1. Vehicle Overview

- **Name**: Fibre-Composite Surface Autonomous Vehicle (SAV)
- **Purpose**: Environmental monitoring, surveillance, and patrolling on water bodies (lakes, rivers, coastal regions)
- **Materials**: Fibre-composite construction for durability, lightweight, and corrosion resistance in aquatic environments
- **Dimensions**:
    - Length: 3-5 meters
    - Width: 1-2 meters
    - Height: 1 meter (including sensor mounts)
    - Weight: 100-150 kg (depending on load)

2. Power and Propulsion

- **Power Source**:
    - Solar panels (100-200W) for extended operation
    - Lithium-ion batteries (24V or 48V system)
- **Propulsion System**:
    - Dual-hull or single-hull design with water-jet or propeller-based propulsion system
    - Electric motors (brushless DC) for silent, efficient propulsion
    - Speed: 5-10 km/h (depending on water conditions)
    - Autonomy: 8-12 hours of continuous operation on battery

3. Navigation and Control Systems

- **Autonomous Navigation**:
    - GPS-based positioning (RTK GPS for high-precision navigation)
    - IMU (Inertial Measurement Unit) for orientation and stability
    - Computer Vision-based object detection and obstacle avoidance (using cameras and LiDAR)
    - Depth sensors for underwater mapping and hazard detection
    - Path-planning algorithms for dynamic routing and collision avoidance
- **Control System**:
    - Onboard flight controller (Raspberry Pi/Arduino with an embedded processor for real-time computing)
    - Remote control via 4G/LTE or satellite communication for manual override (if needed)
    - Edge computing capabilities for onboard data analysis and real-time reporting
    - Fail-safe mechanism for return-to-base in case of loss of communication or power failure

4. Sensors and Environmental Monitoring Equipment

- **Environmental Sensors**:
    - Temperature and humidity sensors
    - pH sensors for water quality assessment
    - Dissolved Oxygen (DO) sensor
    - Turbidity sensor for water clarity
    - Chlorophyll and other pollutants sensors (e.g., nitrate, ammonia)
    - GPS-based location tracking for data correlation
    - Air and water quality sensors for pollution detection
- **Imaging Systems**:
    - High-definition cameras (optical and infrared) for visual monitoring
    - Multispectral or hyperspectral cameras for advanced environmental analysis
    - LiDAR sensor for 3D mapping of submerged objects or terrain
    - Acoustic sensors (hydrophone) for detecting underwater anomalies (e.g., illegal fishing)

5. Communication Systems

- **Data Transmission**:
    - 4G/LTE for standard communication over land
    - Satellite communication (e.g., Iridium) for long-range, remote communication
    - Wi-Fi (if operating near shore)
    - Secure data storage and transfer to cloud or local database for analysis
- **Real-time Updates**:
    - Onboard system sends periodic data streams to a centralized monitoring station
    - Data visualization dashboard (cloud-based) for real-time reporting and analysis

6. Safety and Reliability Features

- **Collision Avoidance**:
    - Integration of radar or ultrasonic sensors for close-range obstacle detection
    - Autonomous docking station for safe return and recharging
- **Environmental Resistance**:
    - Waterproof and corrosion-resistant exterior with IP67 rating
    - Ability to operate in varying weather conditions (including light rain and moderate waves)
- **Safety Protocols**:
    - Geofencing to prevent the vehicle from entering restricted zones
    - Automatic shutdown or emergency alerting in case of system malfunction
    - Buoyancy backup in case of power failure or structural damage

7. Logistics and Deployment

- **Deployment System**:
    - Portable launch system (ramps or docks)

    - Easy-to-transport design for field deployment (lightweight)
- **Maintenance**:
    - Modular components for easy repair and replacement
    - Remote diagnostics and firmware updates over the air

8. Data Analytics and Reporting

- **Data Collection**: Continuous collection of environmental and vehicle status data
- **Data Analysis**:
    - Edge computing for initial analysis and anomaly detection
    - Machine learning models for pattern recognition and predictive maintenance
- **Reporting**:
    - Real-time alerts and reports on environmental conditions
    - Historical data logging for trend analysis (e.g., water quality changes)
    - Geospatial mapping for location-based data visualization

9. Optional Add-ons (Future Enhancements)

- **AI-based Anomaly Detection**: Integration of AI to analyze patterns and detect environmental violations (illegal dumping, fishery violations)
- **Extended Range Communication**: Integration of long-range radio frequency (RF) communication for larger bodies of water.
- **Underwater Sampling**: Autonomous water-sampling mechanisms for collecting water samples at various depths for detailed analysis.

10. Regulatory Compliance

- **Marine Safety Standards**: Compliance with local and international maritime safety regulations for autonomous vehicles in water bodies
- **Environmental Standards**: Compliance with local environmental monitoring regulations (water quality standards, data privacy)

This specification ensures the vehicle is equipped for diverse environmental monitoring tasks while being cost-effective, scalable, and sustainable. It’s essential to tailor the design based on specific use cases and the targeted water body environment.