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NGORONGORO CONSERVATION AREA AUTHORITY

Software Requirements Specification

NCAA Digital Transformation - AI-Powered Surveillance System

Version: 1.0

Date: 2025-11-12

Status: Draft

https://www.ncaa.go.tz

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1 Document Information

Field	Value
Project Name	NCAA Digital Transformation - AI-Powered Surveillance System
Version	1.0
Date	2025-11-12
Project Manager	TBD
Tech Lead	TBD
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Document Status	Draft
Module Code	SURVEILLANCE
Parent Project	NCAA Digital Transformation - Ngorongoro Gateway System

2 Project Overview

2.1 What Are We Building

2.1.1 System Function

A comprehensive AI-powered surveillance system providing unified, intelligent framework for real-time conservation monitoring, threat detection, and security response across the Ngorongoro Conservation Area. The system integrates AI-enabled cameras, Unmanned Aerial Vehicles (UAVs), acoustic sensors, and satellite data into a synchronized command network that transforms surveillance data into actionable intelligence, enabling NCAA to predict, prevent, and respond to security threats with precision.

2.1.2 Users

- Rangers & Field Officers: Real-time threat alerts, patrol coordination, rapid response deployment
- Security Managers: Command center operations, incident management, resource allocation
- Conservation Officers: Wildlife monitoring, habitat protection, anti-poaching operations
- Operations Managers: Strategic deployment planning, performance analytics
- Management & Executive: Security overview, incident reporting, strategic decision-making
- External Partners: TANAPA coordination, law enforcement integration (when authorized)

2.1.3 Problem Solved

Manual surveillance limited to patrol routes and observation posts, reactive response to poaching and illegal activities, no real-time threat detection, limited visibility across vast conservation area (8,292 km²), poor coordination between ranger teams, delayed incident reporting, inability to predict high-risk areas, resource deployment based on guesswork rather than intelligence, and fragmented data preventing pattern analysis for proactive security planning.

2.1.4 Key Success Metric

70% faster threat response through real-time detection and automated alerts, 100% 24/7 situational awareness across critical zones, 60% reduction in ranger safety risks through remote monitoring, predictive threat intelligence identifying high-risk areas 48 hours in advance, complete integration with BI System for pattern analysis, automated incident reporting replacing 90% of manual processes, and comprehensive audit trail for all security operations.

2.2 Scope

2.2.1 In Scope

- AI-enabled fixed cameras at strategic locations (gates, high-risk zones, water points)
- Pan-tilt-zoom (PTZ) cameras for wide-area coverage
- Unmanned Aerial Vehicles (UAVs/drones) for aerial surveillance and rapid deployment
- Acoustic sensors for gunshot and vehicle detection
- Edge computing units for local AI inference and data processing
- Central Command Center with GIS-integrated dashboard
- Real-time threat detection using computer vision and machine learning
- Automated alert system (SMS, email, radio gateway integration)
- Integration with Fleet Management for rapid response coordination
- Integration with BI System for analytics and pattern recognition
- Integration with Nasera AI for predictive threat intelligence
- Mobile app for rangers (alert reception, incident reporting, location sharing)
- Video and image archival with 90-day retention
- Incident management and case tracking system
- Geofencing and intrusion detection
- Night vision and thermal imaging capability
- Weather-resistant deployment for harsh conservation environment

2.2.2 Out Of Scope

- Facial recognition of individuals (privacy considerations)
- Armed response capabilities (system provides intelligence only)
- Wildlife tracking with GPS collars (separate conservation system)
- Community surveillance outside conservation area boundaries
- Integration with national security/intelligence agencies (requires separate approval)
- Autonomous drone operations without human oversight
- Satellite-based surveillance systems (cost prohibitive)
- Perimeter fencing or physical barriers

3 User Requirements

3.1 Ai Threat Detection

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-AI-HUMAN-DETECT	Automatically detect unauthorized human presence in restricted zones	Respond to potential poaching or illegal activity before harm occurs	Must	Computer vision models trained on human silhouettes. Distinguishes between authorized (rangers) and unauthorized personnel. 95% accuracy target. Works day and night with thermal imaging.
FT-SURV-AI-VEHICLE-DETECT	Detect and classify vehicles entering conservation area	Identify unauthorized vehicles and coordinate interception	Must	Vehicle type classification (motorcycle, car, truck). License plate recognition where visible. Alert when vehicle detected in restricted areas.
FT-SURV-AI-WILDLIFE-DETECT	Detect and identify wildlife species in monitored areas	Monitor wildlife movement patterns and detect unusual behavior indicating threats	Should	Species classification for key animals (elephants, rhinos, lions). Behavior analysis for distress

Feature Code	I Want To	So That I Can	Priority	Notes
				indicators. Integration with conservation monitoring systems.
FT-SURV-AI-PATTERN-ANALYSIS	Analyze patterns in detected events to identify recurring threats	Predict future incidents and deploy resources proactively	Must	Nasera AI integration for pattern recognition. Temporal and spatial analysis. Predictive hotspot mapping updated daily.
FT-SURV-AI-ANOMALY	Receive alerts for unusual activities that deviate from normal patterns	Investigate potential threats that may not match known signatures	Should	Unsupervised learning for anomaly detection. Baseline normal activity established over time. Configurable sensitivity levels.

3.2 Camera Systems

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-CAM-FIXED	Deploy fixed AI-enabled cameras at strategic locations	Maintain continuous surveillance of high-value and high-risk areas	Must	Minimum 20 fixed camera locations: gates (9), water points (5), known poaching routes (6). 4K resolution. Night vision.

Feature Code	I Want To	So That I Can	Priority	Notes
				Edge AI processing. Weather-resistant (IP66+).
FT-SURV-CAM-PTZ	Control pan-tilt-zoom cameras remotely from command center	Investigate alerts and track moving subjects across wide areas	Must	Minimum 10 PTZ cameras at strategic high points. Remote control from command center. Auto-tracking mode for detected subjects. 30x optical zoom minimum.
FT-SURV-CAM-THERMAL	Utilize thermal imaging for night surveillance	Detect threats 24/7 regardless of lighting conditions	Must	Thermal cameras at high-risk night poaching areas. Detection range 500m+. Integration with standard camera systems for visual confirmation.
FT-SURV-CAM-HEALTH	Monitor camera system health and receive alerts for malfunctions	Maintain high system availability and address issues quickly	Must	Automated health checks every 5 minutes. Alerts for offline cameras, obstructed views, or degraded video quality. Remote diagnostics capability.

3.3 Uav Integration

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-UAV-DEPLOY	Deploy drones for aerial surveillance of specific areas on-demand	Rapidly assess situations and gather intelligence from aerial perspective	Must	Minimum 5 drones (2 at command center, 3 at field stations). Flight time 30+ minutes. 4K video streaming. GPS waypoint navigation. Manual and autonomous flight modes.
FT-SURV-UAV-MISSION	Plan and execute automated UAV patrol missions	Cover large areas systematically without continuous manual piloting	Should	Pre-programmed flight paths. Geofenced operational boundaries. Return-to-home on low battery. Mission logging and video archival.
FT-SURV-UAV-STREAM	View live video feed from drones in command center	Monitor aerial surveillance in real-time and coordinate ground response	Must	Low-latency video streaming (< 2 second delay). GIS overlay showing drone position. Record and archive all flights. Multi-drone monitoring capability.
FT-SURV-UAV-THERMAL	Equip drones with thermal	Conduct aerial surveillance	Should	Thermal camera payload for at

Feature Code	I Want To	So That I Can	Priority	Notes
	imaging for night operations	during high-risk night hours		least 2 drones. Automatic human/vehicle heat signature detection. Integration with AI detection models.
FT-SURV-UAV-ALERTS	Launch drones automatically in response to critical alerts	Rapidly deploy aerial surveillance to incident locations	Could	Automated launch triggered by high-priority threats. Pre-approved flight zones. Human confirmation before flight. Safety protocols for adverse weather.

3.4 Acoustic Sensors

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-ACOUSTIC-GUNSHOT	Detect gunshots using acoustic sensors	Immediately respond to poaching incidents	Must	Acoustic sensor array covering high-risk zones. Triangulation for location accuracy. Distinguishes gunshots from other sounds. < 30 second alert latency. Range 2-3 km per sensor.
		Identify unauthorized vehicle intrusion	Should	Engine sound recognition. Vehicle type

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-ACOUSTIC-VEHICLE	Detect vehicle sounds in restricted areas	when visual systems unavailable		classification. Direction detection. Useful for night operations when visibility limited.
FT-SURV-ACOUSTIC-WILDLIFE	Monitor wildlife vocalizations for distress signals	Detect potential threats to wildlife based on unusual vocal patterns	Could	Species-specific vocalization recognition. Distress call detection. Integration with conservation monitoring systems.

3.5 Command Center

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-CMD-DASHBOARD	Access centralized command dashboard with real-time data from all sensors	Maintain comprehensive situational awareness and coordinate responses	Must	GIS-based visualization. Live camera feeds (grid view). Alert panel. Ranger location tracking. Incident log. Multi-screen support. 24/7 operation.
FT-SURV-CMD-GIS	View all surveillance assets and incidents on interactive map	Understand spatial relationships and optimize resource deployment	Must	Conservation area boundary overlay. Camera coverage zones. Ranger positions. Incident markers. Historical incident heat map. Route

Feature Code	I Want To	So That I Can	Priority	Notes
				planning for response.
FT-SURV-CMD-ALERTS	Receive prioritized alerts with recommended actions	Focus on critical threats and respond appropriately	Must	Alert severity levels (critical/high/medium/low). Color-coded visual indicators. Audio alerts for critical threats. Acknowledgment tracking. Alert routing to appropriate personnel.
FT-SURV-CMD-VIDEO-WALL	Display multiple camera feeds simultaneously on video wall	Monitor multiple locations and coordinate complex operations	Should	Configurable layout (4x4, 3x3, custom). Full-screen zoom on any feed. Quick switching between camera groups. Recorded playback capability.
FT-SURV-CMD-COMMS	Communicate directly with ranger teams from command center	Coordinate response and provide real-time intelligence	Must	Radio gateway integration. SMS dispatch. In-app messaging to ranger mobile app. Voice communication capability. Group communication for team coordination.

3.6 Incident Management

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-INCIDENT-CREATE	Automatically create incident records when threats detected	Document all security events and maintain complete audit trail	Must	Auto-generated from alerts. Includes timestamp, location, detection source, evidence (video/images). Severity assignment. Unique incident ID.
FT-SURV-INCIDENT-ASSIGN	Assign incidents to ranger teams for response	Ensure clear responsibility and track response progress	Must	Assignment based on location and availability. Mobile notification to assigned rangers. Status tracking (assigned, en route, on scene, resolved). Response time logging.
FT-SURV-INCIDENT-CASE	Link related incidents into cases for investigation	Build comprehensive understanding of repeat offenders and organized threats	Should	Manual and AI-suggested case linking. Evidence consolidation. Pattern identification. Collaboration with law enforcement.
	Generate incident reports	Provide documentation	Must	Standardized report templates.

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-INCIDENT-REPORT	for management and authorities	for decision-making and legal proceedings		Evidence export (video clips, images, data). Timeline reconstruction. PDF export. Integration with BI System.

3.7 Mobile Ranger App

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-MOBILE-ALERTS	Receive real-time alerts on mobile device while on patrol	Respond to threats immediately from my current location	Must	Push notifications for critical alerts. Alert details with map location. Distance and bearing to incident. Response acknowledgment. Works offline with sync when connected.
FT-SURV-MOBILE-REPORT	Report incidents and observations from the field	Contribute real-time intelligence to command center	Must	Incident reporting form with categories. Photo and video capture. GPS auto-tagging. Voice notes. Offline submission with sync.
FT-SURV-MOBILE-LOCATION	Share my location with command center	Enable coordination and ensure my	Must	Background location sharing during active duty. Emergency

Feature Code	I Want To	So That I Can	Priority	Notes
	during operations	safety is monitored		SOS button. Location update every 2 minutes. Battery-optimized tracking.
FT-SURV-MOBILE-EVIDENCE	Capture and upload evidence from incident scenes	Document findings for investigation and prosecution	Must	Photo and video capture with metadata. GPS and timestamp embedding. Secure encrypted upload. Chain of custody tracking.

3.8 Predictive Analytics

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-PREDICT-HOTSPOT	Identify predicted threat hotspots for next 48 hours	Deploy patrols proactively to high-risk areas	Must	Nasera AI analyzing historical incidents, seasonal patterns, environmental factors. Updated daily. Confidence scores. Integration with patrol planning.
FT-SURV-PREDICT-PATTERN	Detect temporal patterns in security incidents	Understand when threats are most likely to occur	Should	Time-of-day analysis. Day-of-week patterns. Seasonal trends. Moon phase correlation. Integration with

Feature Code	I Want To	So That I Can	Priority	Notes
				resource scheduling.
FT-SURV-PREDICT-RISK	Assess risk levels for different zones in real-time	Adjust security posture dynamically based on current threat level	Should	Multi-factor risk scoring (historical incidents, environmental conditions, intelligence reports). Color-coded risk map. Threshold-based alerts.

3.9 Integration Reporting

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-INT-FLEET	Coordinate with Fleet Management System for rapid response	Deploy nearest available vehicles to incident locations	Must	Real-time vehicle location from Fleet System. Availability status integration. Automated vehicle dispatch recommendations. Response time optimization.
FT-SURV-INT-BI	Push surveillance data to BI System for analysis	Analyze security performance and inform strategic decisions	Must	Incident data, response times, threat trends. Executive security dashboards. Cross-departmental correlation (e.g., visitor patterns vs incidents).
			Should	

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-INT-NASERA	Leverage Nasera AI for natural language queries and insights	Ask questions about security data and receive AI-powered recommendations		Natural language interface for surveillance data. Automated insight generation. Recommendation engine for resource allocation.
FT-SURV-REPORTS	Generate automated security and operational reports	Provide accountability and inform management decisions	Must	Daily security briefings. Weekly incident summaries. Monthly performance reports. Annual security analysis. Export to PDF/ Excel.

3.10 Edge Computing

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-EDGE-PROCESSING	Process AI detection locally at camera locations using edge computing	Reduce bandwidth requirements and enable operation during connectivity issues	Must	Intel NUC or NVIDIA Jetson edge devices. Local AI inference for threat detection. Compressed data transmission to command center. Offline operation with local storage.
	Cache video and detection data	Ensure no data loss during	Must	Local SSD storage at edge

Feature Code	I Want To	So That I Can	Priority	Notes
FT-SURV-EDGE-CACHE	locally when network unavailable	connectivity outages		locations. Automatic sync when connection restored. Prioritized sync (alerts before routine video). Storage management with retention policies.

4 Technical Requirements

4.1 Performance Standards

Requirement	Target	How To Test
Threat detection latency	< 5 seconds from detection to alert generation	End-to-end latency testing with simulated threats
AI detection accuracy	≥ 95% accuracy for human/vehicle detection, ≥ 90% for species classification	Validation testing with labeled ground truth dataset
Video streaming latency	< 2 seconds from camera to command center display	Network latency testing under various connectivity conditions
Camera uptime	≥ 98% availability for fixed cameras, ≥ 95% for PTZ cameras	Uptime monitoring over 90-day period
UAV deployment time	< 5 minutes from alert to airborne	Drill testing with response time logging
Command dashboard responsiveness	< 2 seconds for map interactions, < 1 second for alert acknowledgment	UI performance testing with typical data loads
Acoustic detection range	Gunshot detection at 2-3 km radius per sensor	Field testing with controlled gunfire at measured distances
System availability	99% uptime for command center, 95% for edge locations	Availability monitoring with redundancy failover testing

4.2 Platform Requirements

Platform	Minimum Version	Target Version	Notes
AI-Enabled Cameras			

Platform	Minimum Version	Target Version	Notes
	4MP resolution, H.265 encoding, ONVIF compliant	4K resolution, H.265+, edge AI capability	Weather-resistant IP66+, night vision, wide dynamic range
Edge Computing Units	Intel NUC i5, 8GB RAM, 256GB SSD	NVIDIA Jetson Xavier NX or Intel NUC i7, 16GB RAM, 512GB SSD	GPU acceleration for AI inference, fanless for reliability
UAV Systems	30 min flight time, 4K camera, GPS navigation	45+ min flight time, 4K+thermal camera, obstacle avoidance, RTK GPS	Weather resistance, emergency landing capability, compliance with Tanzania aviation regulations
Command Center Infrastructure	Dual server setup, PostgreSQL 13+, 10TB storage	Cluster setup with redundancy, PostgreSQL 15+, 20TB storage	24/7 operation, UPS backup, redundant network connectivity
Mobile Application	Android 8.0, iOS 12	Android 13, iOS 16	Offline functionality, low-power mode for extended operations

4.3 Security Privacy

Requirement	Must Have	Implementation
Video encryption	True	AES-256 encryption for stored video, TLS 1.3 for streaming
Access control	True	Role-based access control (RBAC), multi-factor authentication for command center, audit logging for all video access
Data retention	True	90-day video retention standard, extended retention for incidents, automatic

Requirement	Must Have	Implementation
		archival to cold storage, secure deletion procedures
Privacy protection	True	No facial recognition, camera placement respecting community privacy, data protection compliance, clear signage at monitored areas
Evidence chain of custody	True	Tamper-proof logging, cryptographic hashing of evidence files, access audit trail, legal admissibility standards

5 External Dependencies

5.1 Third Party Services

Service	What It Does	Criticality	Backup Plan
Satellite/Cellular Connectivity	Provide network connectivity for remote camera locations	High	Edge computing with offline caching, periodic sync when connectivity available
Weather Data API	Provide weather forecasts for UAV flight planning	Medium	Manual weather assessment, conservative flight decisions
Map/GIS Services	Provide base maps and geographic data for visualization	Medium	Offline maps, cached geographic data
AI Model Training Platform	Cloud GPU resources for model training and improvement	Low	Less frequent model updates, use pre-trained models

5.2 Device Requirements

Feature	Required	Optional	Notes
Power infrastructure	True	False	Reliable power or solar systems for cameras and edge units, UPS backup for critical locations, battery backup for mobile systems
Network connectivity	False	True	System designed for intermittent connectivity, offline

Feature	Required	Optional	Notes
			operation with periodic sync, cellular/satellite hybrid approach
Command center facility	True	False	Secure facility at NCAA headquarters, video wall, workstations, backup power, redundant communications
UAV landing/launch areas	True	False	Clear areas at command center and field stations, weather protection storage, charging infrastructure

6 Release Planning

6.1 Development Phases

Phase	Features Included	Timeline	Success Criteria
Phase 1 (Core Detection & Command Center - Pilot)	['Command center setup with GIS dashboard', '10 fixed AI cameras at high-priority locations', 'Edge computing for local AI processing', 'Basic threat detection (human/vehicle)', 'Alert system (SMS/email)', 'Mobile app for rangers (basic alerts)']	20 weeks	Command center operational 24/7, 10 cameras detecting threats with 95% accuracy, alerts reaching rangers within 30 seconds, pilot successful at 3 high-risk zones
Phase 2 (Expanded Coverage & UAV Integration)	['20 additional cameras (total 30)', '10 PTZ cameras for wide-area coverage', 'UAV integration with 3 drones', 'Acoustic sensor deployment (5 locations)', 'Thermal imaging capability', 'Incident management system', 'Integration with Fleet Management']	16 weeks	30 cameras operational, UAV rapid deployment functional, gunshot detection operational, complete incident tracking, fleet coordination working
Phase 3 (AI Enhancement & Full Integration)	['Predictive analytics with Nasera AI', 'Pattern recognition and hotspot prediction', 'Advanced species	12 weeks	Predictive hotspots accurate, full analytics operational, all integrations complete, system optimized for

Phase	Features Included	Timeline	Success Criteria
	classification', 'Full BI System integration', 'Automated reporting', 'Performance optimization', 'Staff training completion']		24/7 operations, staff fully trained

6.2 Release Checklist

- Command center facility prepared with video wall and workstations
- All cameras installed, configured, and tested (30 fixed + 10 PTZ)
- Edge computing units deployed and operational
- UAV systems procured, pilots trained, flight operations approved
- Acoustic sensors deployed and calibrated
- AI detection models trained and validated (≥95% accuracy)
- Mobile ranger app deployed to all field officers
- Alert system tested end-to-end (detection to ranger notification)
- Integration with Fleet Management operational
- Integration with BI System pushing surveillance data
- Integration with Nasera AI for predictions functional
- Incident management workflows established
- Video archival system operational with 90-day retention
- Security audit completed, vulnerabilities addressed
- Staff training completed (command center operators, rangers, managers)
- Standard operating procedures documented
- Emergency protocols established and tested
- Data protection and privacy compliance verified

7 Risks Assumptions

7.1 Risks

Risk	Probability	Impact	Mitigation
AI detection false positives causing alert fatigue	Medium	Medium	Continuous model training with local data, adjustable sensitivity thresholds, human confirmation for high-priority alerts, alert aggregation to reduce noise
Harsh environmental conditions damaging cameras and sensors	High	Medium	Ruggedized equipment rated for extreme conditions, weather-resistant enclosures, regular maintenance schedule, spare parts inventory, redundant coverage in critical areas
Limited connectivity preventing real-time surveillance	High	High	Edge computing for local processing, offline operation with caching, hybrid cellular/satellite connectivity, periodic sync acceptable for non-critical data
UAV regulations and airspace restrictions limiting operations	Medium	Medium	Early engagement with Tanzania Civil Aviation Authority, obtain necessary permits, establish

Risk	Probability	Impact	Mitigation
			approved flight zones, manual backup surveillance methods
Power outages affecting surveillance coverage	Medium	High	UPS backup at critical locations, solar power systems, battery backup for mobile units, prioritized power allocation for essential cameras
Poachers adapting tactics to evade detection	Medium	Medium	Continuous model improvement, multiple detection modalities (visual, acoustic, thermal), unpredictable patrol patterns, intelligence-driven operations
Community concerns about privacy and surveillance	Low	Medium	Community engagement and transparency, cameras focused on conservation areas only, no facial recognition, privacy protection policies, clear signage

7.2 Assumptions

- Tanzania Civil Aviation Authority will approve UAV operations within conservation area
- Cellular connectivity available intermittently (offline operation designed for gaps)
- Power infrastructure adequate or can be upgraded (solar where needed)
- Rangers willing to adopt mobile app and digital reporting procedures
- Command center facility can be secured and operated 24/7
- AI detection accuracy sufficient for operational use (95%+ achievable with local training)
- NCAA management committed to data-driven security operations

- Integration APIs available from Fleet Management and BI Systems
- Local community supportive of enhanced surveillance for conservation
- Environmental conditions (dust, heat, rain) manageable with ruggedized equipment

8 Market Specific Considerations

8.1 Primary Market

- Ngorongoro Conservation Area, Tanzania - 8,292 km² conservation area

8.2 Target Demographics

- Security managers transitioning to AI-powered systems
- Rangers with varying technical literacy
- Conservation officers focused on wildlife protection

8.3 Local Considerations

- Vast area (8,292 km²) requiring strategic sensor placement vs full coverage
- Mix of savanna, woodland, and mountainous terrain affecting sensor placement
- Seasonal weather patterns (wet/dry seasons) impacting equipment performance
- Limited infrastructure in remote areas requiring solar power and offline capability
- Cultural sensitivity around surveillance near Maasai communities
- Wildlife-friendly installation avoiding disruption to animal behavior
- Coordination with TANAPA at shared boundaries (Nabi gate, Serengeti border)
- Compliance with Tanzania wildlife protection laws and regulations
- Local technical support limitations requiring robust systems and remote management
- Multi-lingual support (English, Swahili) for ranger interfaces

8.4 Threat Landscape

8.4.1 Primary Threats

Poaching (rhinos, elephants), illegal grazing, unauthorized access, wildlife trafficking

8.4.2 Temporal Patterns

Night operations common for poaching, dry season increased activity, moon phase correlation

8.4.3 Geographic Hotspots

Border areas, water points, known wildlife corridors, access roads

8.5 Conservation Integration

8.5.1 Unesco Alignment

Supports World Heritage Site protection obligations

8.5.2 Tanapa Coordination

Shared intelligence and operations at conservation area boundaries

8.5.3 Iucn Standards

Aligns with conservation monitoring best practices

8.5.4 Data Sharing

Selective sharing with conservation partners and law enforcement (subject to approvals)

9 Sign Off

9.1 Approval

Role	Name	Signature	Date

9.2 Document History

Version	Date	Changes Made	Changed By
1.0	2025-11-12	Initial draft based on NCAA Digital Transformation roadmap Section 2.4	SRS Development Team

10 Detailed Feature Requirements

10.1 Ft Surv Ai Human Detect

10.1.1 Priority

Must Have

10.1.2 User Story

As a security manager, I want to automatically detect unauthorized human presence in restricted zones so that I can respond to potential poaching before harm occurs

10.1.3 Preconditions

AI cameras operational; Detection models trained; Alert system configured

10.1.4 Postconditions

Humans detected with 95%+ accuracy; Alerts generated within 5 seconds; Evidence captured and stored

10.1.5 Test Cases

Id	Description	Weight
SURV-AI-TC-001	Detect single person at 100m distance in daylight	High
SURV-AI-TC-002	Detect multiple persons (group) at 50m distance	High
SURV-AI-TC-003	Detect person at night using thermal imaging	High
SURV-AI-TC-004	Distinguish between ranger (authorized) and intruder based on context	Medium
SURV-AI-TC-005		High

Id	Description	Weight
	Achieve ≥95% detection accuracy over 30-day test period	
SURV-AI-TC-006	False positive rate < 5% to prevent alert fatigue	High

10.2 Ft Surv Uav Deploy

10.2.1 Priority

Must Have

10.2.2 User Story

As a security manager, I want to deploy drones for aerial surveillance on-demand so that I can rapidly assess situations from aerial perspective

10.2.3 Preconditions

UAV systems operational; Pilots trained; Flight zones approved; Weather suitable

10.2.4 Postconditions

Drone airborne within 5 minutes; Live video streaming; Flight logged

10.2.5 Test Cases

Id	Description	Weight
SURV-UAV-TC-001	Deploy drone within 5 minutes of alert	High
SURV-UAV-TC-002	Stream 4K video to command center with <2 second latency	High
SURV-UAV-TC-003	Execute pre-programmed patrol route autonomously	Medium
SURV-UAV-TC-004		High

Id	Description	Weight
	Return to home on low battery (20% remaining)	
SURV-UAV-TC-005	Achieve 30+ minute flight time with 4K camera	High
SURV-UAV-TC-006	Archive all flight video with GPS overlay	Medium

10.3 Ft Surv Acoustic Gunshot

10.3.1 Priority

Must Have

10.3.2 User Story

As a security manager, I want to detect gunshots using acoustic sensors so that I can immediately respond to poaching incidents

10.3.3 Preconditions

Acoustic sensors deployed; Detection algorithms configured; Alert routing established

10.3.4 Postconditions

Gunshots detected within 30 seconds; Location triangulated; Rangers alerted

10.3.5 Test Cases

Id	Description	Weight
SURV-ACOUSTIC-TC-001	Detect gunshot at 2km range from sensor	High
SURV-ACOUSTIC-TC-002	Triangulate gunshot location using 3+ sensors (±50m accuracy)	High
SURV-ACOUSTIC-TC-003		High

Id	Description	Weight
	Distinguish gunshot from other loud sounds (thunder, vehicles)	
SURV-ACOUSTIC-TC-004	Alert rangers within 30 seconds of detection	High
SURV-ACOUSTIC-TC-005	Log all acoustic events with timestamp and location	Medium

10.4 Ft Surv Cmd Dashboard

10.4.1 Priority

Must Have

10.4.2 User Story

As a command center operator, I want a centralized dashboard with real-time data from all sensors so that I can maintain comprehensive situational awareness

10.4.3 Preconditions

Command center operational; All sensors connected; Data pipeline functional

10.4.4 Postconditions

Dashboard displays live data; Alerts visible; Map interface responsive

10.4.5 Test Cases

Id	Description	Weight
SURV-CMD-TC-001	Display all 30+ cameras on GIS map with status indicators	High
SURV-CMD-TC-002	Show live video from selected camera in <2 seconds	High
SURV-CMD-TC-003		High

Id	Description	Weight
	Display active alerts in priority order with recommended actions	
SURV-CMD-TC-004	Show ranger positions on map (updated every 2 minutes)	High
SURV-CMD-TC-005	Support 24/7 operation with multi-user access	High
SURV-CMD-TC-006	Dashboard load time <3 seconds with all sensors active	Medium

10.5 Ft Surv Predict Hotspot

10.5.1 Priority

Must Have

10.5.2 User Story

As an operations manager, I want to identify predicted threat hotspots for next 48 hours so that I can deploy patrols proactively

10.5.3 Preconditions

Nasera AI operational; Historical incident data available; Environmental data integrated

10.5.4 Postconditions

Hotspot predictions generated daily; Confidence scores provided; Patrol planning updated

10.5.5 Test Cases

Id	Description	Weight
SURV-PREDICT-TC-001	Generate hotspot predictions for next 48 hours daily	High
SURV-PREDICT-TC-002		High

Id	Description	Weight
	Achieve 70%+ accuracy in predicting high-risk zones	
SURV-PREDICT-TC-003	Display predictions on GIS map with confidence scores	High
SURV-PREDICT-TC-004	Incorporate seasonal patterns and environmental factors	Medium
SURV-PREDICT-TC-005	Update predictions as new incidents occur	Medium

10.6 Ft Surv Mobile Alerts

10.6.1 Priority

Must Have

10.6.2 User Story

As a ranger, I want to receive real-time alerts on my mobile device so that I can respond immediately from my current location

10.6.3 Preconditions

Mobile app installed; Ranger authenticated; Location sharing enabled

10.6.4 Postconditions

Alert received within 30 seconds; Location and details displayed; Response tracked

10.6.5 Test Cases

Id	Description	Weight
SURV-MOBILE-TC-001	Receive push notification within 30 seconds of alert generation	High
SURV-MOBILE-TC-002		High

Id	Description	Weight
	Display incident location on map with distance/bearing from current position	
SURV-MOBILE-TC-003	Acknowledge alert and update status (responding/on scene)	High
SURV-MOBILE-TC-004	Work offline with sync when connectivity restored	High
SURV-MOBILE-TC-005	Access alert details including photos/video from detection	Medium

10.7 Ft Surv Int Fleet

10.7.1 Priority

Must Have

10.7.2 User Story

As a command center operator, I want to coordinate with Fleet Management System so that I can deploy nearest available vehicles to incidents

10.7.3 Preconditions

Fleet Management integration operational; Vehicle locations available; API authenticated

10.7.4 Postconditions

Nearest vehicles identified; Dispatch recommendations provided; Response coordinated

10.7.5 Test Cases

Id	Description	Weight
SURV-INT-TC-001	Query Fleet System for vehicles within 10km of incident	High

Id	Description	Weight
SURV-INT-TC-002	Receive vehicle locations and availability status in <2 seconds	High
SURV-INT-TC-003	Recommend optimal vehicle for dispatch based on location and availability	High
SURV-INT-TC-004	Track response vehicle location in real-time on surveillance dashboard	Medium

11 Additional Context

11.1 Success Metrics

11.1.1 Threat Response Time

70% reduction from alert to ranger deployment (currently reactive to 15 min proactive)

11.1.2 Situational Awareness

100% 24/7 visibility across critical zones (vs limited patrol coverage)

11.1.3 Ranger Safety

60% risk reduction through remote monitoring and early warning

11.1.4 Predictive Accuracy

70%+ accuracy identifying high-risk zones 48 hours in advance

11.1.5 Incident Documentation

100% automated evidence capture vs 50% manual documentation

11.1.6 System Uptime

99% command center availability, 95% edge location availability

11.1.7 Detection Accuracy

95%+ for human/vehicle detection reducing false positives

11.2 Deployment Architecture

11.2.1 Camera Network

30 fixed cameras + 10 PTZ cameras at strategic locations with edge AI processing

11.2.2 Uav Fleet

5 drones (2 command center, 3 field stations) with 4K and thermal capabilities

11.2.3 Acoustic Array

5 sensor locations providing overlapping coverage of high-risk zones

11.2.4 Edge Computing

Intel NUC or NVIDIA Jetson at each camera cluster for local AI inference

11.2.5 Command Center

Centralized facility with video wall, GIS workstations, 24/7 operations

11.2.6 Mobile Component

Ranger app on smartphones for alerts, reporting, and coordination

11.2.7 Integration Layer

APIs connecting to Fleet Management, BI System, Nasera AI, and Gateway

11.3 Ai Model Stack

11.3.1 Computer Vision

YOLO-based object detection for humans, vehicles, wildlife

11.3.2 Classification

Species identification models, vehicle type classification

11.3.3 Behavior Analysis

Anomaly detection, pattern recognition for unusual activities

11.3.4 Predictive Models

Hotspot prediction, risk scoring, temporal pattern analysis

11.3.5 Acoustic Ai

Gunshot detection, vehicle sound recognition, wildlife vocalizations