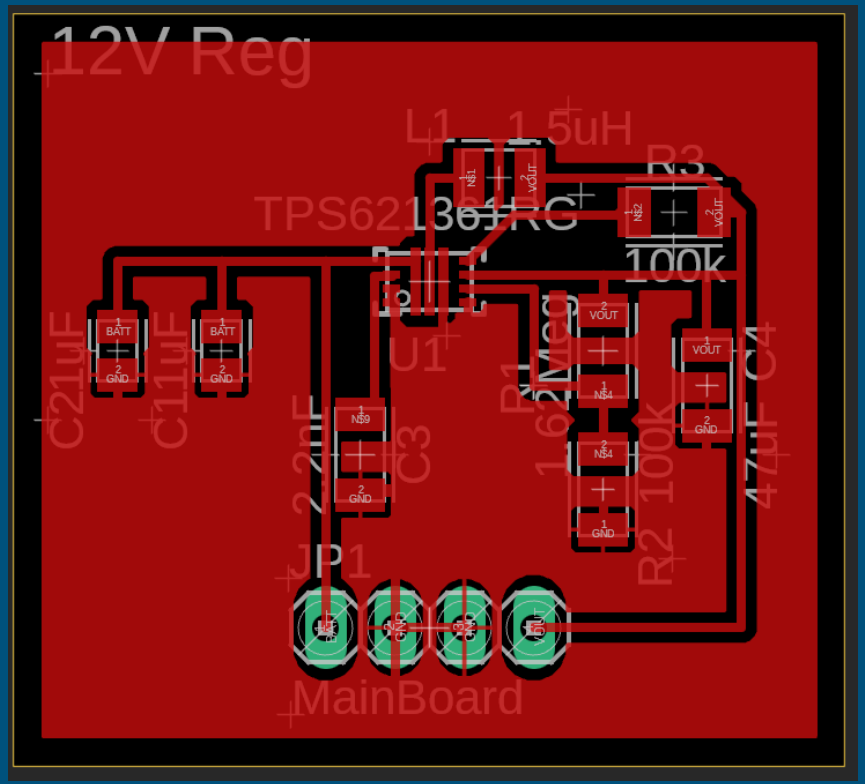




12V Regulator Schematic

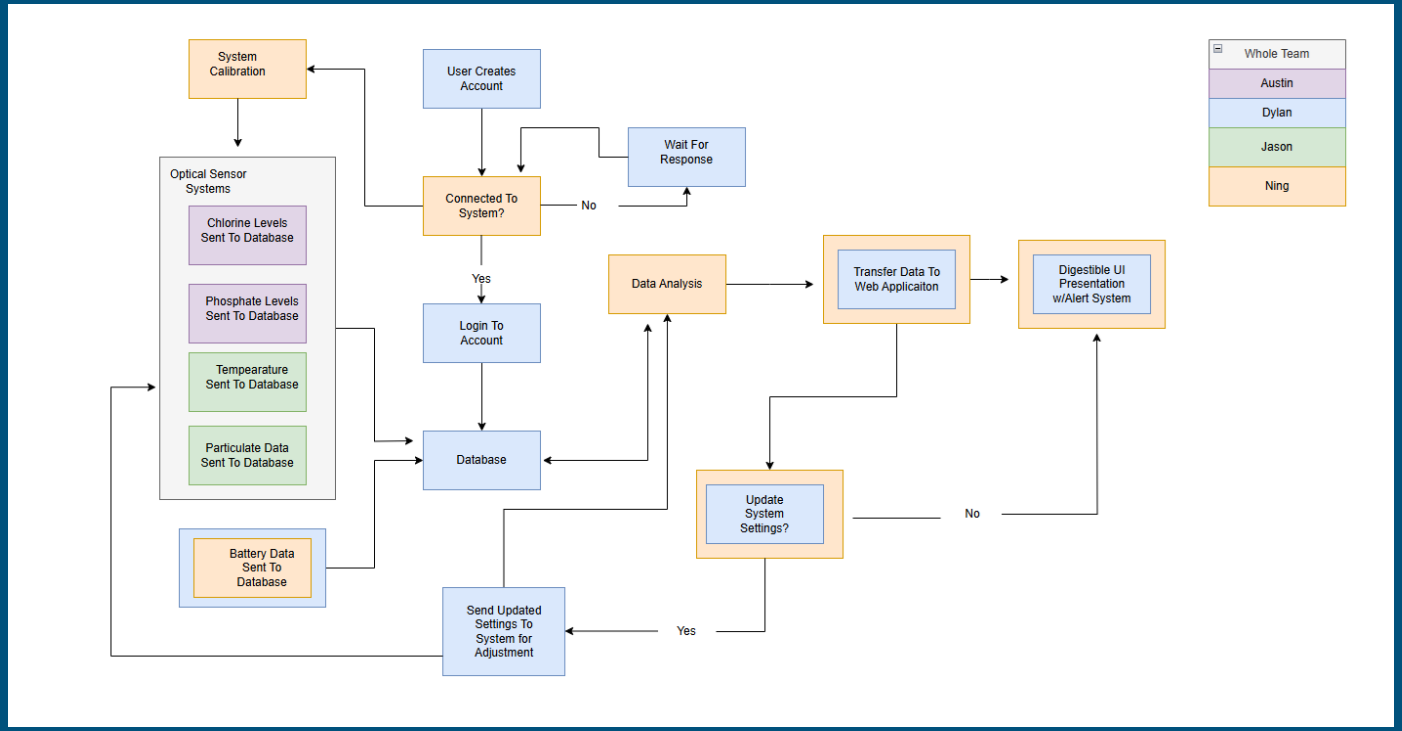


12V Regulator Layout



Software Selection

Software Block Diagram



Device-Server Communication Protocol

802.11 b/g/n:

- Frequency Band: 2.4 GHz to 5 GHz
- Channel Width: 20 MHz to 40 MHz
- Data Rate: 11 Mbps to 600 Mbps

HTTP 1.1:

- One Message Connection
- Webserver Compatible
- Not Constantly Connected

Website Architecture Selection

Web Architecture	LAMP	MERN	MENN
In date	Out of fashion	Deprecated tools	Yes
Simple Routing	Yes	no	Yes
Consistent Language	no	Yes	Yes
Deployability	Only on Linux	Any computer	Any computer
Server Side Rendering	no	no	yes

Containerization Method Selection

Technology	Size	Speed	Different OS	Ease of use	Security	Kubernetes
Podman	smallest	fast	no	good	good	supported
Docker	small	fast	no	best	average	supported
Virtual Machine	largest	slow	yes	worst	good	Supported with addons

Deployment Options

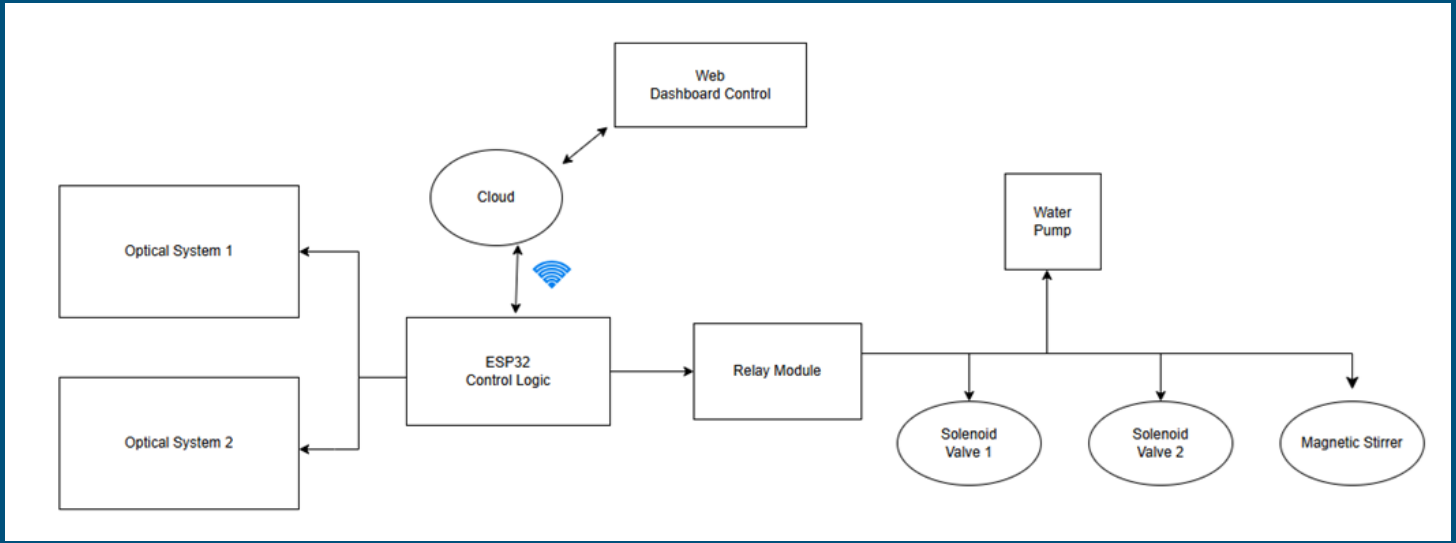
Manger	Docker Compose	Kubernetes
Scalable	no	yes
Network Tools	yes	yes
Persistence Tools	yes	yes
Security	present	better
Image Handling	Uses Docker Daemon	Requires a separate running registry

Web Host Selection

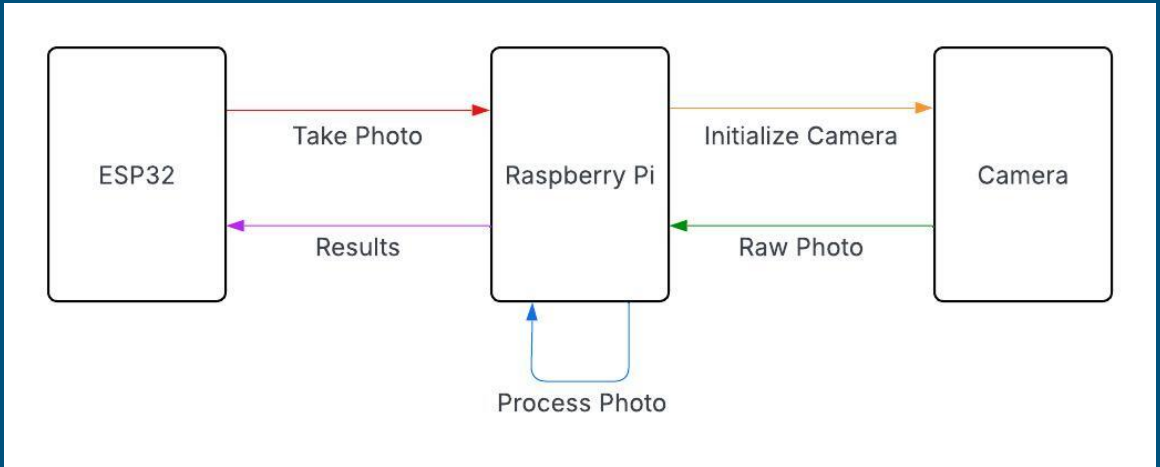
Web Host	Digital Ocean	Google Cloud	AWS	Azure
Cost	$24	$48.91	$37.96	$65.92
CPUs	2	2	2	2
Ram	4	8	8	4

Software Design

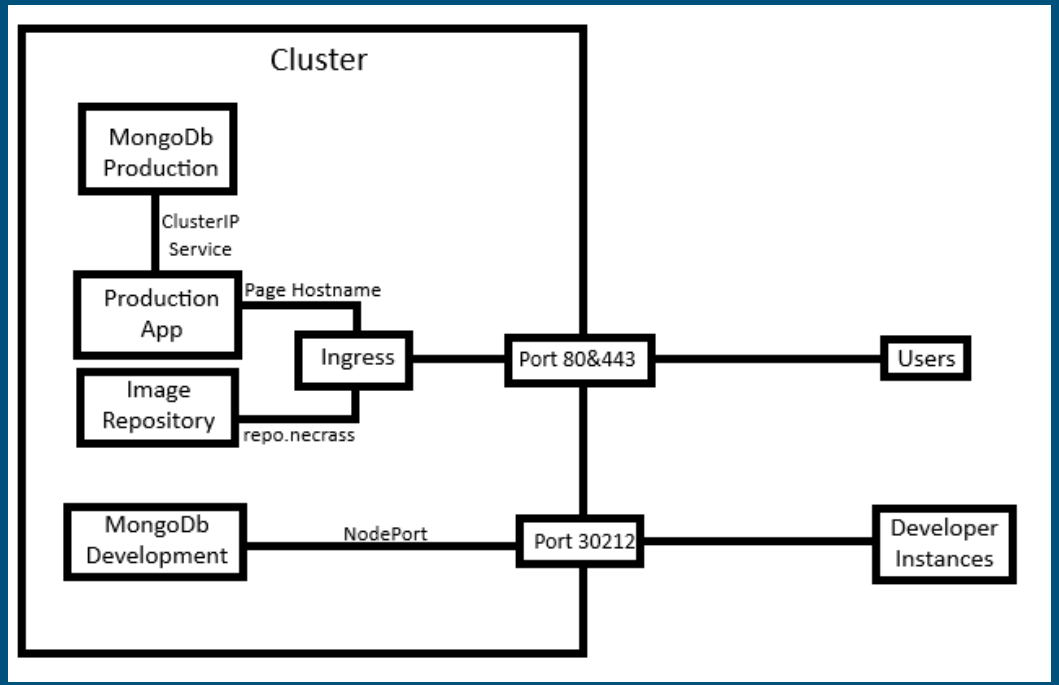
ESP32 Control System



Particulate System



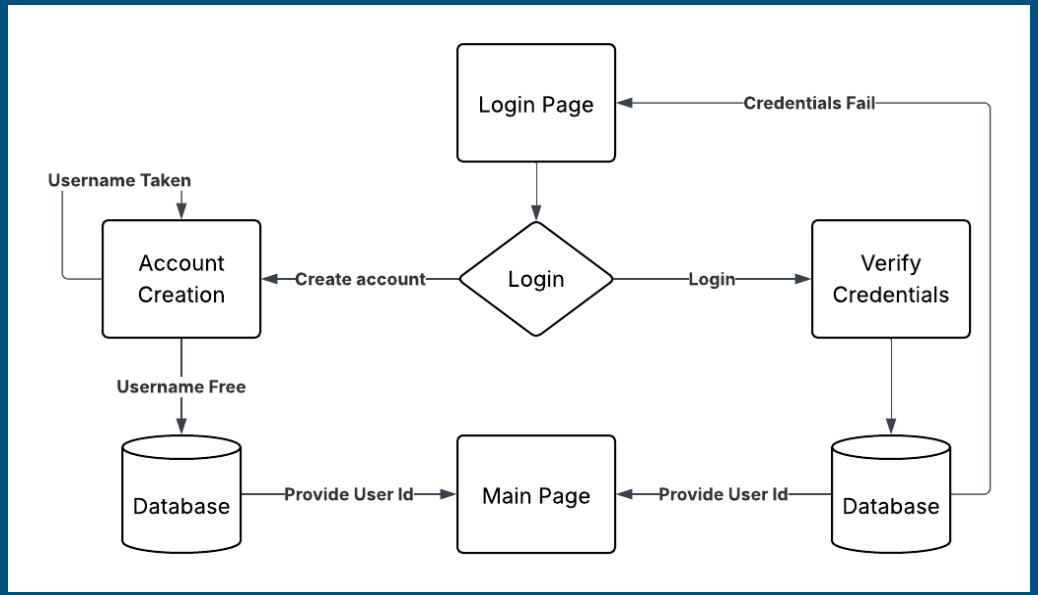
Web Traffic Design



Web Server Backend - Account Data Structure

Variable	Description
Id	Unique Id associated with account.
Username	Username of account.
Password	Password of account.
Devices	A list of device serial numbers associated with the account

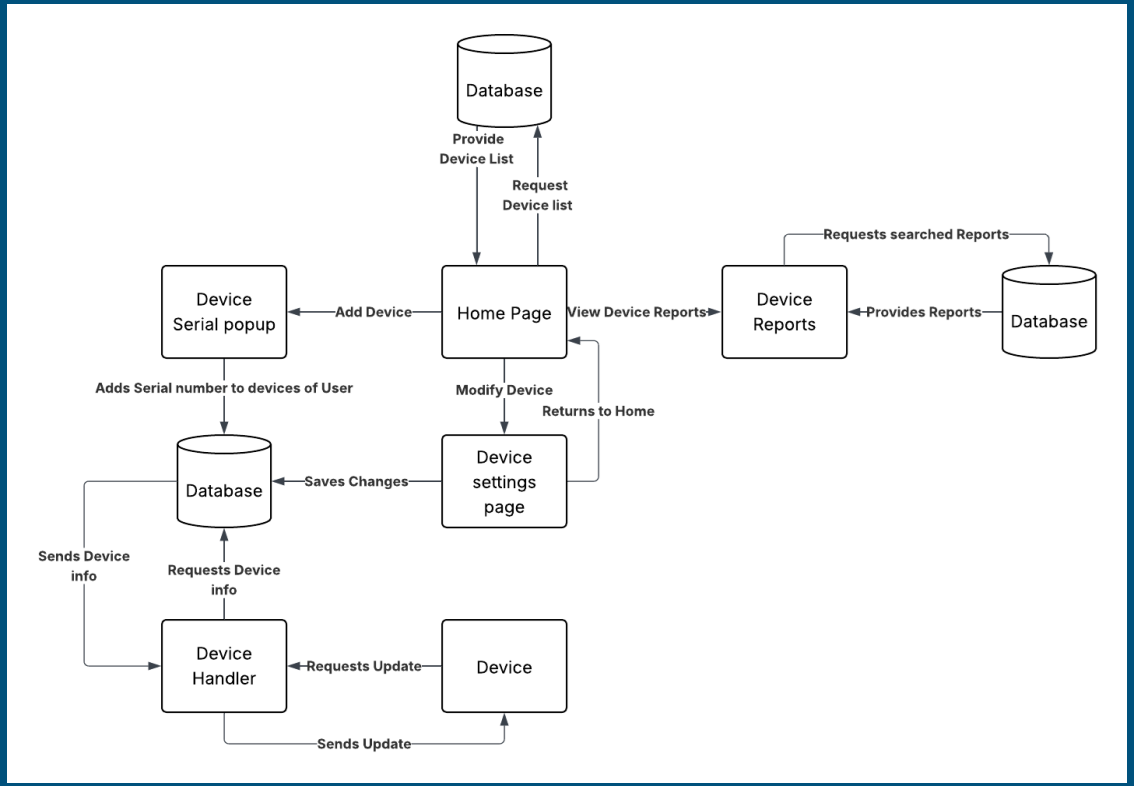
Web Server Backend - Account Flowchart



Web Server Backend - Device Data Structure

Variable	Description
Serial Number	The serial number of the device
Battery Charge	Percent of battery remaining
Reports	A list of reports gathered by the device
Connected	A boolean to show if the device is connected
Pump Status	A boolean showing that the pump is functioning
5V Regulator Status	A boolean showing that the 5V regulator is functioning.
12V Regulator Status	A boolean showing that the 12V regulator is functioning.
Sample Rate	How often the system samples the pool.
Need Update	Boolean signifying an update is required of the device.
Test Chlorine	Boolean requesting chlorine test
Test Phosphate	Boolean requesting phosphate test
Test Temperature	Boolean requesting temperature test
Test Particulate	Boolean requesting particulate test
Update Servers	Servers to notify about pool changes

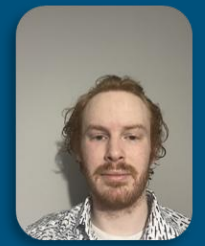
Web Server Backend - Device Flowchart

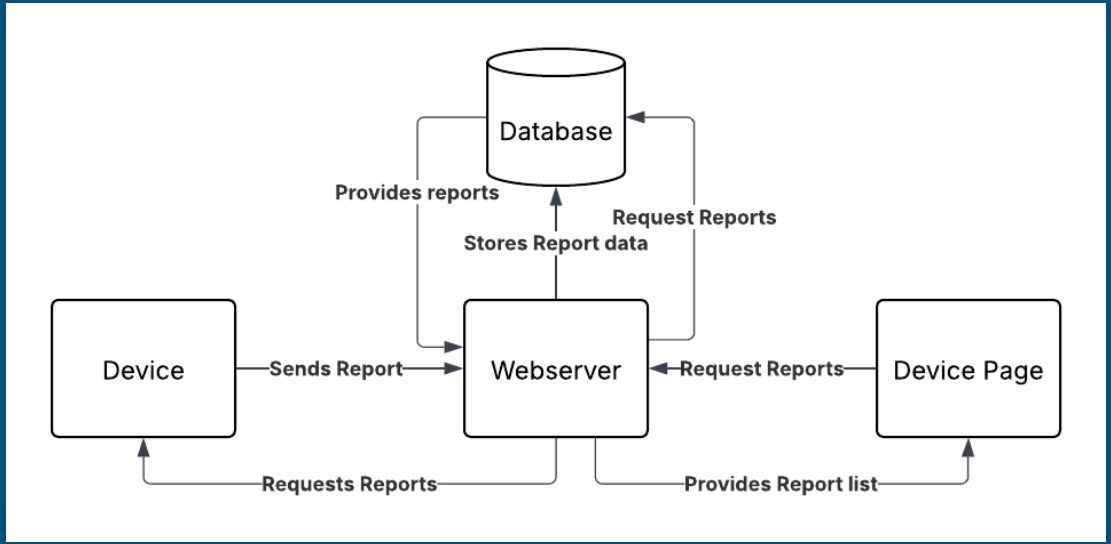


Web Server Backend - Report Data Structure

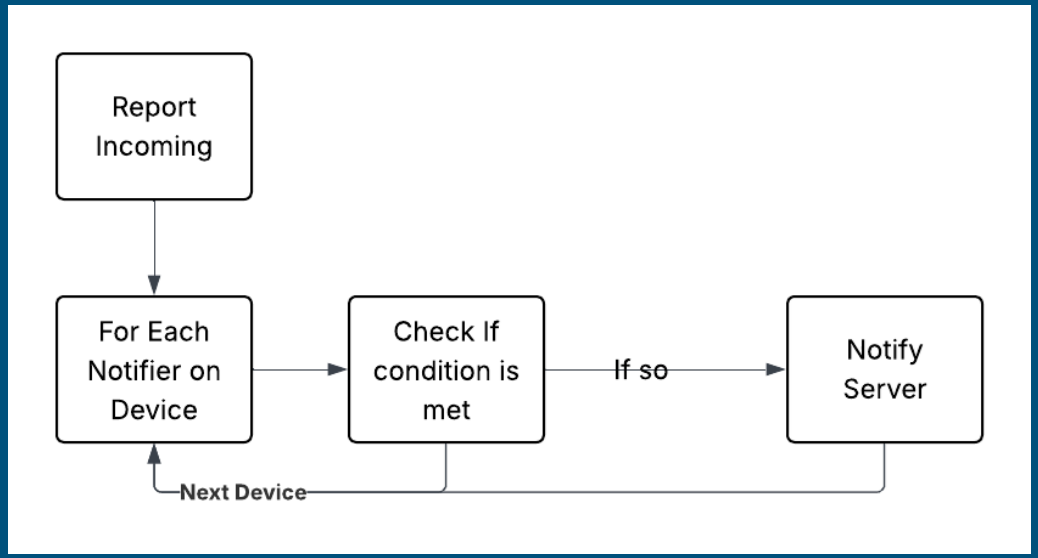
Variable	Description
Chlorine Concentration	Concentration of chlorine within the pool at time of the report.
Phosphoric Acid Concentration	Concentration of phosphoric acid within the pool at time of the report.
Temperature	Temperature of pool at time of report.
Particulates Amount	Amount of particulates in pool
Particulate Size	Size of particulates in pool

Web Server Backend - Report Flowchart

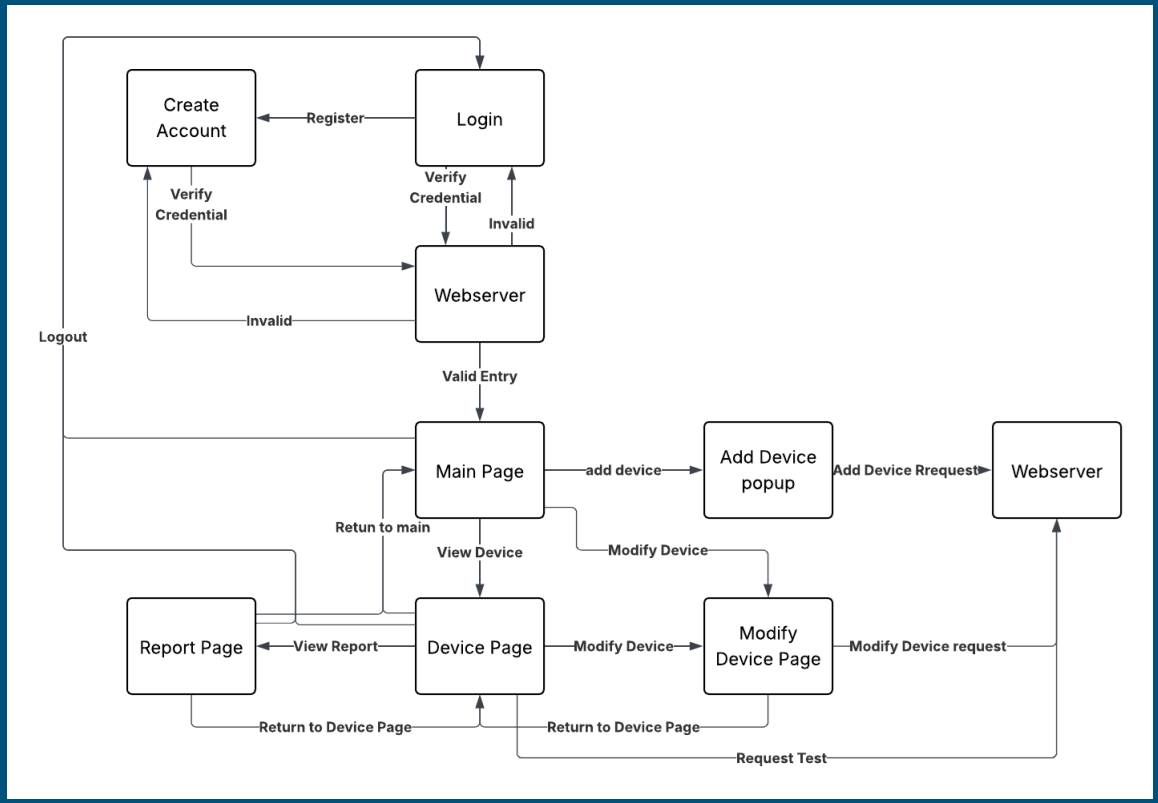




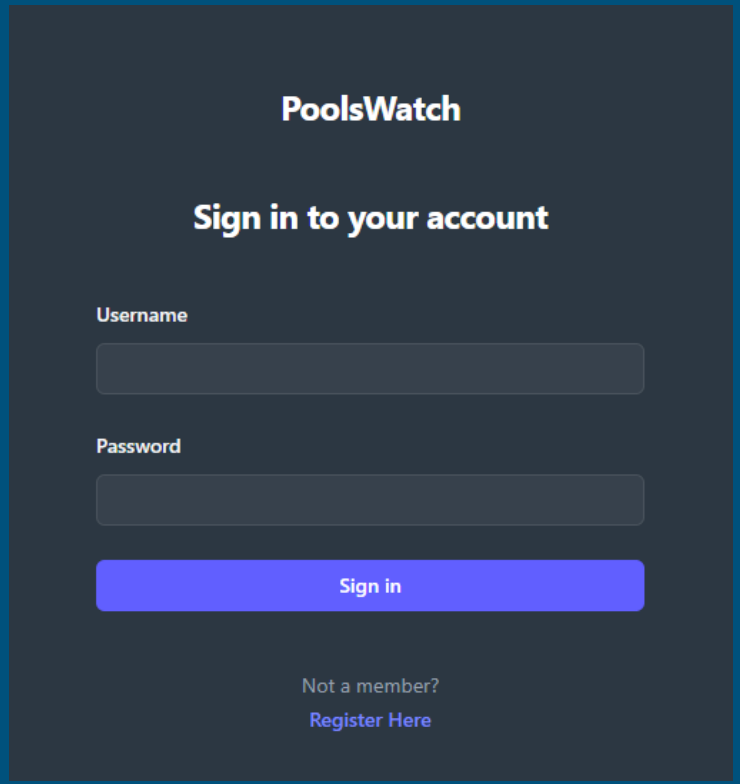
Web Server Backend - Notifications Flowchart

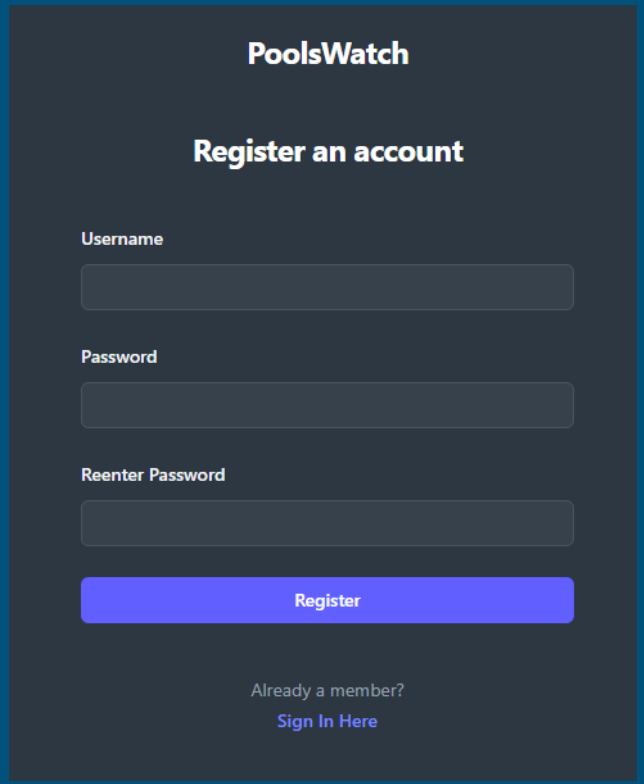


Web Server Frontend

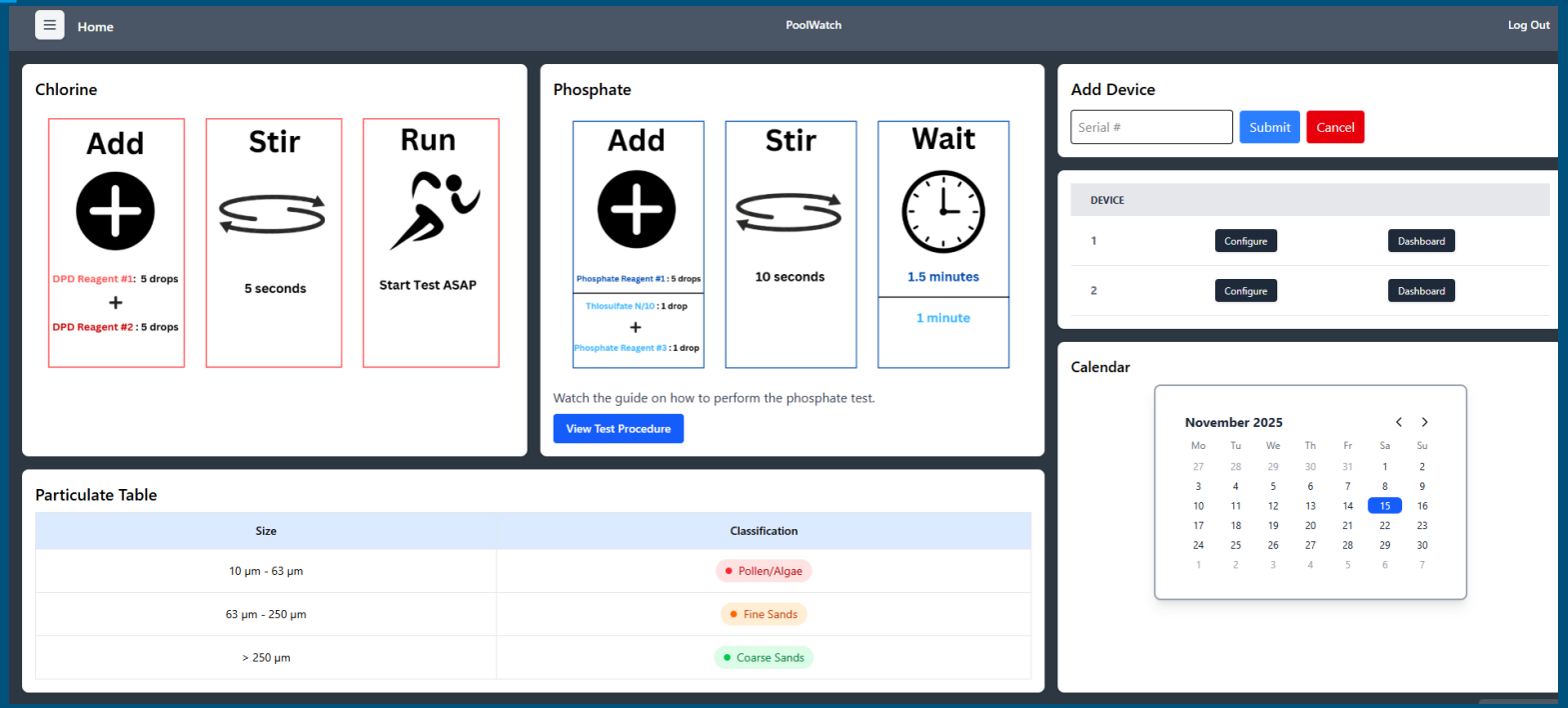


Web Server Frontend - Login Page





Web Server Frontend - Main Page



Web Server Frontend - Device Page

Home Device #2 Search reports Settings Log Out

Status

Disconnected
Battery: 0.85
pumpStatus: working
fiveRegulator: failed
twelveRegulator: working
sampleRate: 24

Tests

Test Chlorine
Test Phosphate
Test Temperature
Test Particulate

TEST	TEMPERATURE	CHLORINE CONCENTRATION	
11/13/2025 - 21:16:8	72.16	0	Delete
11/13/2025 - 21:15:32	0	0	Delete

Web Server Frontend - Device Configuration

Home Device #2 PoolWatch Remove Device Log Out

Settings

Sample Rate(hours)

24

Update

Notifications

Server Server Type

Email

Logic

Add

SERVER	TYPE	LOGIC	
dhughes1582@gmail.com	email	TEMP<100	Delete

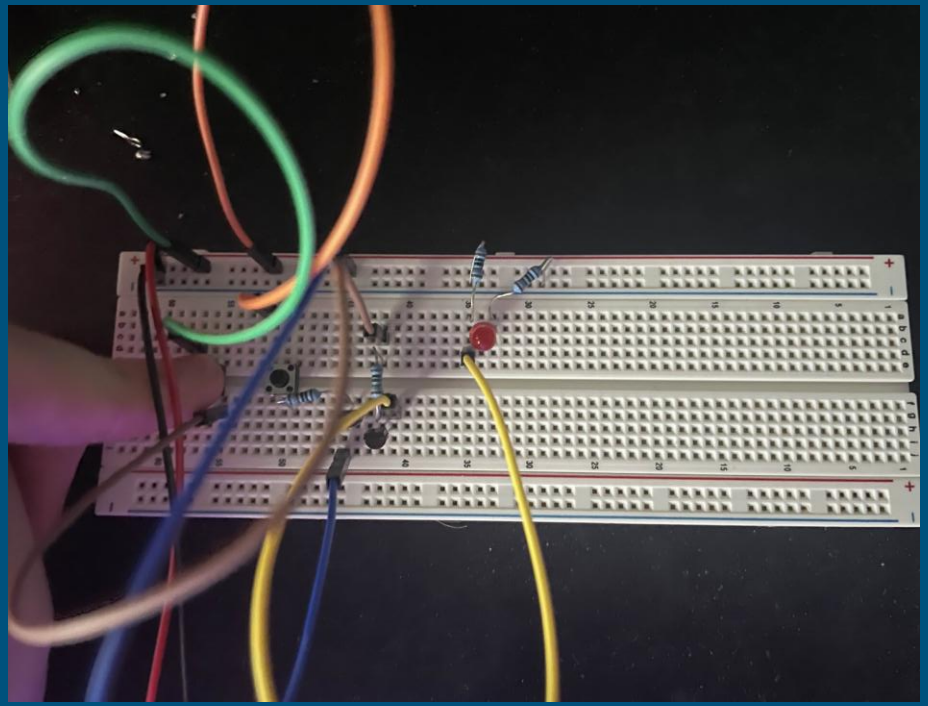
Web Server Frontend - Report Page

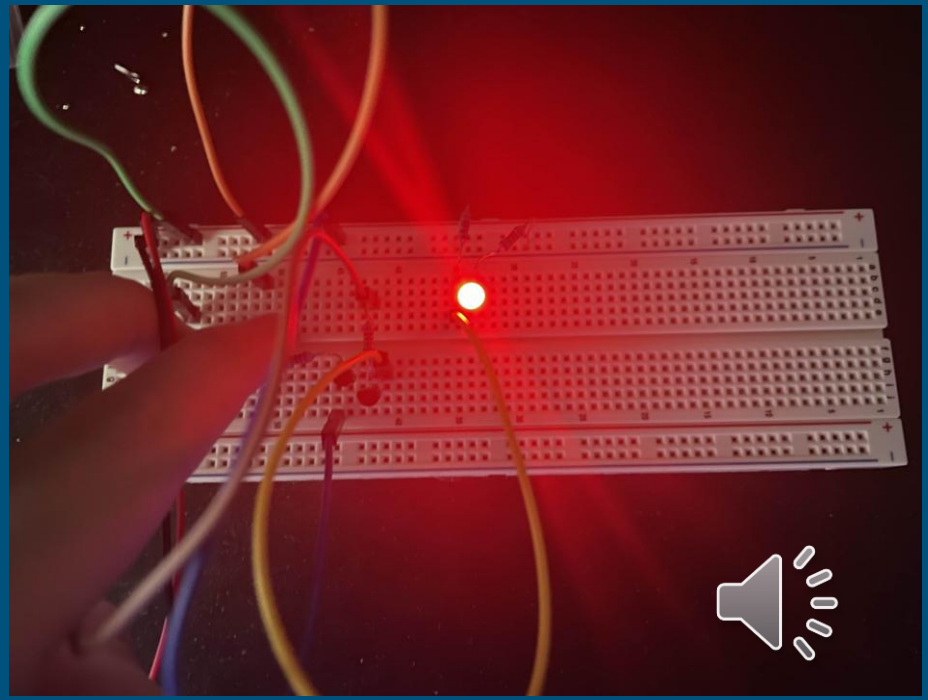
Home Device #2 Report: 11/13/2025 - 21:16:8 Delete Log Out

Results
Chlorine Concentration: 0
Phosphate Concentration: 0
Temperature: 72.16
Particulate Amount: 7
Particulate Size: Percentage of Particles <63 microns: 57.14% (Likely Pollen or Algae), Percentage of Particles 63–125 microns: 42.86% (Likely Fine Sands), Percentage of Particles >125 microns: 0.00% (Likely Coarse Sands)

Prototyping

Debug Panel Tests





Water Pump Test

Water Pump
Mode and Direction Selector

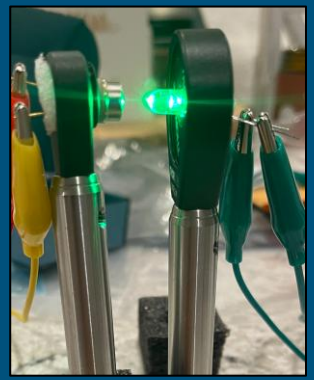
Water Pump Tubing
into Cuvettes

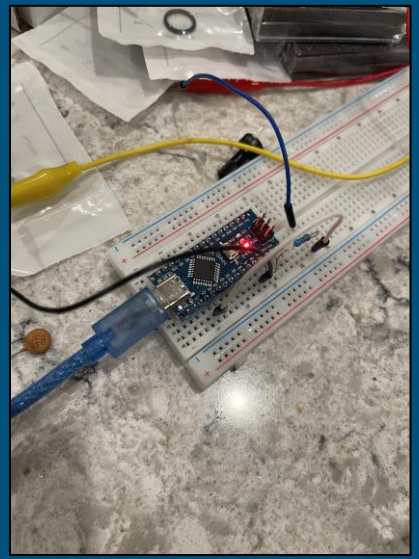
Reagent Mixer Test

First Prototype of Magnetic Stirrer

Final Design of Magnetic Stirrer

Optoelectronic Feasibility Test





Chlorine

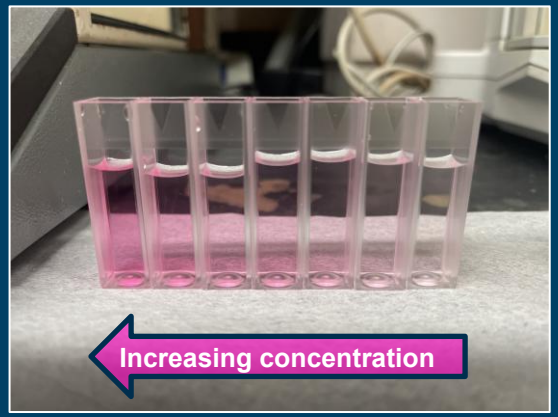
Voltage (V)	Photocurrent (μA)
-2.00	279.0

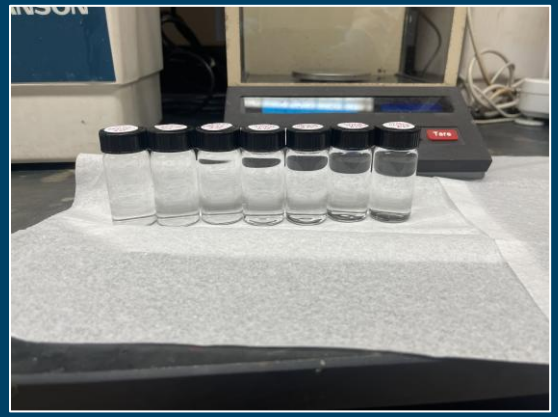
Phosphate

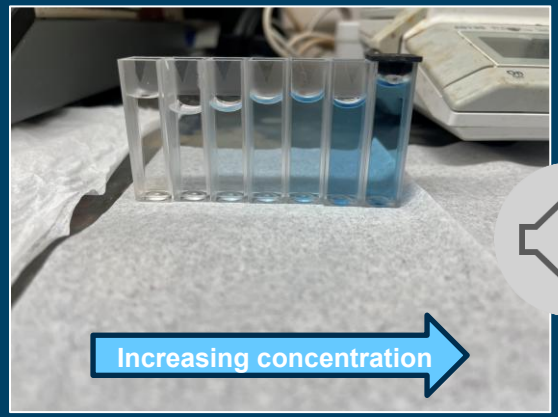
Voltage (V)	Photocurrent (μA)
-2.00	280.0

Calibration Curve I

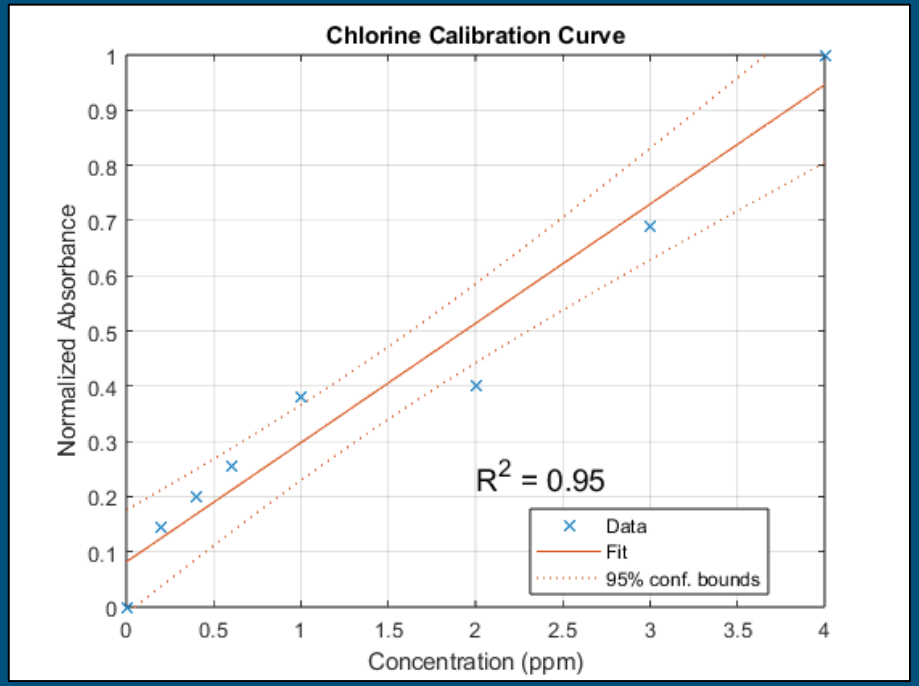
Chlorine	Phosphate

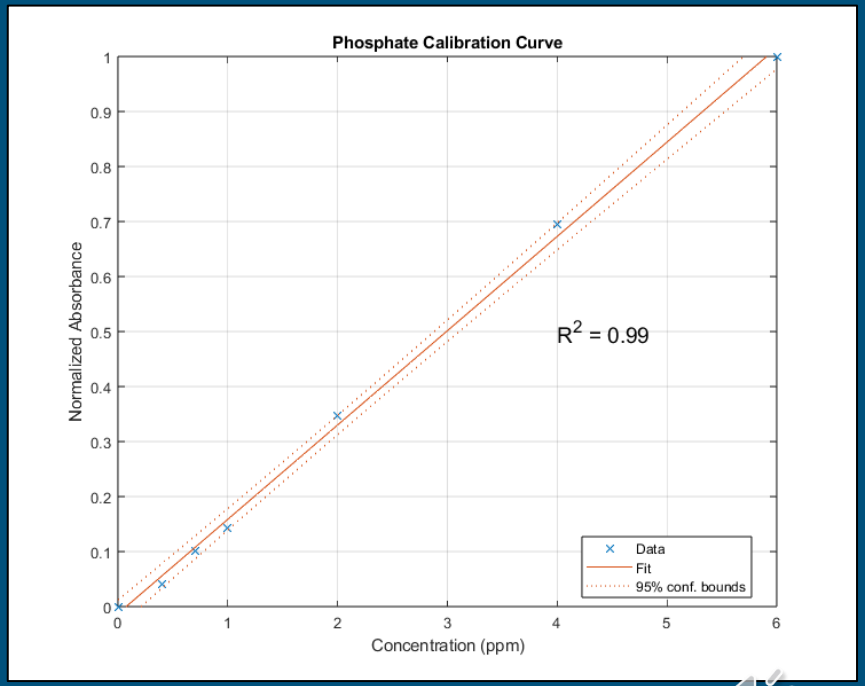






Calibration Curve II





$$A = \log_{10}\frac{I_0}{I} = \varepsilon bc \qquad (1)$$

Website Testing - Device Registration

```
POST /device/exists HTTP/1.1
Host: device.skadi:8080
Content-Type: application/json
Content-Length: 19
Connection: close
```

Serial Number

```
{"serialNumber": 1}
```

```
HTTP/1.1 200 OK
X-Powered-By: Express
Access-Control-Allow-Origin: *
Content-Type: application/json; charset=utf-8
Content-Length: 16
ETag: W/"10-/Xn4Kh95AH5gGcOOqqetzlOj8pQ"
Date: Sat, 15 Nov 2025 15:52:56 GMT
Connection: close
```

Response

```
{"answer":false}
```

```
POST /device/create HTTP/1.1
Host: device.skadi:8080
Content-Type: application/json
Content-Length: 121
Connection: close
```

Registration

```
{"serialNumber": 1, "battery": 0.5, "pumpStatus": true, "fiveRegulator": true, "twelveRegulator": true, "sampleRate": 10}
```

```
HTTP/1.1 200 OK
X-Powered-By: Express
Access-Control-Allow-Origin: *
Content-Type: application/json; charset=utf-8
Content-Length: 16
ETag: W/"10-do6uB5t9n+N7lyRaEx6jXcf7Kd4"
Date: Sat, 15 Nov 2025 15:52:56 GMT
Connection: close
```

Response

```
{"update":false}
```

Website Testing - Report Sending

```
POST /report/add HTTP/1.1
Host: device.skadi:8080
Content-Type: application/json
Content-Length: 127
Connection: close
```

Report 1

```
{"serialNumber": 1, "report": {"ClCon": 0.5, "PCon": 0.2, "tempature": 82, "particulateAmount": 2, "particulateSize": "Large"}}
```

```
HTTP/1.1 200 OK
X-Powered-By: Express
Access-Control-Allow-Origin: *
Content-Type: application/json; charset=utf-8
Content-Length: 16
ETag: W/"10-do6uB5t9n+N7lyRaEx6jXcf7Kd4"
Date: Sat, 15 Nov 2025 15:52:56 GMT
Connection: close
```

Response 1

```
{"update":false}
```

```
POST /report/add HTTP/1.1
Host: device.skadi:8080
Content-Type: application/json
Content-Length: 128
Connection: close
```

Report 2

```
{"serialNumber": 1, "report": {"ClCon": 0.2, "PCon": 0.5, "tempature": 480, "particulateAmount": 3, "particulateSize": "Small"}}
```

```
HTTP/1.1 200 OK
X-Powered-By: Express
Access-Control-Allow-Origin: *
Content-Type: application/json; charset=utf-8
Content-Length: 16
ETag: W/"10-do6uB5t9n+N7lyRaEx6jXcf7Kd4"
Date: Sat, 15 Nov 2025 15:53:06 GMT
Connection: close
```

Response 2

```
{"update":false}
```

Website Testing - Device to Server Test

```
HTTP/1.1 200 OK
Date: Tue, 22 Jul 2025 16:39:00 GMT
Content-Type: application/json; charset=utf-8
Content-Length: 120
Connection: close
X-Powered-By: Express
Access-Control-Allow-Origin: *
ETag: W/"78-/G0dYwyuXgnow4dZ1EaD6rjNSkI"

{"needUpdate":true,"sampleRate":24,"testChlorine":true,"testPhosphate":true,"testTempature":true,"testParticulate":true}
```

Received Message

```
true
true
true
true
true
Update Sample Rate
24.00
Run Chlorine Test
Run Phosphate Test
Run Tempature Test
Run Particulate Test
```

Tests Ran From Message

Administrative Content

Budget

Sub-Systems	Description	Cost
Optical System #1	This will include all lenses, mounts, and light sources.	$430.00
Optical System #2	This will include all lenses, mounts, and light sources.	$ 430.00
Electrical Hardware System	This will include PCB, Microcontrollers, etc.	$ 325.00
Mechanical System	Pump, valves, Servo motors, etc.	$90.00
Chemicals	DPD and Ammonium Molybdate with ascorbic acid reagents.	$35.00
Web Hosting	Hostname and web provider	$80.00
Total		$1,390.00

Work Distribution

Deliverables	Primary	Secondary
Optical Chlorine and Phosphate Concentration Analyzer	Austin Naugle	NA
Particulate Imaging System	Jason Ser	NA
Packaging Design	Jason Ser	Austin Naugle
Temperature Sensor	Jason Ser	NA
Website Design and Administration	Dylan Hughes	NA
PCB Design and Integration	Dylan Hughes	Ning Dim
MCU Selection and Integration	Ning Dim	Dylan Hughes
Pump Design/Implementation	Ning Dim	Austin Naugle
Power Supply Selection and Integration	Ning Dim	Dylan Hughes


Questions?