SmartCity

Telecom Roadmap

PREPARED FOR

CITY OF DOUGLAS

City of Douglas, AZ

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DATE

July 31, 2023

FINAL

Native Network's mission is to
Connect Tribes, Municipalities & Utilities
to **Empower** & **Prosper**.

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DISCLAIMER

Executive Summary

The Telecommunications Roadmap is being submitted by Native Network with the goal of addressing all the deliverables that were laid out in the RFP #IFB-2023-IT-0001 and agreed upon in the associated Professional Service Agreement dated January 31, 2023.

This document was undertaken with the goal of providing all the research, industry knowledge, facts, and data the City of Douglas needs for its planning, funding, and implementation of the recommended telecommunications infrastructure and Smart City initiatives.

The process utilized to formulate the specific recommendations involved 41 in-person stakeholder interviews to understand all the needs, wants and desires for city departments, regional agencies, and community members. In addition, tours of all major facilities and data collection were conducted to develop the current state of the City's infrastructure. A drive test of the City and surrounding areas was conducted to map and analyze the cellular coverage and quality in and around the City. Additionally, we analyzed current network documentation, network plans, existing GIS, existing SCADA, regional expansion plans, downtown corridor requirements, and existing towers and assets. After establishing the baseline of existing capabilities, the Native Network team began to design core infrastructure and engage with manufacturers of various smart applications to determine the best way to leverage existing assets and develop the new complementary network.

Key Recommendations

This section serves as a high-level summary of all strategic recommendations from this Roadmap. The recommendations fall in one of the following categories: governance, network, and phasing.

Governance

It is critical that the governance structure of the City supports the Smart City Plan. City government supplies the direction and oversight for the project, establishes a cross-departmental Smart City Plan Committee, and hires a Smart City Director role.

We recommend that City government utilize climate and community resilience frameworks in all strategic planning and decision-making. One specific framework that supports the integration of resilience planning is the Climate Resilience Framework developed by the federal government; the federal government has highlighted climate and community resilience planning as critical priorities, and incorporating resilience frameworks will not only support Douglas's long-term sustainability but also position it to be more competitive for future funding opportunities.

The City government then establishs the Smart City Committee. This committee creates the final Smart City Plan and provides accountability and oversight as Plan implementation progresses. Deciding what plan elements should be included and how to evaluate and prioritize potential plan focus areas are integral roles of this committee. It creates a funding evaluation/prioritization guide to assess potential funding opportunities and determines the types of funding for each phase of the Smart City Plan. The Smart City Plan Committee generates buy-in and understanding of the Plan amongst all city departments and the community.

The Smart City Director is the facilitating member of the Smart City Committee and is the subject matter expert for all elements of the Smart City Plan. The Director identifies, evaluates, and pursues funding opportunities with the support of various stakeholders. It is critical that the Smart City Director stay up-to-date on Smart City advancements and continues to re-evaluate the Plan, looking for opportunities and optimizations as it progresses. This role fosters public/private partnerships and communicates with stakeholders to bring the Smart City Plan to fruition.

Proposed Network

The Telecommunications Roadmap Project designed for the City of Douglas prioritizes a highly-reliable, scalable, and secure infrastructure to support the City's Smart City initiatives for 25-30 years. This is consistent with the Douglas Vision 2032 strategic plan.

The network design incorporates various components, including transport fiber optic cable, microwave backhaul, and both fixed wireless access (FWA) and Private LTE (P-LTE) systems. Standard Ethernet switching and routing ensures seamless connectivity between the network elements, high-speed data transfer, efficient network management, and robust security are embedded into the network. The Smart City infrastructure is supported by a robust software package provided by Aveva, a Schneider Electric company. The suite of software includes all facets to manage utilities such as water and wastewater, as well as a full range of complementary Smart City functions.

Fiber optic cables are capable of virtually unlimited speed and capacity, with low latency. Typical connection speeds for fiber are up to 100Gbps. Fiber optic cables are the most expensive type of connectivity, however, due to high resilience and the other aforementioned benefits, are preferred whenever feasible.

Microwave systems connect remote locations, like towers, into the network at 10Gbps speeds and can be deployed more cost-effectively and more quickly than fiber optics. The microwave systems are designed to 99.999% reliability due to carrier-grade, multi-frequency technology.

The fixed wireless access (FWA) network provides low cost, high-speed connections to city-owned buildings and targeted locations. The fixed wireless sites are deployed at the towers to ensure up to 1Gbps connections using unlicensed frequencies.

Private LTE, also deployed on the city towers, provides a range of services, including voice and data mobility and IoT applications. The network uses licensed frequency to ensure stability and reliability. The network is the primary interface to the SCADA/IIoT/IoT sensor networks, with thousands of potential connections per site. The Private LTE network provides voice and data capabilities city-wide, including annexed and remote locations such as the New Port of Entry.

Networking equipment is standards-based using common Ethernet protocols. This allows inter-networking between all the proposed technologies as well as existing equipment in the City's current network. The proposed equipment offers higher capacity, scalability and advanced protocols, allowing the network to meet needs for 5-10 years before potential equipment refresh; a refresh may be desired to take advantage of new technology or performance gains.

Phasing

The recommended solutions have been developed in phases based on foundational/core assets, the need/want/desire capabilities identified by the City's stakeholders, and the anticipated funding requirements and capabilities. The 3 phases were then arranged by geographic zones in the city, referred to: 1) Downtown Corridor and SCADA, 2) City-Wide and 3) Annex-Regional. The phases will realistically take approximately 10 years to fund and implement, providing the City with a robust and detailed plan for the foreseeable future. The following pages give key statistics for each phase along with the corresponding infrastructure and component maps for further visualization of the impacted locations.

Phase 1 – Downtown Corridor & SCADA

This phase includes G Avenue and the main business corridor. This is the most visible portion of the City from a local business perspective and will have the most impact quickly. SCADA affects a larger area; however, it is a fundamental component of the Smart City, so it is included in this phase.

HIGHLIGHTS	DETAILS & INFORMATON
Timeline	2024-2026
Network Infrastructure	Fiber conduit, SCADA, upgrade water towers, fixed wireless, Private LTE, Smart Poles
Smart Applications	Public WiFi, Smart Lighting, EV Charging, Security Cameras, Smart Billboards, Waste Management, Water Management, Smart Transportation, Traffic Management
Capital Expenditure Cost	**$5,627,684.10**
Revenue Opportunities	Land lease, water tower lease, Public WiFi
Operating Expenses	Smart City Director, implementation, and grant writing consulting
Funding Options	Annual capital budget, Remaining un-allocated ARPA funds
Financial Highlights	Limited revenue from 2 water towers, reduced telecom costs, additional expenses for staffing and continued consulting
Key Benefits	Improved Internet to government buildings, water management compliance, citizen and visitor access to public WiFi, improved communication and safety, and EV Charging

Phase 2 – City-Wide

The city-wide phase includes the remainder of the city limits, including the airport. This phase incorporates fiber networking, wireless services, and most Smart City applications.

HIGHLIGHTS	DETAILS & INFORMATON
Timeline	2027-2029
Network Infrastructure	4 new towers, additional fiber conduit, fixed wireless, Private LTE, SmartPoles
Smart Applications	Geographical expansion - Public WiFi, Smart Lighting, EV Charging, Security Cameras, Smart Billboards, Waste Management, Water Management, Smart Transportation, Traffic Management
Capital Expenditure Cost	**$8,227,172.31**
Revenue Opportunities	Tower space, Private and Public WiFi, EV Charging
Operating Expenses	Additional staff dedicated to software integration and data analysis, annual licensing and maintenance for network equipment and smart applications
Funding Options	Federal, state, philanthropic, such as T-Mobile's Hometown Grants Program, competitive grants, bonds
Financial Highlights	Additional revenue from mobility carriers for tower space
Key Benefits	City parks receive all the Smart City capabilities rolled out in Phase 1

Phase 3 – Annex-Regional

This phase includes the proposed and potential annex areas as identified by the City's management team. This also covers regional interests, that are not potential annexation targets but are important to the region. An example maybe the transportation corridor and connectivity between the City and Cochise College.

HIGHLIGHTS	DETAILS & INFORMATON
Timeline	2030-2032
Network Infrastructure	Additional fiber conduit, fixed wireless, Private LTE, SmartPoles
Smart Applications	Geographical expansion - Public WiFi, Smart Lighting, EV Charging, Security Cameras, Smart Billboards, Waste Management, Water Management, Smart Transportation, Traffic Management
Capital Expenditures	**$8,317,208.20**
Revenue Opportunities	Conduit, increased footprint for Private and Public WiFi, EV Charging and SmartPoles
Operating Expenses	Increased annual licensing and maintenance for increased network equipment and smart applications for geographical expansion.
Funding Options	Federal, state, and philanthropic competitive grants, bonds, revenue bonds
Financial Highlights	Additional revenue from carriers for fiber conduit
Key Benefits	Annex areas receive all the Smart City capabilities rolled out in Phase 1

Each phase is dependent upon funding availability; however, it is estimated that it will take 2-3 years to complete each phase, from securing funding to full implementation. There is some degree of overlapping of phases to be expected. Core infrastructure is the key driver for the timeline, with applications following an as-needed approach.

It is important to note that ongoing reviews of the Smart City Plan should be conducted to revise phasing and application rollout to accommodate the needs of the City. An annual report is recommended, drafted by the Smart City Director for stakeholder committee review.

10 Year Financial Snapshot

Below are the capital expenditures, revenue, and operating expenses by phase. Revenue has been modeled conservatively. There is room to increase the number by adding EV charging, based on a needs assessment and traffic study, and additional fiber conduit sales in Phase 3.

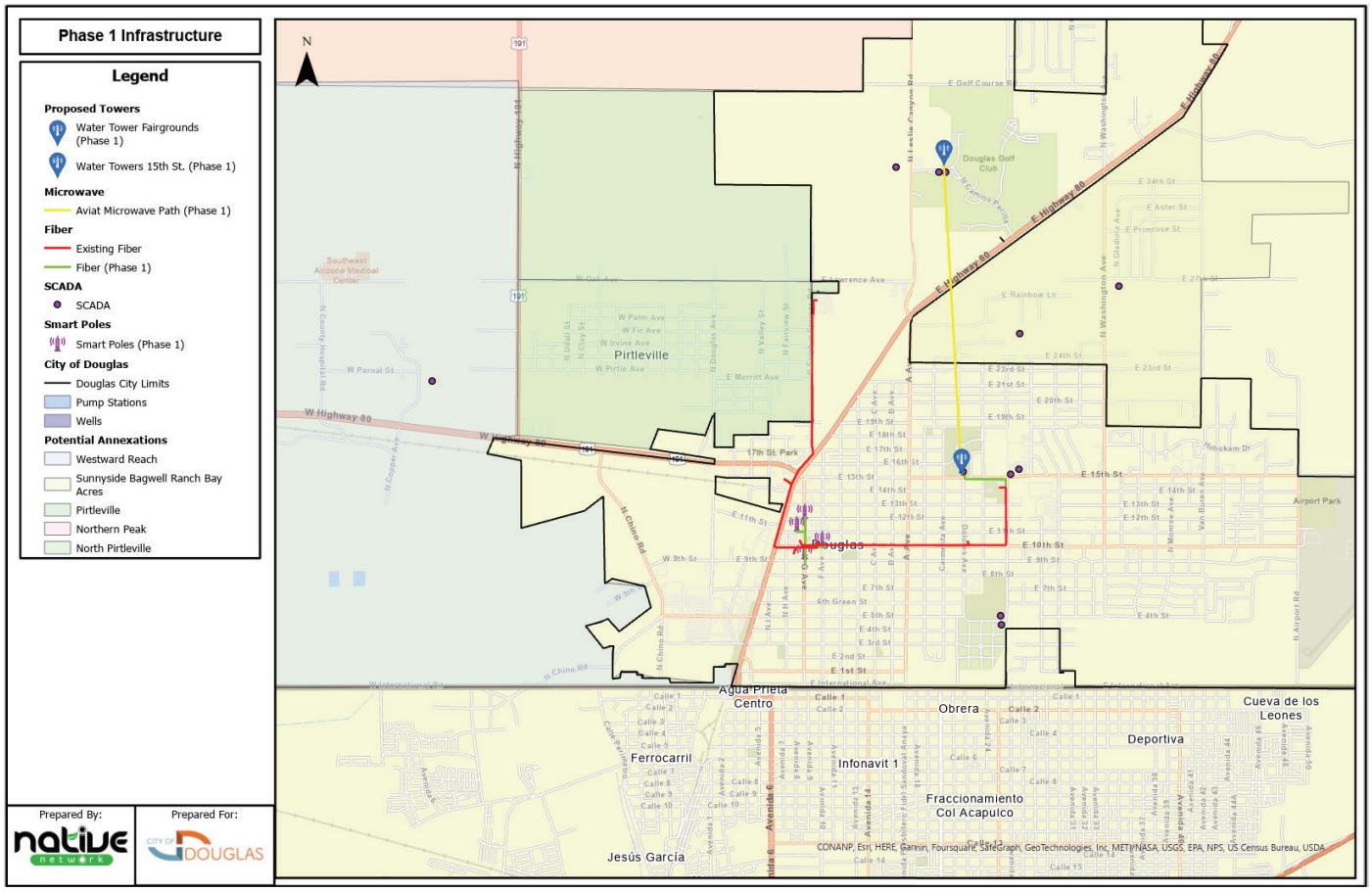
HIGH LEVEL	PHASE 1	PHASE 2	PHASE 3	TOTAL BY TYPE
PHASE TIMELINE	2024-2026	2027-2029	2030-2033	
Capital Expenditure Totals	**$5,627,684.10**	**$8,227,172.31**	**$8,317,208.20**	**$22,172,064.60**
Revenue Totals	$371,800.00	$941,700.00	$2,429,600.00	$3,743,100.00
Operating Expense Totals	$460,800.00	$1,909,318.73	$3,183,005.52	$5,553,124.25
NET INCOME:	**($89,000.00)**	**($967,618.73)**	**($753,405.52)**	**($1,810,024.25)**

As the CIty transitions over time, it is important to remember that return on investment for Smart City initiatives must be measured in an non-traditional way, incorporating the cost benefits and positive impact on the overall economy as follows:

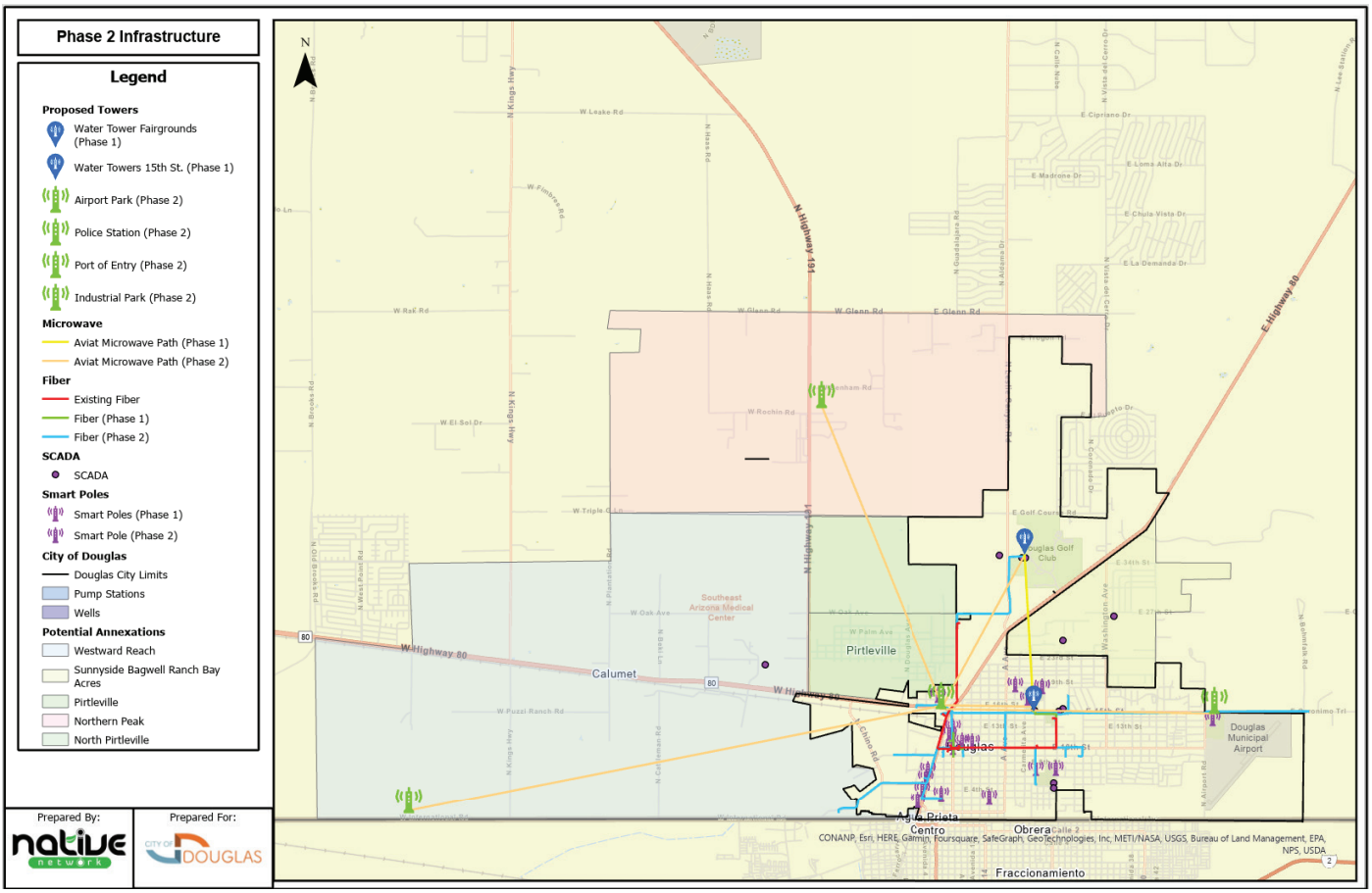
1. **Efficiency:** Smart technologies lead to efficient resource use, which can result in cost savings in utilities like water, energy, and waste management.
2. **Maintenance & Repair Costs:** IoT and other smart technologies can predict maintenance needs, reducing unexpected repair costs and prolonging the lifespan of infrastructure.
3. **Increased Productivity:** Improved connectivity and services can enhance productivity and thus potentially increase economic growth and tax revenues.
4. **Tourism:** Smart cities often attract tourists, which can create a new source of income.

The financial snaphot corresponds with the phasing recommended in this documents and utilizes the dependencies for implementation while allowing the maximum flexibility to integrate Plan elements according to funding availability and City priorities. The structure of the proposed network emphasizes a core network infrastructure that enables the City to layer on various Smart City applications and realize substantial benefits for the City and its citizens. To realize long-term sustanability and increased funding opportunities, it is crucial that the CIty adopt reslience paradigms for decition-making.

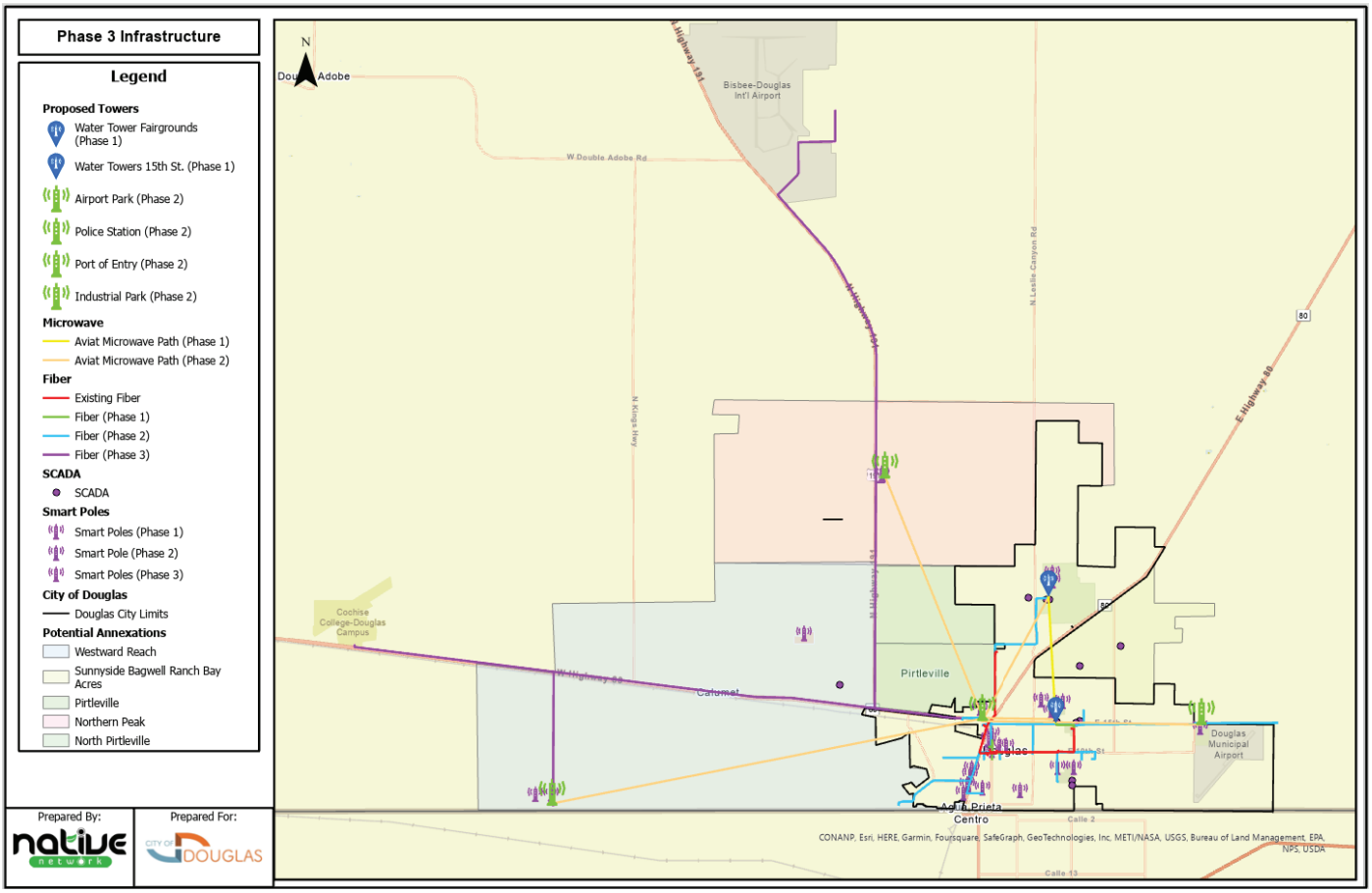
Infrastructure maps include proposed locations of towers, SCADA, and SmartPoles along with the routes for fiber, and microwave backhaul. The phased implementation begins in the downtown corridor, expands to the city limits, and finally reaches the potential annex areas as the City inevitability expands. The infrastructure is the backbone for the Smart City applications.



Map of Phase 1 - Downtown Corridor & SCADA - Infrastructure Design



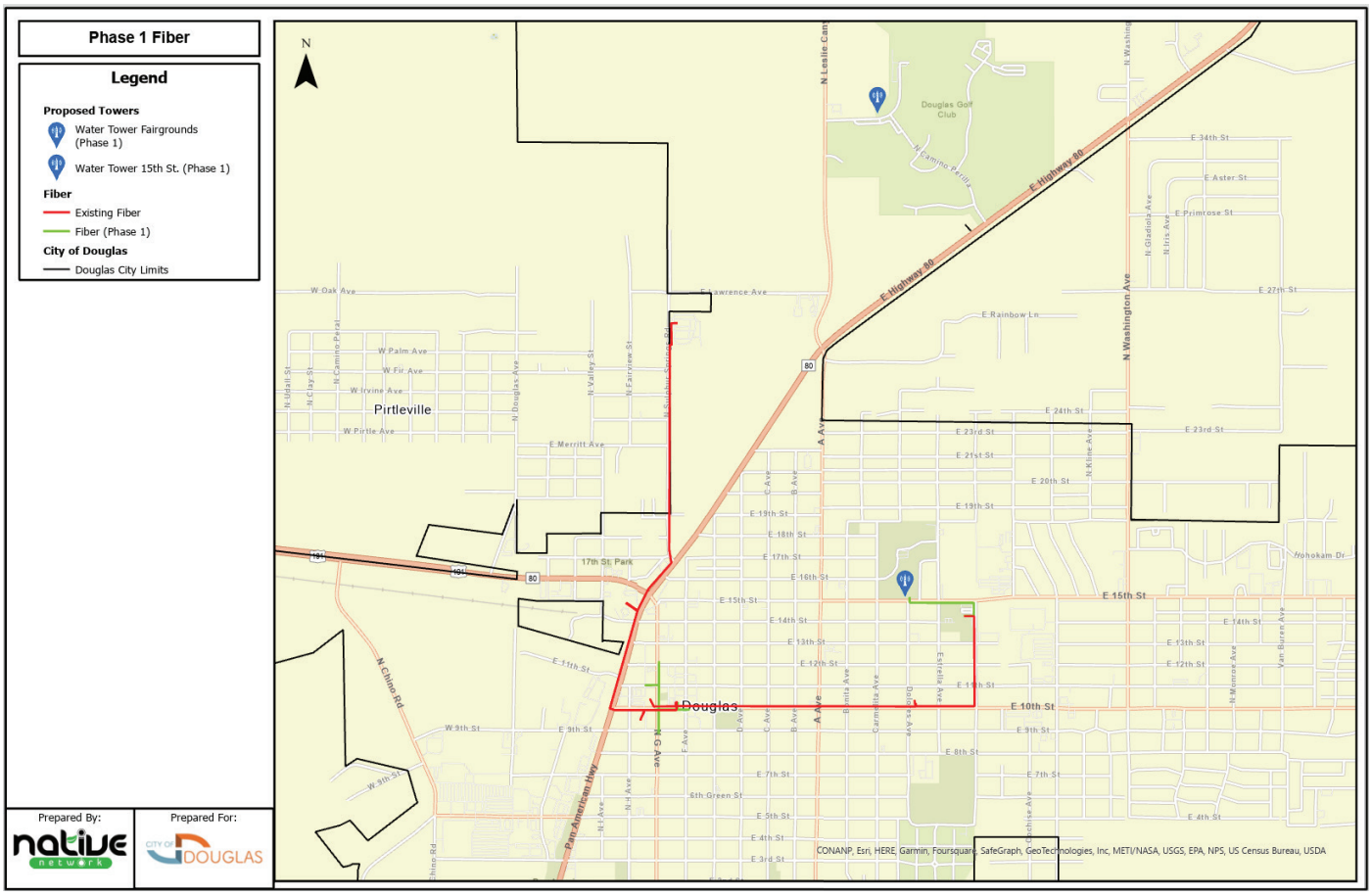
Map of Phase 2 - City-Wide - Infrastructure Design



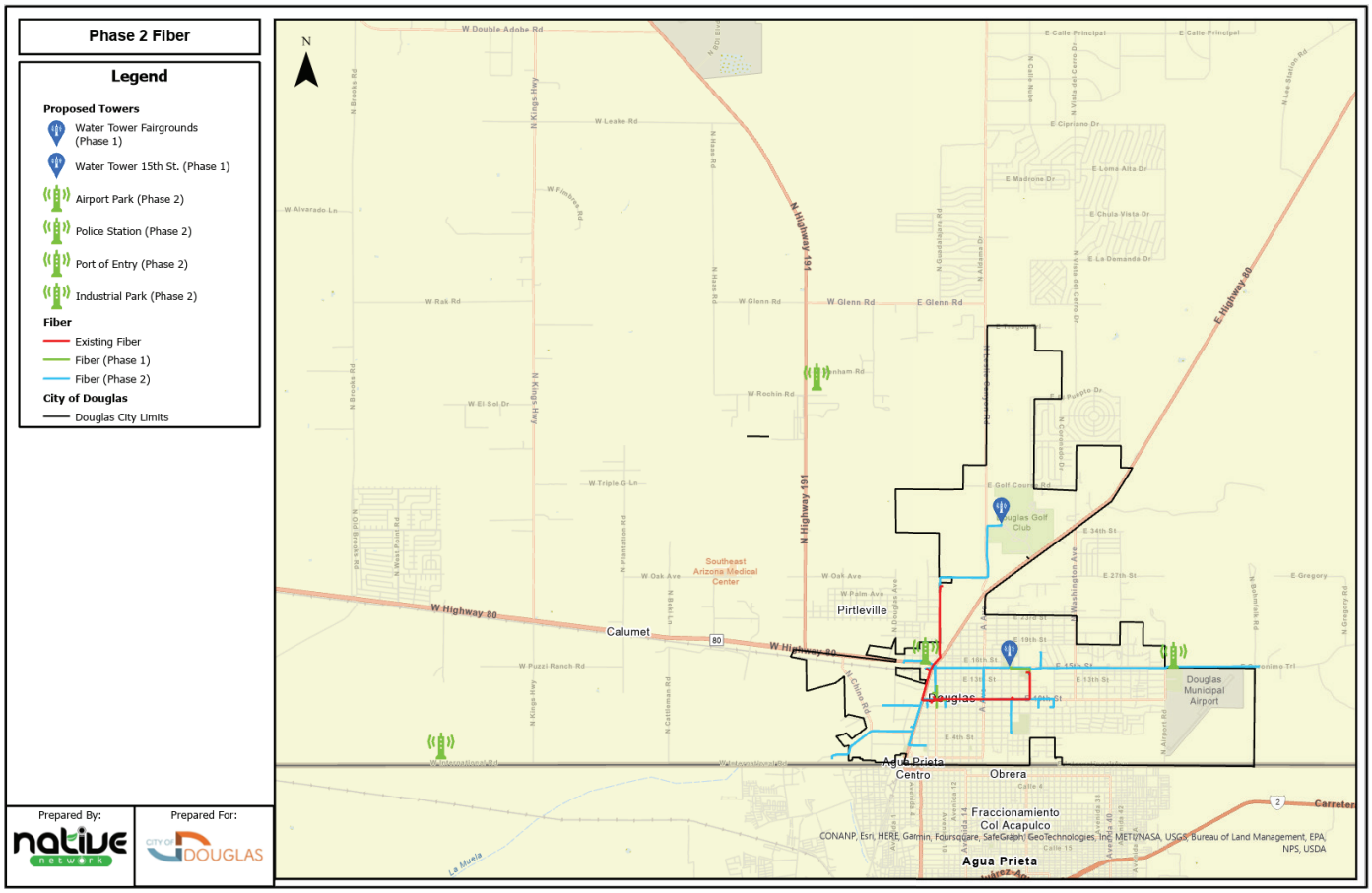
Map of Phase 3 - Annexed-Regional - Infrastructure Design

The specific **Fiber Optic** Infrastructure to be constructed in each phase is provided below.

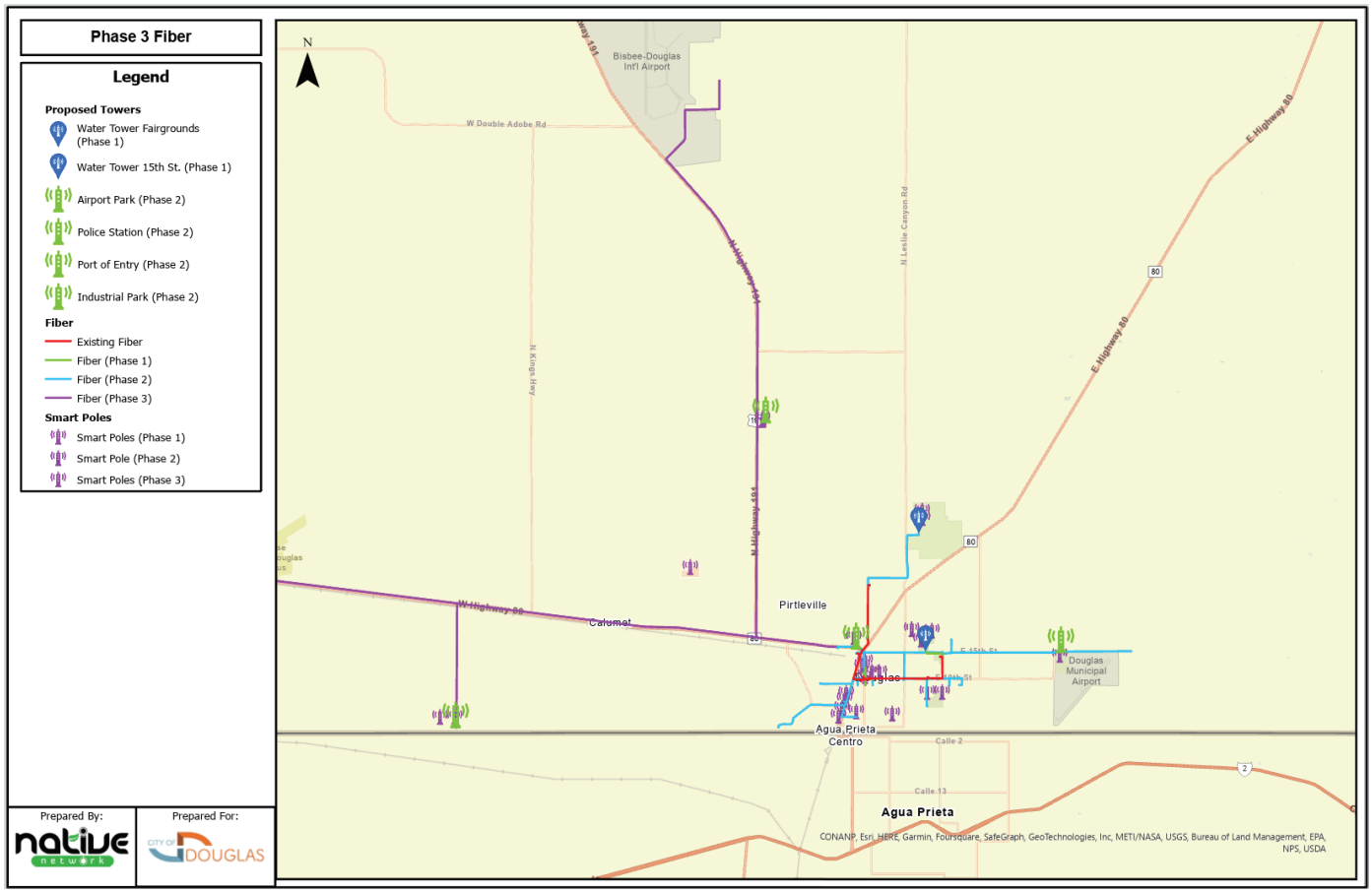
The fiber maps show the routes for fiber and conduit through the various phases in the infrastrucutre development of the City. The fiber will be used as the City's high-speed transport network capable of symmetrical 1Gbps upload/download speeds and scalable to 10Gbps in the future.



Map of Phase 1 - Fiber - Infrastructure Design



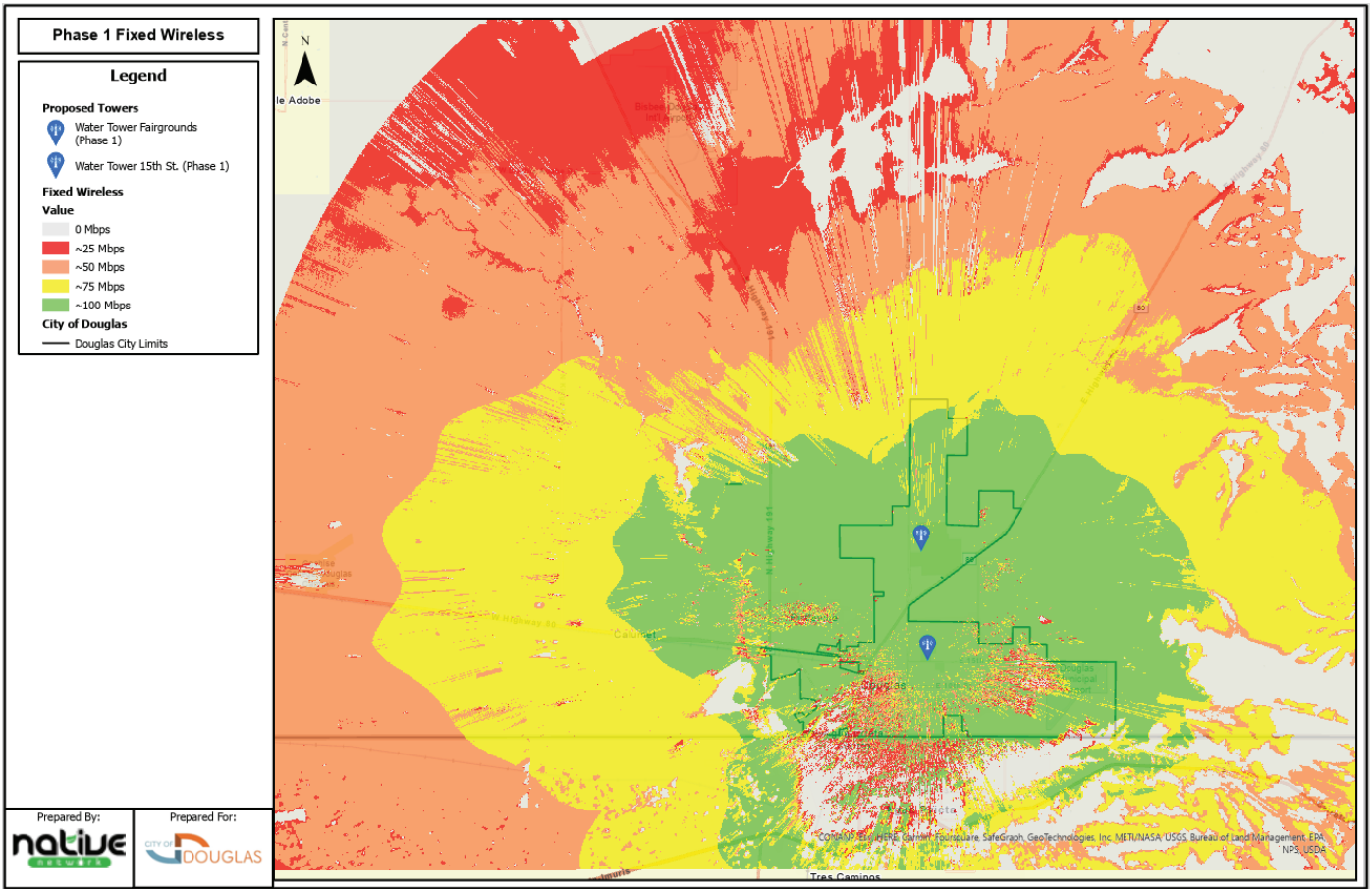
Map of Phase 2 - Fiber - Infrastructure Design



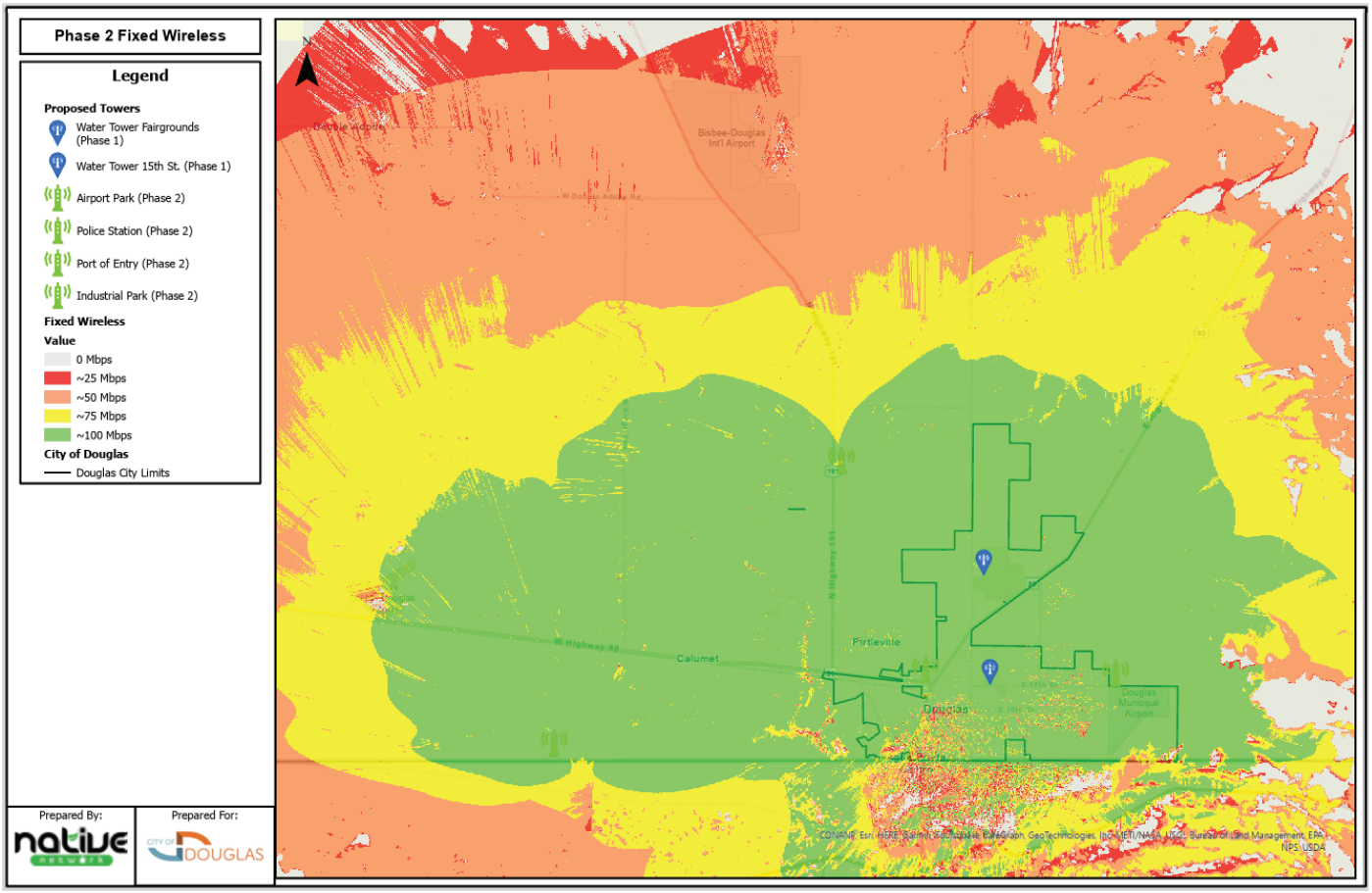
Map of Phase 3 - Fiber - Infrastructure Design

The specific **Fixed Wireless** infrastructure to be constructed in each phase is provided below. All Fixed Wireless to be completed by end of Phase 2.

The Fixed Wireless maps display the power of the radio frequency received (RSRP) throughout the map; this has been calculated into throughput in megabits per second (Mbps)(i.e. bandwidth available for data transfer).



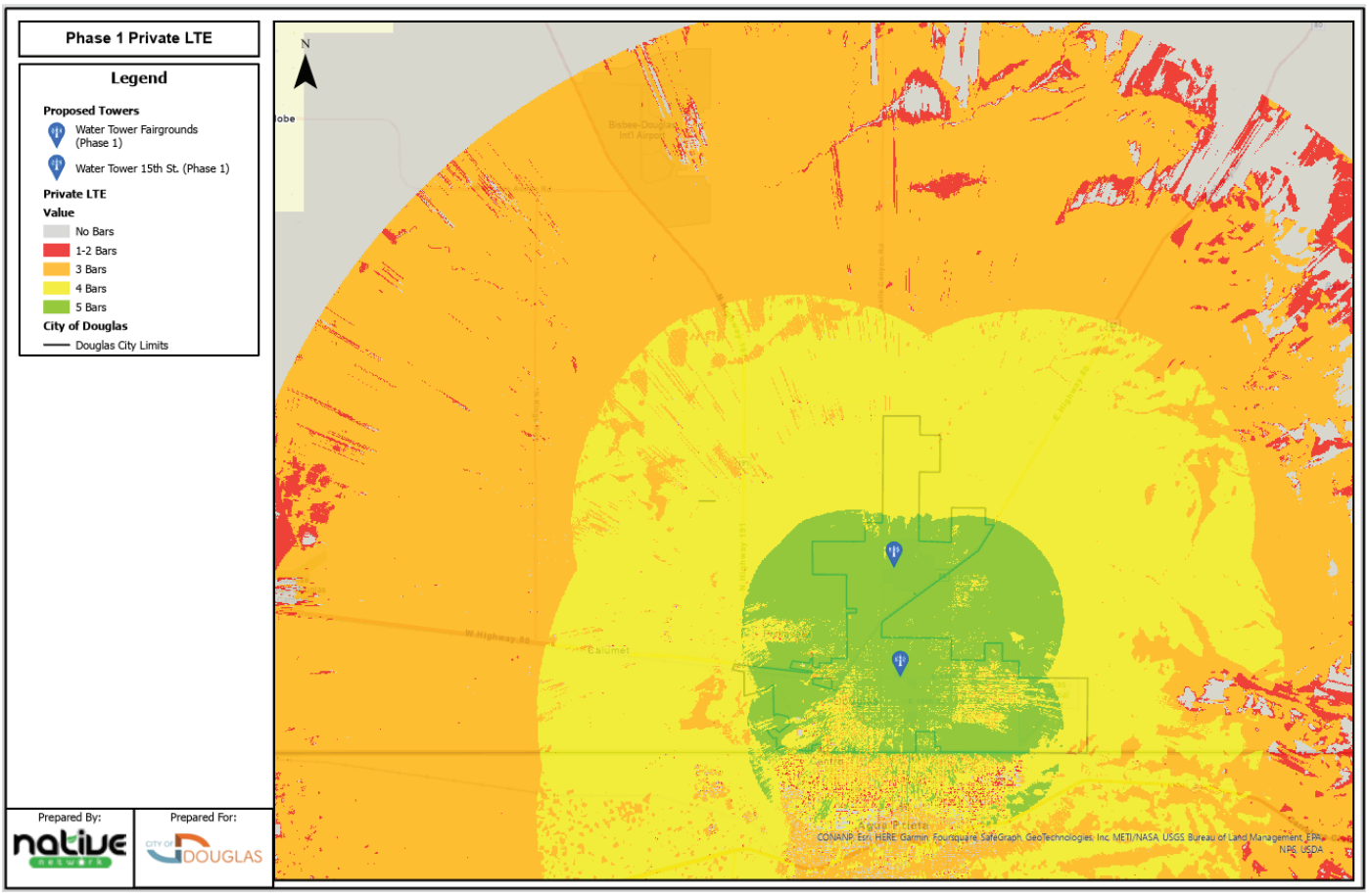
Map of Phase 1 - Fixed Wireless - Infrastructure Design



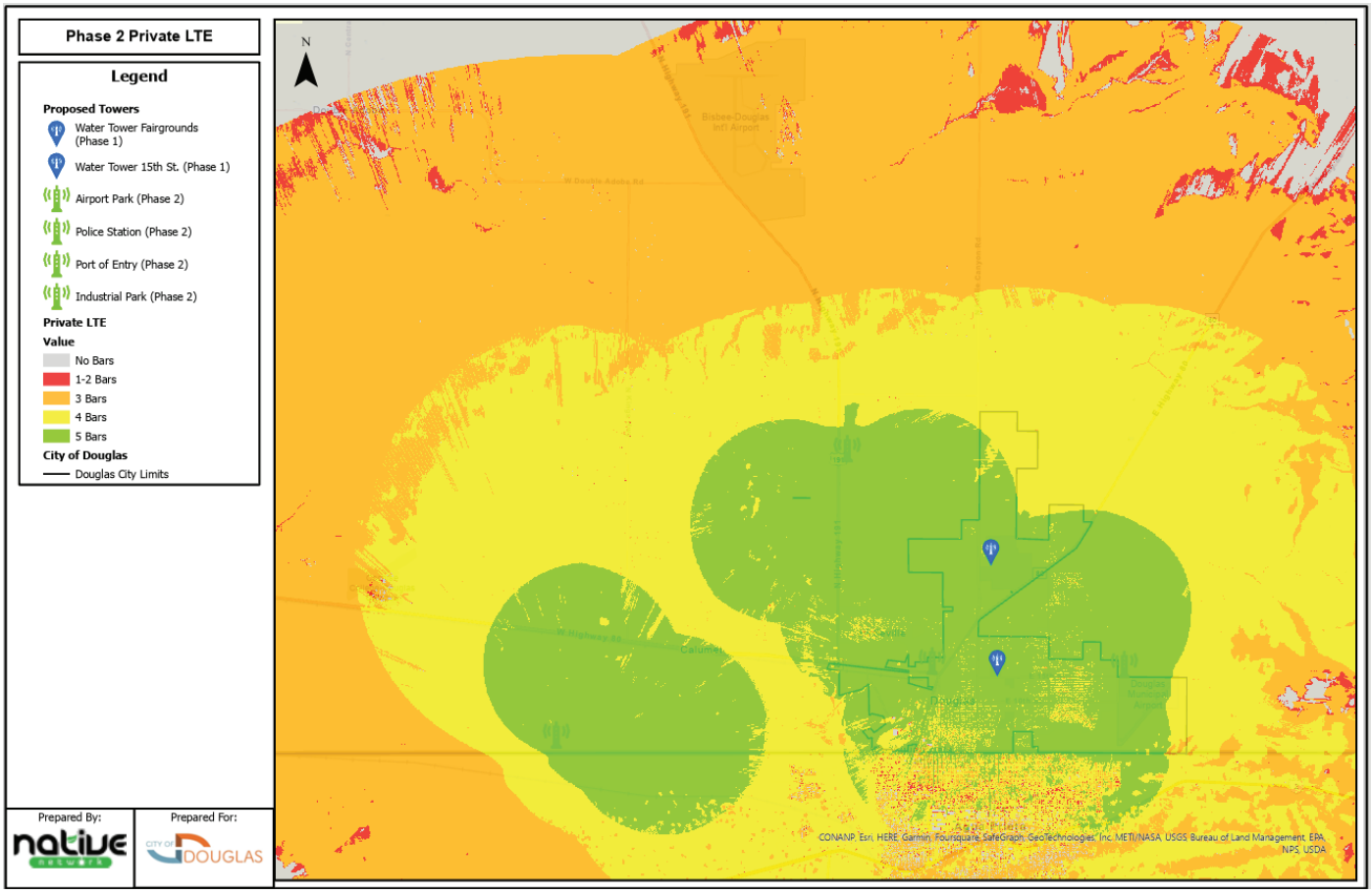
Map of Phase 2 - Fixed Wireless - Infrastructure Design

The specific **Private LTE** Infrastructure to be constructed in each phase is provided below. By the end of Phase 2 all initial 4G Network is complete. Phase 3 adds 5G functionality to entire coverage area.

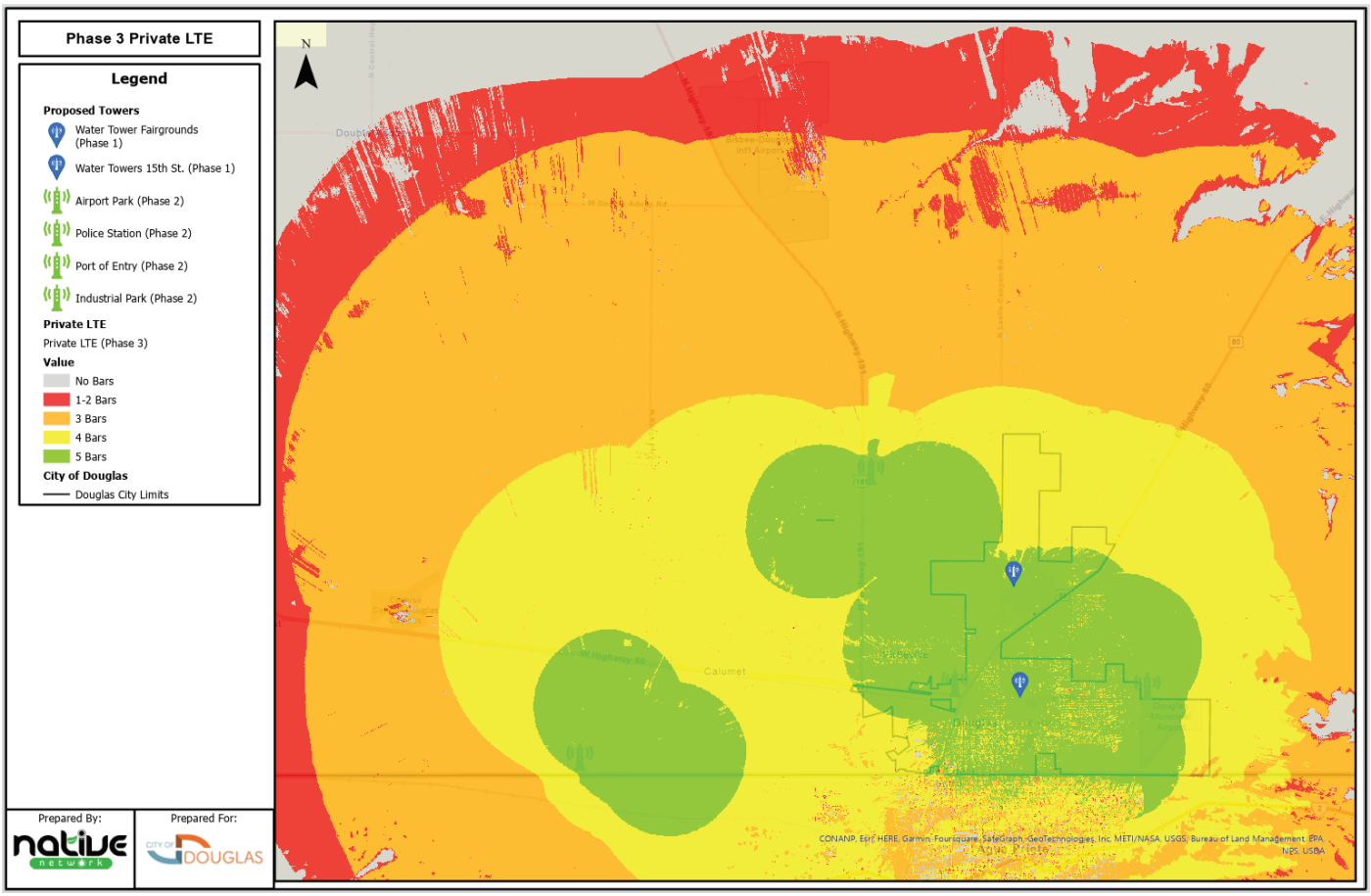
The Private LTE maps display the power of the radio frequency received (RSRP) throughout the map; this has been shown in number of bars you would find on your cellular device.



Map of Phase 1 - Private LTE - Infrastructure Design

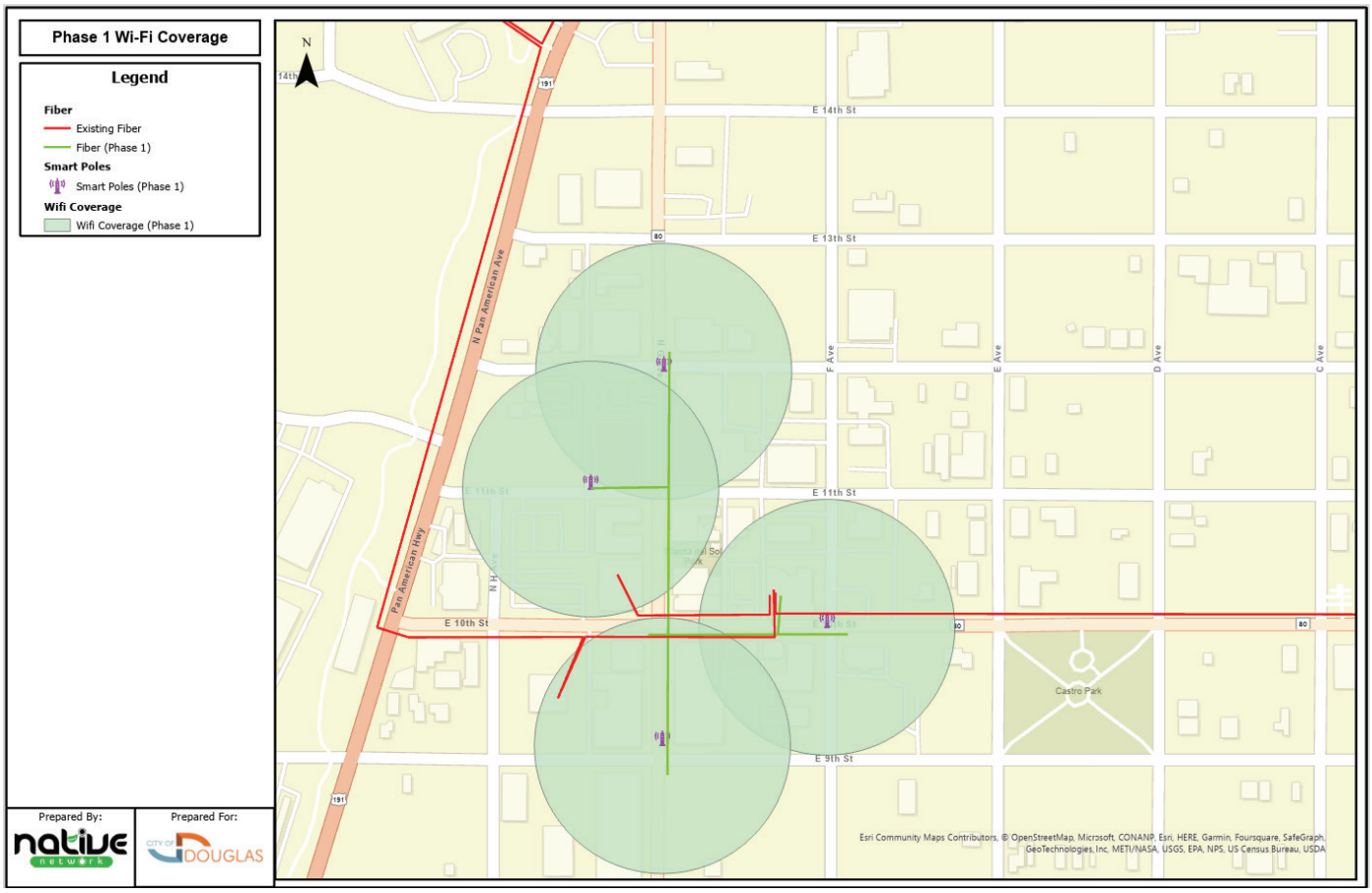


Map of Phase 2 - Private LTE - Infrastructure Design

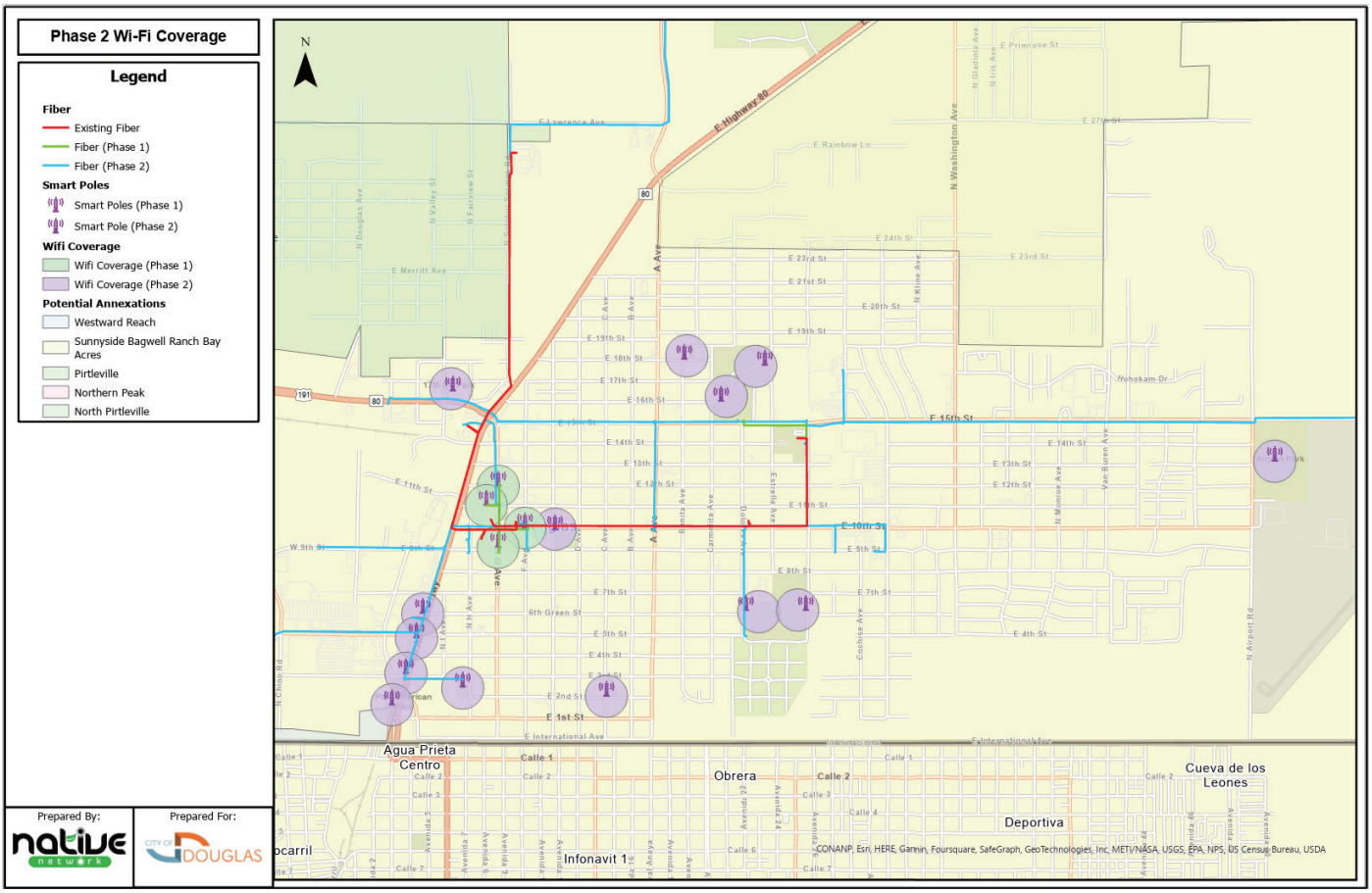


Map of Phase 3 - Private LTE - Infrastructure Design

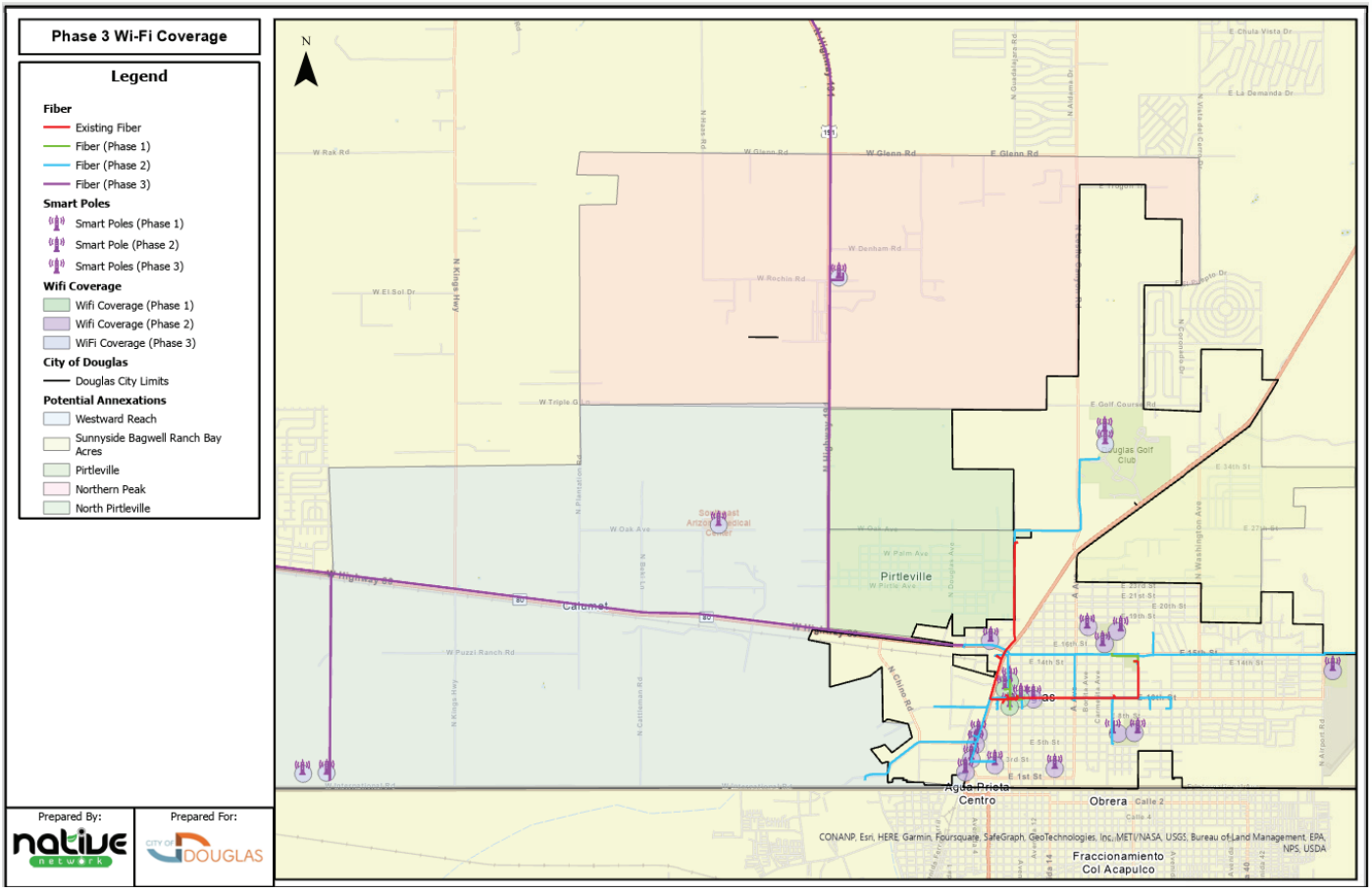
The **public Wifi** Infrastructure to be constructed in each phase is provided below. The technology corresponds with the placement of SmartPoles within the region.
The public WiFi maps display the estimated coverage each node is capable of broadcasting.



Map of Phase 1 - WiFi Coverage - Infrastructure Design



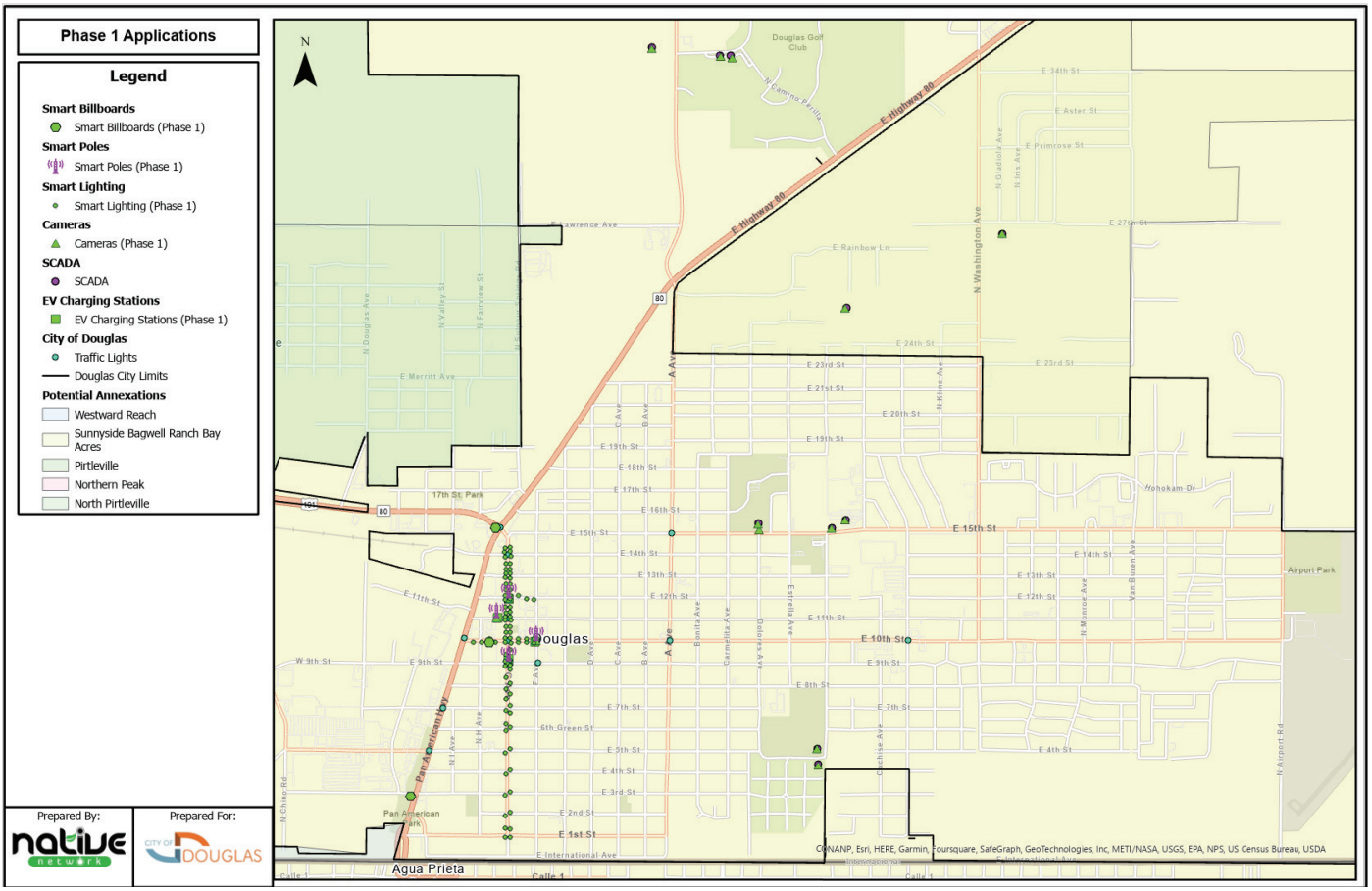
Map of Phase 2 - WiFi Coverage - Infrastructure Design



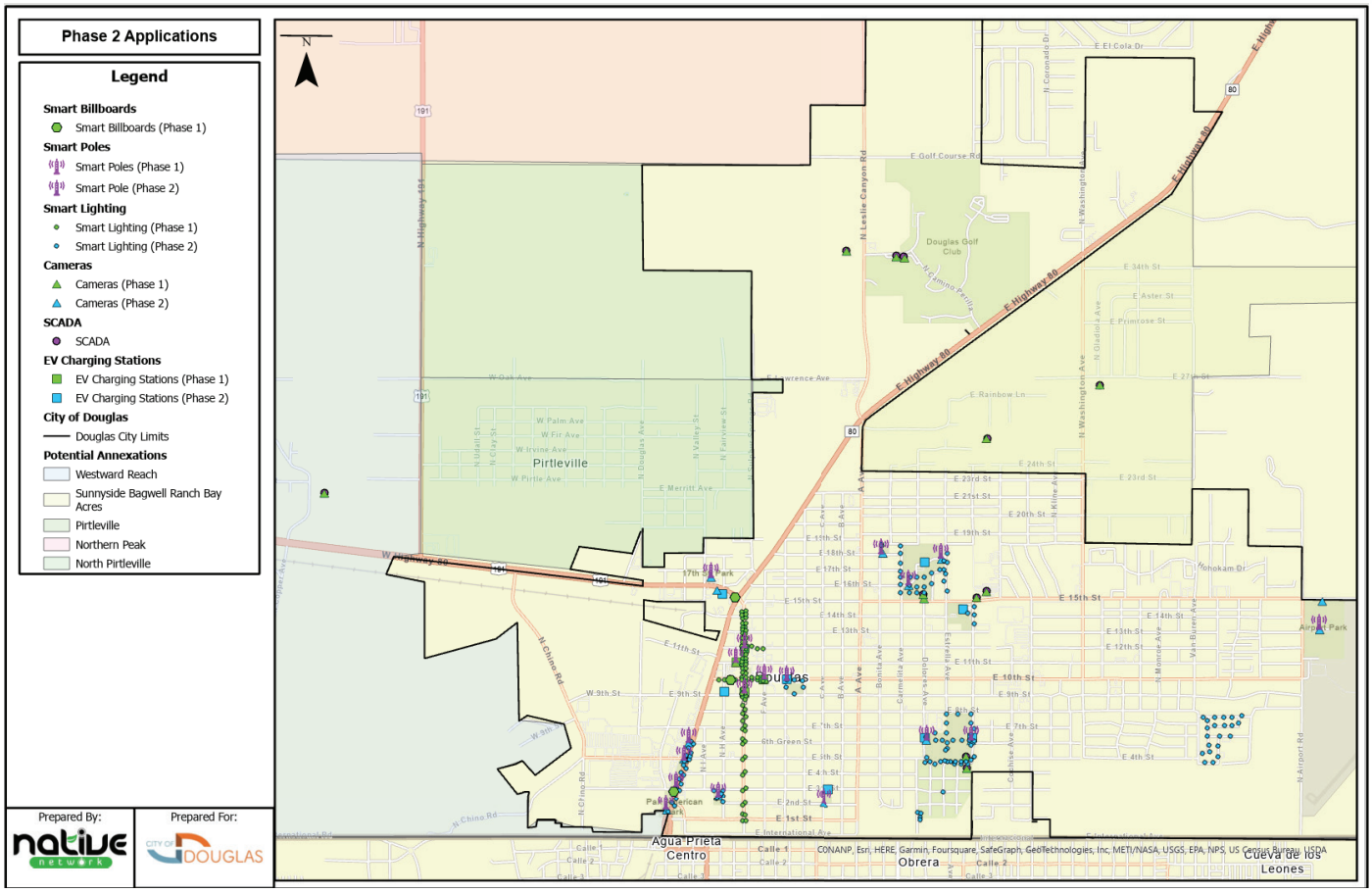
Map of Phase 3 - WiFi Coverage - Infrastructure Design

Smart Applications are rolled out progressively as the phases proceed. The most intense phase is Phase 1 where most of the application incorporation occurs. Installing on servers, programming and integration require significant resources. The second and third phases of the Telecom Roadmap increase the footprint of the original applications. Some applications are introduced in Phase 2 to take advantage of the City's capacity to provide these additional services. It is important to note that application selection was limited to those most popular with smaller cities. There are hundreds of additional Smart City applications that can be introduced to take advantage of the new infrastructure.

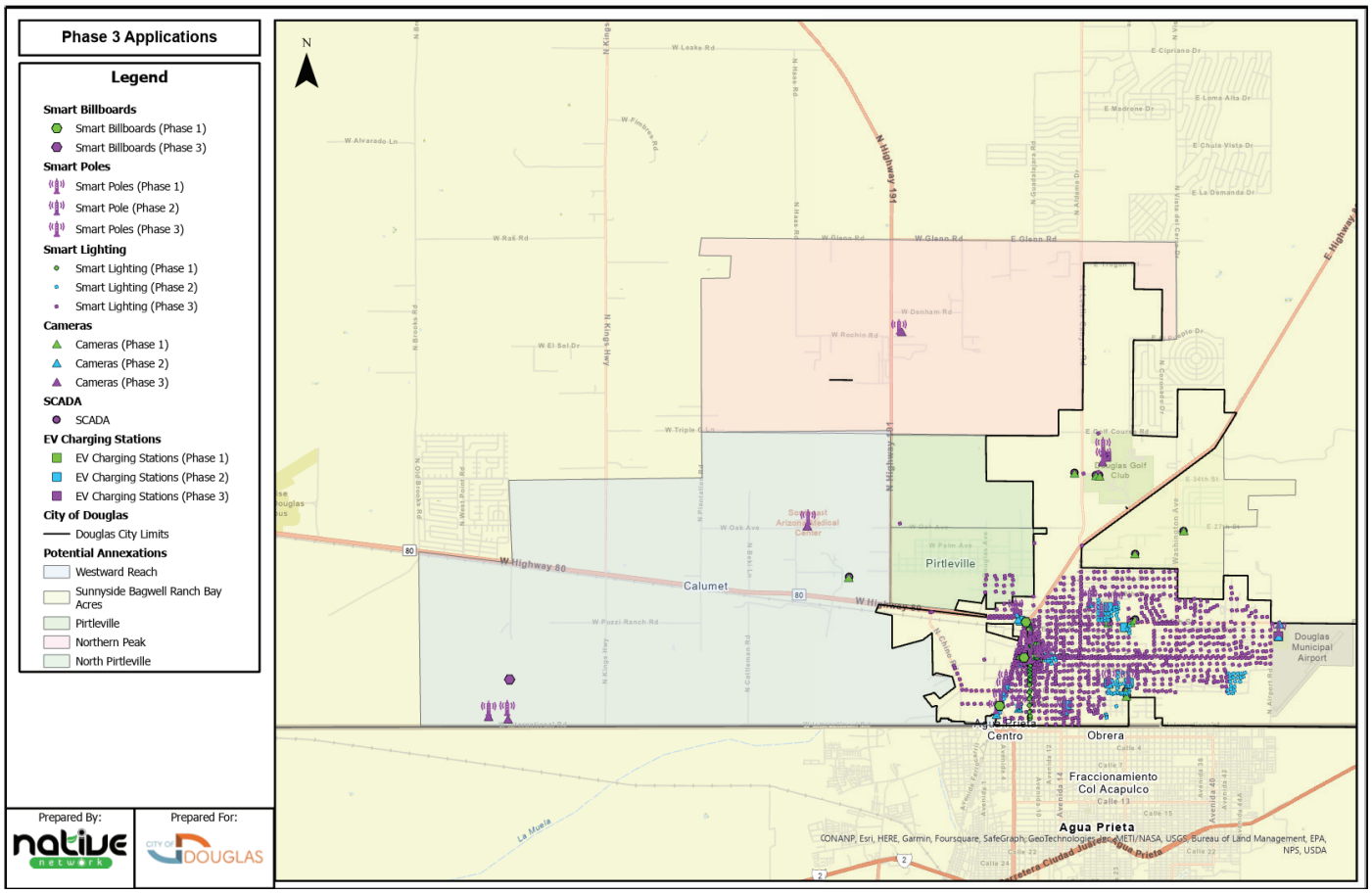
Application maps include proposed locations of smart billboards, smart lighting, EV chargers, and smart surveillance. The phased implementation begins in the downtown corridor, expands to the city parks, and finally reaches the potential annex areas as the City inevitability expands. The applications are the components of the Roadmap that will provide the community with the community the most perceptible benefits.



Map of Phase 1 - Smart Applications



Map of Phase 2 - Smart Applications



Map of Phase 3 - Smart Applications


SMART APPLICATIONS
Smart City Surveillance
• Video surveillance systems with real-time monitoring and analytics.
• Emergency response systems for rapid incident detection and response.
• Predictive analytics for crime prevention and proactive policing.
• Public alert systems for timely communication during emergencies.
Smart Lighting
• Utilize energy-efficient LED bulbs, reducing energy consumption & lowering electricity costs.
• Incorporate features like motion sensors or surveillance cameras, improving safety.
• Flexible programming options to adjust lighting schedules, dimming levels, or color temperature.
• Collect data on energy usage, maintenance needs, & performance metrics.
Smart Traffic Management
• Real-time traffic monitoring & analysis for optimized traffic flow.
• Adaptive signal control systems to reduce congestion & improve intersection efficiency.
• Intelligent transportation management centers for incident detection & response.
• Traffic violation detection & enforcement through automated systems.
Smart Parking
• Real-time information on available parking spaces.
• Minimizes unnecessary circling for parking, reducing traffic congestion in the city.
• Make cashless payments, & receive notifications or reminders through mobile apps or digital signage.
• Automated monitoring & management helps streamline operations & enforce parking regulations effectively.
EV Charging Stations
• Infrastructure for electric vehicle (EV) charging in public and private spaces.
• Fast-charging stations to reduce charging time and support long-distance travel.
• Mobile applications for locating and reserving EV charging stations.
• Payment systems and authentication for secure and convenient charging transactions.
• Integration with renewable energy sources for sustainable and clean charging solutions.
• Real-time monitoring of charging station availability and status.
Smart Public Transportation
• Optimize bus routes based on real-time traffic data, passenger demand, & other factors, improving operational efficiency & reducing travel times.
• Real-time updates on bus schedules, arrival times, & route changes through mobile apps, digital signage, etc.
• Enable contactless payment methods, such as mobile ticketing or smart cards, reducing transaction times.
• Generate data on ridership, bus utilization, & performance metrics.
Smart Enviro Monitoring
• Real-time monitoring of air quality, water quality, and noise levels.
• Sensor networks for data collection and analysis to support environmental management.
• Early detection of pollution sources and proactive measures for mitigation.
• Data-driven decision-making for sustainable resource management and conservation.
• Integration with emergency response systems for timely environmental incident management.
Smart Waste Management
• Sensor-based waste bin monitoring for optimized waste collection routes.
• Real-time fill level data to reduce overflowing bins and improve efficiency.
• Smart bin compaction systems for increased waste capacity and reduced collection frequency.
• Smart litter sensors to detect and alert about littering hotspots.
• Integration with citizen reporting platforms for efficient waste management and response.
Smart Governance & Citizen Services
• Digital platforms for transparent & accessible government services.
• Citizen engagement tools to foster participatory decision-making.
• Open data initiatives for sharing government information & promoting transparency.
• Online service portals for convenient access to public services & permits.
• Smart city dashboards for real-time monitoring & reporting of city performance.
• Citizen feedback mechanisms to address concerns & improve service delivery.
Smart Integration, Edge Analytics & AI
• Seamless integration of various smart city components, systems, & data sources, ensuring interoperability & smooth operation across multiple applications & platforms.
• Data processing & analysis closer to the data source, allowing real-time insights & decision-making.
• Minimize latency, enhances responsiveness, & improves efficiency.
• Leverages AI algorithms & machine learning techniques to process & analyze data in real-time, enabling immediate action & response to changing conditions or events.
• Analyze historical & real-time data to identify patterns, trends, & anomalies, enabling predictive analytics for proactive decision-making & problem-solving.
• Optimize all city operations, leading to improved efficiency, cost savings, & better service delivery.
• Accurate, data-driven decision support, enabling informed choices for infrastructure planning, resource allocation, & policy formulation.
• Development of personalized & context-aware smart services, tailoring experiences & offerings to individual residents & businesses.
• Continuous learning & improvement & adapting to evolving needs & changing conditions.
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Applications & Infrastructure with Phasing
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native network
July, 2023
1 PHASE 1 2 PHASE 2 3 PHASE 3
Fiber
• High-speed and reliable internet connectivity, enabling fast data transfer and supporting various smart city applications.
• Enhanced communication infrastructure for seamless connectivity between different smart city systems, improving efficiency and collaboration.
• Scalable and future-proof network architecture, accommodating the growing demand for data and supporting future technological advancements.
Fixed Wireless
• Broadband connectivity to underserved areas of Douglas, ensuring equitable access to high-speed internet for residents and businesses.
• Rapid deployment and cost-effective solution for extending network coverage and bridging the digital divide in remote or challenging terrain.
• Flexible and scalable connectivity option, providing reliable wireless connectivity for smart city applications such as smart parking, surveillance, and environmental monitoring.
Microwave Backhaul
• Reliable and high-capacity connectivity for transmitting data between smart city devices, enabling seamless integration and communication.
• Low-latency and high-speed data transfer, supporting real-time applications and minimizing delays in data transmission.
• Robust and resilient network infrastructure, ensuring continuous connectivity even in adverse weather conditions or challenging environments.
SCADA
• Centralized monitoring and control of critical infrastructure systems such as water supply, wastewater management, and energy distribution, improving efficiency and response times.
• Real-time data collection and analysis for proactive maintenance and predictive modeling, optimizing resource allocation and reducing operational costs.
• Enhanced security and risk management, detecting anomalies and potential threats to critical infrastructure, ensuring uninterrupted service delivery.
Private LTE
• Dedicated and secure communication network for city services and operations, ensuring reliable and fast connectivity for smart city applications.
• Support for mission-critical applications and real-time data transmission, enabling efficient emergency response and public safety measures.
• Increased capacity and coverage for high-demand areas, accommodating the growing number of connected devices and supporting future smart city expansions.
Smart Poles
• Integrated connectivity and infrastructure for multiple smart city applications such as lighting, environmental monitoring, and surveillance, reducing clutter and optimizing resource utilization.
• Wireless connectivity options, including Wi-Fi and 4G/5G, providing seamless connectivity for residents, businesses, and IoT devices.
• Efficient use of public space by housing multiple services and technologies in a single pole, enhancing aesthetics and urban design.
Vertical Assets
• Extended coverage and connectivity for the city of Douglas, ensuring reliable communication and data transfer across the entire city area.
• Support for additional smart city applications and services, enabling the deployment of new technologies and expanding the capabilities of the smart city infrastructure.
• Increased capacity and network resilience, accommodating the growing demand for data and ensuring uninterrupted connectivity for residents, businesses, and public services.
SMART INFRASTRUCTURE

Next Steps for City of Douglas

FUNDING TYPE	STATUS, DETAILS & COMMENTS
Within 30 days:	• Circulate the Telecom Roadmap to all key stakeholders for review
Within 60 days:	• Provide a formal opportunity for key stakeholders to ask questions about the Telecom Roadmap • Establish members of the Smart City Plan Committee • Prepare and publish SCADA Request For Bid (RFB)
Within 120 Days:	• Hire Smart City Director (or interim 3rd party) • Hold the first meeting of the Smart City Plan Committee • Create guidelines for Smart City Plan • Fully fund SCADA project (approx. $1.6M) with existing allocation and uncommitted remaining ARPA funds • Select SCADA award recipient
Within 180 days:	• Start new SCADA deployment • Hold a Smart City Plan workshop for Smart City Plan Committee members (can be facilitated by a 3rd party) • Map out all current and future City projects for a 10-year period to align with the Telecom Roadmap • Establish a consistent cadence of meetings for the Smart City Plan Committee • Use Telecom Roadmap details to apply for all relevant grants in the upcoming funding cycle (Spring 2024 for Phase 1) that will support the completion of one (or part of one) of the Smart City initiatives
Within 1 year:	• Approve official Smart City Plan • Create a Funding Evaluation Tool • Identify and determine how to measure KPIs (key performance indicators) for the Plan • Integrate Telecom Roadmap recommendations into city governance and into planning and design for existing projects • Continue to refresh funding list and apply for funding opportunities for each strategic priority in the Smart City Plan

Key Terms & Function

- **Telecom Roadmap** – This is a compilation of the network design, technology selection, financial data, benefits, and funding resources to serve as the foundation for the Smart City initiatives.
- **Smart City Director** – This person or entity has full responsibility for the funding, implementation/project management, measurement and reporting of the Smart City Plan.
- **Smart City Plan Committee** – This oversight group is formed of key stakeholder groups for decision making, prioritization and accountability to the success of various Smart City initiatives.
- **Smart City Plan** – This is the specific, detailed plan that is coordinated and balanced with all City priorities over a 10-year period. This is critical in eliminating silos that are not productive or efficient.
- **Key Performance Indicators (KPI's)** – There are a set of measurements for the success of each priority of the Smart City Plan. These should encompass the important data sets for various stakeholders and be reviewed quarterly.

1. Background

1.1 Who We Are

Native Network, Inc was founded by telecommunications veteran Andrew Metcalfe in 2015 after having built several successful telecommunications networks and companies, Cellular One and Northwest Telephone. Mr. Metcalfe's long and distinguished telecom career has always focused on rural and underserved markets and bridging the digital divide. He and his team are experts in developing infrastructure and operational plans for telecommunications roadmaps. Due to its telecommunications activity in the State of Arizona and work with a Native American Tribe in Tucson, Native Network became aware of Douglas's telecommunications goals.

1.2 Project Context

Native Network responded to the City of Douglas' RFP in July of 2022 and was notified in September of the same year that it was the successful bidder to provide a Telecommunications Roadmap. Contract negotiations were completed in January of 2023 and a kickoff meeting was held on site in February 2023.

The Telecommunications Roadmap Project was started February of 2023 with a completion date of July 2023 and a final presentation to the Mayor and City Council in August 2023.

1.3 What is a Smart City?

Urbanization's rapid progression and technological advancements have birthed the Smart City concept. A smart city denotes a community sphere that employs digital technologies and data-driven solutions to enhance its residents' life quality, improve sustainability, and optimize resource management. Smart Cities aim to create more connected, efficient, and habitable spaces by integrating various sectors and harnessing innovative technologies.

Smart cities' key characteristics are infrastructure and connectivity, data-driven decision making, sustainable development, and citizen engagement and participation. These features interact synergistically to offer a comprehensive solution that brings Smart City benefits to fruition.

Smart cities are predicated on advanced infrastructure and solid connectivity, which includes high-speed Internet access, sensor networks, and communication systems that enable the unimpeded flow of data and information. Smart cities' vast data collection from sensors, devices, and platforms is analyzed to understand various facets of city life, like transportation, energy usage, public safety, and resource management. The insights gained from data-driven decision making allow city authorities to address challenges preemptively and optimize services.

Sustainability is a priority in smart cities, which employ eco-friendly practices and collect and analyze environmental data. Energy-efficient structures, smart grids, waste management systems, and renewable energy sources are some of the initiatives taken towards sustainability. Smart cities contribute to a greener and more sustainable future by curbing resource use and emissions.

Citizen engagement and participation are essential aspects of a smart city. Digital platforms and mobile applications provide city inhabitants access to information, a channel to give feedback, and a means to actively contribute to city planning and governance.

Smart cities provide numerous benefits, like improved life quality, enhanced efficiency and sustainability, economic growth and innovation encouragement, and improved mobility and transportation. Through smart healthcare systems, efficient public services, and advanced public safety measures, Smart Cities enhance inhabitants' life quality.

Smart cities' integration allows resource optimization, reduced energy consumption, and minimized environmental impact. Waste and overall efficiency are improved through smart grids, water management systems, and efficient transportation networks. Economic growth and innovation are spurred by smart cities, attracting investments and fostering technology-driven industries. Smart City initiatives also offer job opportunities and enhance the economy's competitiveness.

Intelligent traffic management, real-time navigation, and smart parking solutions are features of smart transportation systems that allow smooth mobility within the city. These features reduce congestion, travel time, and pollution while promoting sustainable transportation modes.

However, smart cities face several challenges, like privacy and security, digital equity, cost and implementation, and stakeholder collaboration. Privacy and cybersecurity concerns arise from extensive data collection and use. Safeguarding personal information and ensuring solid cybersecurity measures is crucial in maintaining trust and protecting citizens' rights. Efforts must be made to bridge the digital divide resulting from unequal technology and connectivity access.

The costs involved in building and implementing Smart City infrastructure necessitate careful planning and prioritization of investments to ensure maximum benefits and long-term sustainability. The development of a Smart City requires stakeholder collaboration for sustainability; effective governance and coordination are necessary to align interests and ensure successful implementation.

1.3.1 The Rural Difference

The application of Smart City technologies in rural community settings has distinct characteristics compared to urban areas, presenting both unique challenges and opportunities.

The infrastructure present in rural and small towns often requires significant investment to enable advanced Smart City technologies. These small, rural communities may lack high-speed internet connectivity, a crucial prerequisite for collecting, transmitting, and analyzing voluminous data. The continuous operation of various smart devices and sensors can also be hindered due to an unstable electricity grid.

The scale of deployment in such regions differs significantly from urban areas, impacting the cost-effectiveness of the technological implementations. The reduced scale could be interpreted as an opportunity to decrease costs. However, it can also pose a potential hurdle by limiting the economic feasibility of certain Smart City initiatives.

Rural communities tend to have different needs and priorities compared to larger, urban cities. Priorities might lean towards agriculture management, water quality, access to healthcare, and education, rather than urban-centric issues like traffic management or public transportation systems.

Population density is another significant factor that differentiates rural or small-town communities from urban environments. The sparser population in these areas requires the adaptation of technological solutions to their unique needs. Therefore, a greater focus might be placed on technologies like remote healthcare delivery or distance learning instead of those for managing high-density housing or public transport.

Community engagement presents a unique dynamic in rural and small-town settings. Given that these communities are often closely-knit, this characteristic can create opportunities for citizen engagement and participation in Smart City initiatives. However, the local governance structures may differ from those in urban areas, requiring a tailored approach to integration and communication.

Resources, both in terms of capital and expertise for the implementation and ongoing maintenance of Smart City technology, may be limited in smaller communities. This makes the role of external partners and stakeholders even more vital for the success of such initiatives.

Notwithstanding these challenges, the implementation of Smart City technologies in rural areas and small towns carries substantial potential. Innovative solutions targeting the specific needs of these communities, such as remote healthcare, precision farming, and efficient resource management, can greatly enhance quality of life and economic opportunities. With the right strategies and partnerships, Smart City technologies can act as a catalyst for significant positive transformations in rural areas and small towns.

The technologies utilized in the smart city vary greatly, however the core information flow and control is typically provided by a combination of older established protocols such as expensive Supervisory Control and Data Acquisition (SCADA) for critical applications such as water and waste water management, and newer, less expensive protocols such as Internet of Things (IoT) and Industrial Internet of Things (IIoT). These solutions can be integrated into the Smart City framework to provide a much lower-cost solution to many common and less critical applications, such as water conservation, city management and security.

1.4 What is IoT?

The Internet of Things (IoT) is a concept that refers to the network of interconnected physical objects, devices, and sensors that can communicate and exchange data with each other through the internet. It represents a paradigm shift in the way we interact with our environment and the objects around us. In essence, IoT enables the digital transformation of everyday objects into smart devices that can collect and transmit data, leading to increased automation, efficiency, and convenience.

The foundation of IoT lies in connectivity. Devices within the IoT ecosystem are equipped with wireless technologies such as WiFi, Bluetooth, or cellular networks, allowing them to establish seamless connections and communicate with each other and with the Internet. This connectivity enables the exchange

of data and information, facilitating the automation of processes, real-time monitoring, and intelligent decision-making.

Sensors play a vital role in the IoT ecosystem. These small devices embedded within IoT objects can detect and measure various physical parameters such as temperature, humidity, motion, and more. Sensors collect real-time data from the environment and send it to connected devices or cloud platforms for analysis and processing. This data provides valuable insights that can be used to monitor and control various aspects of our lives, from managing energy consumption in smart homes to optimizing industrial processes in factories.

IoT has widespread applications across different industries and sectors. In healthcare, for example, IoT devices and wearables enable remote patient monitoring, real-time health tracking, and personalized healthcare services. In transportation, IoT technologies enable intelligent traffic management systems, smart parking solutions, and autonomous vehicles. In agriculture, IoT enables precision farming through sensors that monitor soil moisture, weather conditions, and crop health.

However, with the immense potential of IoT come several challenges that need to be addressed. Security and privacy concerns are significant, as the interconnected nature of IoT devices raises the risk of data breaches and unauthorized access. Standardization and interoperability also pose challenges, as different devices and systems may use proprietary protocols and lack compatibility with one another. Furthermore, the vast amounts of data generated by IoT devices require efficient management and analytics capabilities.

With foresight and good IT planning and management, the Internet of Things represents a transformative concept that is reshaping our world. With its ability to connect and digitize everyday objects, IoT is revolutionizing industries, improving efficiency, and enhancing our quality of life. As the IoT ecosystem continues to evolve, addressing challenges such as security, standardization, and data management will be crucial to unlocking its full potential and ensuring a future where connected devices seamlessly and securely integrate into our daily lives.

1.5 What is IIoT?

IIoT, which stands for the Industrial Internet of Things, is a transformative concept that leverages the power of connectivity and data in industrial settings. It refers to the integration of sensors, devices, machinery, and software systems in industrial environments to enhance productivity, efficiency, and safety. IIoT represents a significant evolution in industrial operations, enabling the digital transformation of traditional industries and revolutionizing the way they operate.

IIoT has the potential to revolutionize industrial sectors such as manufacturing, energy, transportation, and logistics. In manufacturing, IIoT enables the creation of smart factories where machines and equipment are interconnected, allowing for real-time monitoring and control of production processes. This leads to improved operational efficiency, reduced downtime, predictive maintenance, and optimized resource allocation.

At its core, IIoT leverages the power of connectivity to establish a network of industrial devices and systems. Through wired or wireless technologies, such as Ethernet, Wi-Fi, or cellular networks, sensors and devices in industrial environments communicate with each other, collect real-time data, and share it across the network. This connectivity enables seamless collaboration, enabling machines and systems to work together intelligently.

The integration of sensors plays a pivotal role in IIoT. Sensors deployed in industrial settings can monitor various parameters such as temperature, pressure, humidity, vibration, and more. They collect data from equipment, machinery, and production processes, providing real-time insights into performance, conditions, and potential issues. This data is then analyzed and utilized to optimize operations, predict maintenance needs, and improve overall efficiency.

One of the key advantages of IIoT is its ability to enable automation and autonomous decision-making. By integrating sensors and devices with intelligent software systems, industrial processes can be streamlined and automated. IIoT allows for remote monitoring and control, enabling real-time adjustments and optimizing performance without human intervention. This automation improves operational efficiency, reduces errors, and enhances safety by eliminating manual tasks and providing a consistent and reliable process.

The main challenge of IIoT is the integration and compatibility of diverse systems and devices. Different manufacturers and legacy equipment may have proprietary protocols and standards, requiring effort to ensure seamless interoperability.

Industrial Internet of Things (IIoT) is revolutionizing industrial processes and operations. By leveraging connectivity, sensors, and automation, IIoT enables industries to optimize efficiency, increase productivity, and improve safety. With the potential to transform manufacturing, energy, transportation, and other sectors, IIoT offers a path to a more connected and intelligent industrial landscape, paving the way for enhanced operational excellence and growth.

1.6 What is SCADA?

SCADA stands for Supervisory Control and Data Acquisition. It is a system used to monitor and control industrial processes, infrastructure, and facility operations. SCADA systems are commonly employed in various industries such as manufacturing, energy, water and wastewater management, transportation, and telecommunications.

The key components of SCADA are supervisory control, data acquisition, Human-Machine Interface (HMI), communication infrastructure, and control logic. The supervisory control component of SCADA involves the monitoring and control of processes and equipment. It allows operators to oversee and manage operations remotely from a central control center. Operators can monitor real-time data, view graphical representations of processes, and issue commands to control equipment and processes.

The data acquisition component of SCADA involves the collection and retrieval of data from sensors, meters, and other devices. SCADA systems gather data from various sources such as temperature sensors, pressure gauges, flow meters, and PLCs (Programmable Logic Controllers). The data is then transmitted to the central SCADA system for analysis and visualization.

The Human-Machine Interface (HMI) component provides a graphical user interface that allows operators to interact with the SCADA system. It presents real-time data, alarms, and status indicators in a user-friendly format. Operators can monitor system performance, set control parameters, and respond to alarms and alerts. SCADA systems rely on a communication infrastructure to transmit data between the central control center and remote field devices. This infrastructure can include wired connections (such as Ethernet or serial communication) or wireless technologies (such as radio or cellular networks). The communication infrastructure enables real-time data exchange and remote-control capabilities.

These systems use control logic and algorithms to automate processes and make decisions based on the collected data. Control algorithms can be pre-programmed or dynamically adjusted based on system requirements and conditions. They enable the system to optimize operations, respond to changing conditions, and implement control strategies.

SCADA systems provide a powerful platform for monitoring, controlling, and managing industrial processes. They enable real-time data acquisition, remote control, and decision-making, leading to improved operational efficiency, enhanced productivity, and increased safety and security in various industries.

Why is SCADA important in the context of a Smart City?

The SCADA system plays a crucial role in the context of a Smart City. It provides essential monitoring, control, and data management capabilities for effective operation and management of various critical infrastructure and services within a smart city. A smart city consists of a complex network of interconnected systems and infrastructure, such as energy grids, water and wastewater systems. The SCADA system serves as a central platform that integrates and manages these critical systems, allowing a holistic view and control of the city's operations. It enables city officials and operators to monitor and manage multiple systems concurrently, leading to improved efficiency and coordination.

The SCADA system also supports predictive maintenance strategies in a smart city. By continuously monitoring equipment and infrastructure, it can detect early signs of potential failures or issues. This allows for proactive maintenance and repair activities to be scheduled, minimizing downtime and service disruptions. Moreover, the SCADA system's ability to analyze historical data and trends enables the application of predictive analytics to forecast future demand, identify patterns, and optimize operations further.

The SCADA system plays a pivotal role in the efficient functioning of a smart city; it is the core platform supporting centralized monitoring, control, and management of critical infrastructure and services ensuring key systems remain operational while allowing additional input from other lower cost systems to fill in sensory gaps. The SCADA system, in conjunction with the IoT and IIoT networks, generates and analyzes vast amounts of data from various sensors and devices across the city. The SCADA software platform can provide valuable insights into system performance, usage patterns, and trends. By leveraging the critical SCADA data and powerful vast array of IoT and IIoT sensor data processed through advanced analytics and visualization tools, city officials can make informed decisions regarding infrastructure planning, service delivery, and policy formulation. Data-driven decision-making enables evidence-based strategies that enhance the livability, sustainability, and resilience of the smart city.

1.7 Data Acquisition Concerns & Security

Efficient management of IoT and IIoT networks is addressed with good network architecture, solid IT policies and processes, and adhering to enhanced IT and physical security protocols.

While SCADA is an established protocol typically utilized in an isolated, air-gapped network to reduce unauthorized access, IoT and IIoT continue to revolutionize the technological landscape and require interaction between disparate networks and software to operate, increasing complexity of security requirements.

IT departments face the complex challenge of effectively managing these networks. The interconnectivity and vast number of devices in IoT and IIoT environments require comprehensive processes and stringent security measures. The crucial components for securely managing IoT and IIoT networks while addressing critical processes are network architecture and design, security measures, data management, and lifecycle management.

Network Architecture and Design:

- **Scalability:** IT departments must develop a flexible network architecture that accommodates the growing number of devices and data traffic in IoT and IIoT environments.
- **Segmentation:** Segregating IoT and IIoT devices into distinct network segments helps isolate potential security breaches, reduces the attack surface, and simplifies management.
- **Device Provisioning:** Establishing a streamlined process for onboarding and provisioning devices ensures that only authorized and secure devices gain access to the network.
- **Network Monitoring:** Implementing comprehensive monitoring systems enables IT teams to identify and resolve network anomalies promptly, ensuring optimal performance and security.

Security Measures:

- **Authentication and Authorization:** Strong authentication mechanisms, such as two-factor authentication and digital certificates, ensure that only authorized devices and users can access IoT and IIoT networks.
- **Encryption:** Data transmitted between IoT and IIoT devices should be encrypted to prevent unauthorized access. Implementing secure protocols such as SSL/TLS and leveraging encryption algorithms like AES enhances data security.
- **Access Control:** Role-based access control (RBAC) enables IT administrators to assign specific privileges and permissions to devices and users, limiting potential security risks.
- **Patch Management:** Regularly applying security patches and updates to IoT and IIoT devices and their associated software mitigates vulnerabilities and minimizes the risk of exploitation.
- **Threat Detection and Response:** Deploying intrusion detection and prevention systems (IDPS) and leveraging advanced analytics allows IT departments to identify and respond to potential security threats promptly.

Data Management:

- Data Governance: Establishing clear policies and procedures for data collection, storage, and usage helps ensure compliance with regulatory requirements and maintains data integrity.
- Data Encryption: Encrypting sensitive data at rest and in transit provides an additional layer of protection against unauthorized access.
- Data Backup and Recovery: Regularly backing up IoT and IIoT data and implementing disaster recovery plans safeguard against data loss and enable swift recovery in the event of an incident.

Lifecycle Management:

- Asset Inventory: Maintaining an up-to-date inventory of IoT and IIoT devices, including their firmware and software versions, assists in identifying potential vulnerabilities and planning for necessary upgrades.
- Device Monitoring and Maintenance: Continuously monitoring device performance and conducting regular maintenance activities, including firmware updates and patch installations, ensures devices remain secure and function optimally.
- End-of-Life Disposal: Establishing proper procedures for decommissioning and disposing of IoT and IIoT devices guarantees that sensitive data is securely erased and prevents unauthorized access.

Effectively managing IoT and IIoT networks requires a comprehensive approach that addresses both processes and security concerns. By implementing robust network architecture, stringent security measures, efficient data management strategies, and lifecycle management practices, IT departments can maximize the benefits of IoT and IIoT while mitigating potential risks. Adhering to these guidelines will empower organizations to embrace the transformative potential of IoT and IIoT while maintaining a secure and well-managed network environment.

2. Stakeholders

2.1 Stakeholder Analysis Report

As we set forth on this project, the team strove to understand the unique details of Douglas, understanding that what works in one area may not work in another area within the region. As a baseline for the process, we extracted data from Sierra Vista, Nogales, and Douglas, Arizona, to determine what drives each local economy and what areas should be focused on as a differentiator for the stakeholders of Douglas.

Sierra Vista, with a population of around 43,000, has an economy heavily influenced by the military presence, mainly Fort Huachuca, which significantly drives the local economy, and a budget of more than $205M for 2023 if all grants are approved. Their development efforts focus on supporting and growing businesses that cater to the military and defense industries.

Nogales, with a population of around 20,000, has an economy heavily influenced by its location on the border with Mexico. The city's expected budget will be approximately $85M for 2023, with economic development efforts focusing on cross-border trade and commerce, including manufacturing, logistics, and warehousing. Nogales has implemented several initiatives to support economic development, such as a foreign trade zone, a regional economic development alliance that promotes collaboration with Mexico, and a business incubator.

Douglas, with a population of around 16,500, has an economy heavily dependent on international trade and the agriculture industry. The city's economic development efforts have primarily focused on attracting new businesses, supporting existing businesses, and promoting international trade. Douglas has also implemented several initiatives to support economic development, including a foreign trade zone, a microenterprise program for small businesses, and a business incubator.

With that general data in mind, additional data was also extracted from in-person visits and survey responses to gain a more granular understanding of needs, wants and desires from community stakeholders. Please see the attached Stakeholder Interviews & Analysis document for more specific detail.

CATEGORY	DEPARTMENT & DEPARTMENTAL CONCERN(S)
Infrastructure & Communications	• **City Manager:** Infrastructure, Smart City, Economic Development • **IT:** Communications, Infrastructure preparedness • **Public Works:** Water, Power grid, Automation • **Schools:** Infrastructure
Security, Safety & Emergency Response	• **Finance:** Billing, Security, Breaking down silos • **Economic Development:** Cost, Communications, School safety, Keep dollars in the community • **Fire:** Communications, Safety, Security • **Police:** Student safety, Funding, Communications • **Public Works:** Automation, Security • **Schools:** Student safety, Communications, Power grid, Cybersecurity
Technology & Digital Literacy	• **Health Care:** Lack of laptops & cell phones, Digital literacy, Automated transportation • **Human Resources:** Technology, Communications, Staff overworked • **Library:** Environmental concerns, Communications, Telecommunications coverage
Power Grid, Grid Stability & Backup	• **IT:** Infrastructure, Grid sability, Cybersecurity • **Prison:** Grid instability, Communications, transportation • **Border Patrol:** Grid Instability, Sewer, Communications
Miscellaneous Concerns	• **City Manager:** Data reliability • **Economic Development:** Transparency, Communications, Education • **Health Care:** Call center expense, Communications, Power backup • **Parks & Rec:** Staff performance, Water conservation, Communications • **Public Works:** Compliance • **Schools:** Infrastructure

Based on the combined regional data, and survey analysis, five priority needs emerge for Douglas to support improvements related to Smart City solutions could enhance City of Douglas's economic growth and resilience:

1. **Improve infrastructure:** Enhancing all forms of infrastructure, such as communications, highways and airports, would facilitate better response and access to the city for operational purposes, businesses and visitors.
2. **Diversify the local economy:** Expanding the local economy beyond agriculture and international trade by attracting businesses in industries such as manufacturing, technology, and healthcare can provide more stable and varied job opportunities for the community.
3. **Develop a skilled workforce:** Offering job training programs and investing in educational opportunities for residents can help create a skilled workforce attractive to new businesses.
4. **Enhance the local business environment:** Streamlining regulatory and administrative processes for businesses can make it easier and more attractive for businesses to start and operate in Douglas.
5. **Promote tourism:** Investing in tourism for the downtown corridor.

The regional differentiator then becomes focusing on Smart City solutions to cost-effectively meet the identified priority needs.

To achieve these objectives, the prioritization of specific categories of Smart City solutions are identified as follows:

CATEGORY	NEEDS, WANTS & DESIRES
Infrastructure & Connectivity	• NEED: Robust, high-speed internet connectivity & advanced telecommunications networks. • **WANT:** Integration of IoT devices & sensors to monitor & optimize city systems. • **DESIRE:** 5G or higher network capabilities for seamless connectivity & advanced services.
Transportation & Mobility	• NEED: Efficient public transportation systems, smart traffic management, & reduced congestion. • **WANT:** Promotion of electric & autonomous vehicles, smart parking, & bike-sharing programs. • **DESIRE:** Interconnected, multi-modal transportation systems with real-time information & seamless payment options.
Energy & Resource Management	• NEED: Smart grids for efficient energy distribution & consumption monitoring. • **WANT:** Integration of renewable energy sources & energy storage solutions. • **DESIRE:** Advanced waste management systems, including waste-to-energy conversion & smart recycling.
Environment & Sustainability	• NEED: Monitoring & control of air, water, & noise pollution levels. • **WANT:** Development of green spaces, urban farming, & sustainable building practices. • **DESIRE:** Climate-resilient infrastructure & planning for long-term environmental challenges.
Public Safety & Security	• NEED: Advanced surveillance systems, emergency response, & crime prevention. • **WANT:** Integration of AI & data analytics for predictive policing & threat detection. • **DESIRE:** Enhanced cybersecurity measures to protect city networks & citizen data.
Health & Well-Being	• NEED: Accessible & efficient healthcare services, including telemedicine & e-health platforms. • **WANT:** Promotion of active lifestyles, fitness programs, & mental health support. • **DESIRE:** Real-time monitoring of public health data for early disease detection & outbreak prevention.
Governance & Citizen Engagement	• NEED: Transparent, efficient, & responsive government services through e-governance platforms. • **WANT:** Citizen participation in decision-making & feedback mechanisms via digital channels. • **DESIRE:** Encouragement of civic innovation & collaboration through open data initiatives & hackathons.
Education & Skills Development	• NEED: Access to quality education & digital literacy programs. • **WANT:** Promotion of lifelong learning, upskilling, & reskilling through online platforms. • **DESIRE:** Collaboration with industry & academia to foster innovation, entrepreneurship, & a future-ready workforce.
Economic Growth & Employment	• NEED: Attraction of businesses & investments through a conducive environment & Smart City infrastructure. • **WANT:** Affordable housing, access to basic services, & equal opportunities for all residents. • **DESIRE:** Inclusive economic growth & job creation, catering to diverse skill sets & backgrounds.
Social Inclusion & Equity	• NEED: Advanced surveillance systems, emergency response, & crime prevention. • **WANT:** Digital inclusion initiatives, ensuring all citizens can access & benefit from Smart City solutions. • **DESIRE:** Promotion of cultural diversity, community-building, & social cohesion.

3. Current State Assessment

3.1 Field Report

INITIAL SITE VISIT
Tuesday, February 7, 2023 in Douglas, Arizona

Native Network team participants:

- Andrew Metcalfe, *CEO/Chief Engineer*
- Dustin Sayre, *Network Engineer*

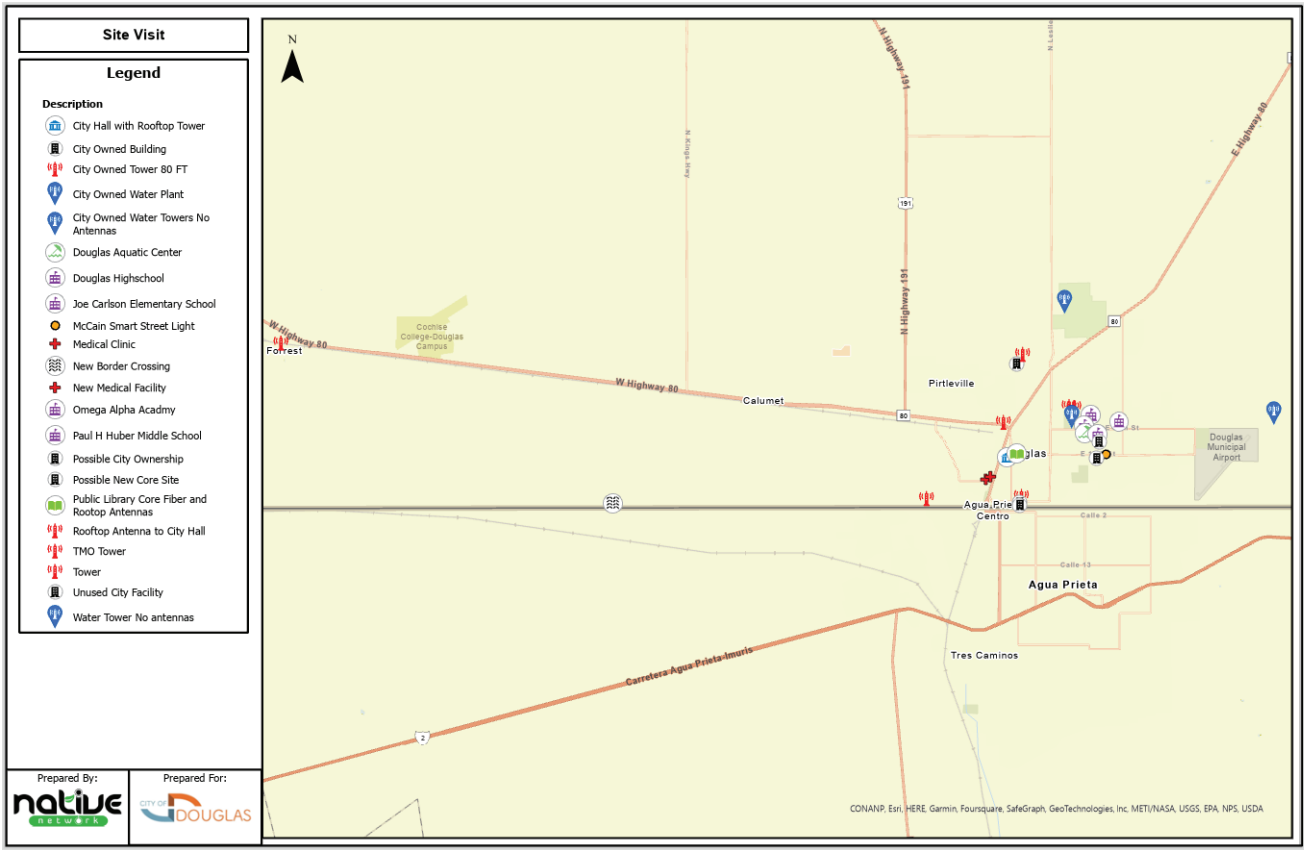
Native Network team arrived on site 9:00 AM, Feb. 7, and an initial meeting took place with City of Douglas stakeholders – the working team:

- Ana Urquijo, *City Manager*
- Luis Pedroza, *Assistant City Manager*
- Joel Camacho, *IT Director*
- Rene Rios, *Procurement Director*
- Xenia Gonzalez, *Neighborhood Resources & Grants Director*
- Jennifer Smith, *Community Services & Economic Development Director*

After introductions, a discussion of the progression of the project, timeline, and key data requirements for each department was covered. The discussion continued to the topic of key stakeholders and interested parties to be interviewed over the course of the study.

The conversation ended with a discussion of the City's current infrastructure and what a smart city might look like as well as the new border crossing and its effect on the City in the short and long term.

Upon conclusion of the kickoff meeting, Native Network, IT Director Joel Camacho and Procurement Director Rene Rios proceeded to visit key infrastructure in the community including:



Map of Site Visits
(CityofDouglas.kmz file provided for details)

Site visits to city facilities and key locations

- Water System
  - Reservoir
  - Water Storage (water tanks)
  - Water Lines
- Sewer System
  - Feeder and Main Lines / Lift Station
  - Sewer Treatment Plant
- Telecommunications
  - City-owned Towers
  - 3rd Party Towers
  - Fiber Optic Network
  - Radio Networks
    - Multiple point to point unlicensed radio system
- IT Infrastructure (City Hall)
- Police Department / Fire Department
- Land / Buildings owned by the City
- Parks & Recreations Areas
- Schools / Libraries
- Medical Facilities
- Border Crossing Existing and Proposed
- Industrial Part (Hwy 191)

Site Visit Observations

City of Douglas is a small town in Southwest Arizona, located in Cochise County and has a population of approximately 16,500. It is positioned on the US Border with Mexico and has an active border crossing. The Mexican city of Agua Prieta is located just across the border. Agua Prieta has a population of approximately 150,000 with heavy daily traffic crossing the border for work and shopping.

A vibrant shopping area has been developed in recent years to take advantage of this border crossing trend, including a Walmart store that regularly checks in as the busiest in the nation.

The topology of the City is a slightly sloping from South to North and West to East. This gives the town a good radio frequency coverage opportunity with limited sites required. The City lies in the north-west to south-east running Sulfur Springs Valley.

Interviews with Jose Camacho and Rene' Rios were conducted during a driving survey of the City's infrastructure and key locations. It was evident that the City lacks fiber optic networks and has limited capability to automate systems and provide much needed high-speed broadband to its own facilities.

The town operates its own water and sewer systems which are primarily gravity-fed systems. Two large water towers in the center of town serve to segment the higher ground from the lower ground, offering a transition point for the system. These two water towers also present a good opportunity to serve as radio towers for data collection of IoT and SCADA networks via private LTE systems and point-to-multipoint fixed wireless systems.

The City has several point-to-point microwave systems using unlicensed bands and low-cost equipment. This link connects critical city infrastructure where the limited fiber optic networks do not. These networks as well as the fiber originate at city hall and connect to the various other city locations.

The City has two primary telecommunications providers, Cox Communications and Lumen Communications. Cox is primarily a cable provider with a limited footprint and Lumen, is the Incumbent Local Exchange Company (ILEC), with primary phone and DSL Internet services. It is noted that Cox was awarded an ARPA grant of close to $11M to build out the residential broadband in the community over the next several years.

A wireless ISP, Simply Bits recently purchased by Ting Internet (a Tucows subsidiary), has extended their network into Douglas, and provides broadband via fixed wireless technology. The primary transmission point is from the roof of the Gadsden Hotel.

One of the most notable issues with the City of Douglas is that there is no hospital, and patients must be transferred via ambulance to Bisbee or Tucson. An air ambulance is available for severe cases, and an emergency room facility and walk-in type clinics are available.

3.2 | Infrastructure Current State

Today, the City of Douglas has limited infrastructure to leverage Smart City technology. Some fiber and wireless connections exist to support basic network functionality and the existing SCADA system. Water and wastewater systems are included in the assessment of current infrastructure. While they do not directly support the Smart City transition, they are a major component requiring management as part of the Telecommunications Roadmap and are included to provide a comprehensive view of existing infrastructure.

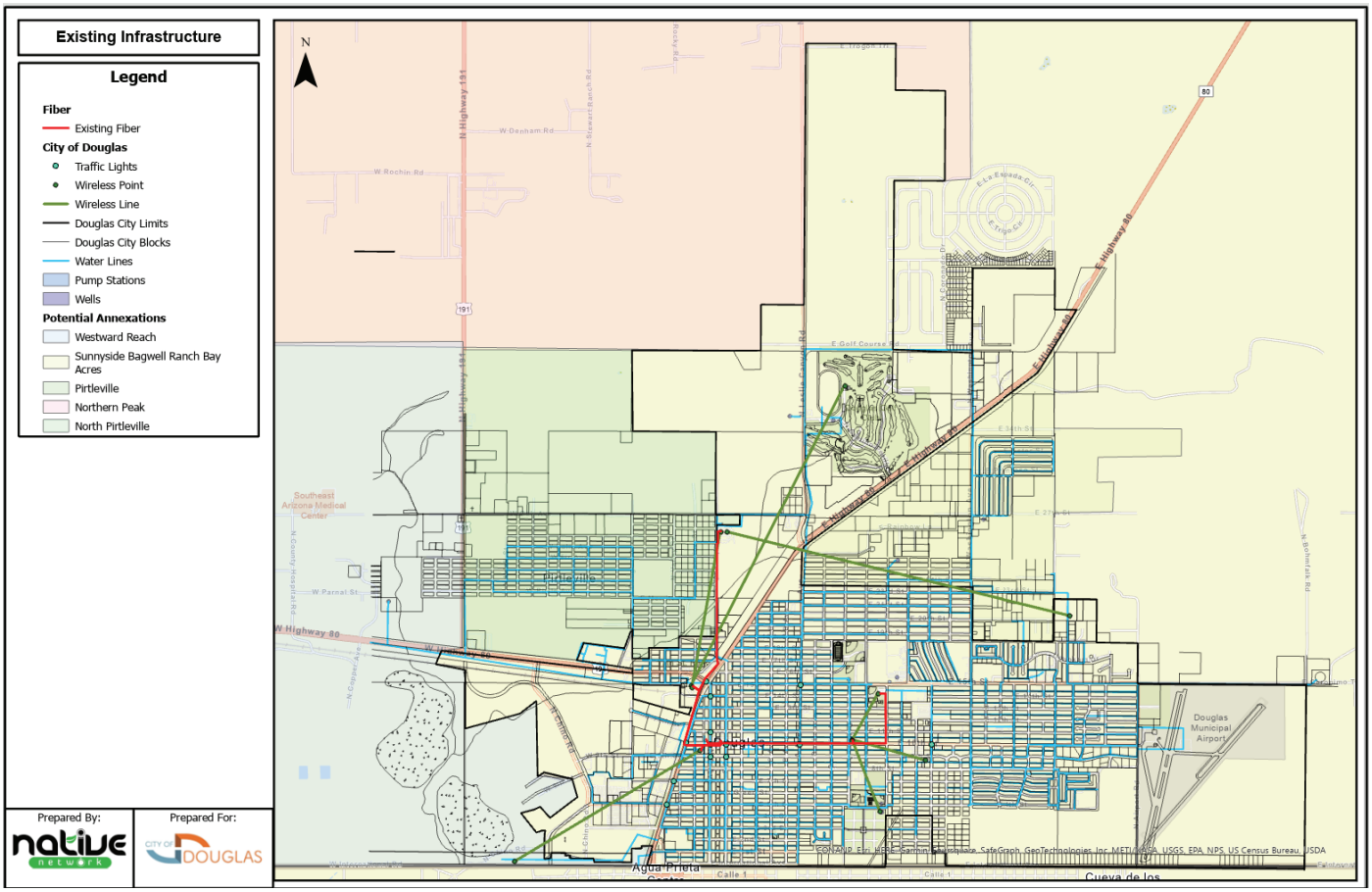
The existing infrastructure is incorporated into the design proposals by Native Network later in this report. A detailed map identifying all the current infrastructure is provided.

All current infrastructure is integral to the Smart City design, as it will need to be augmented or upgraded with new sensor technology to support the Smart City Plan.

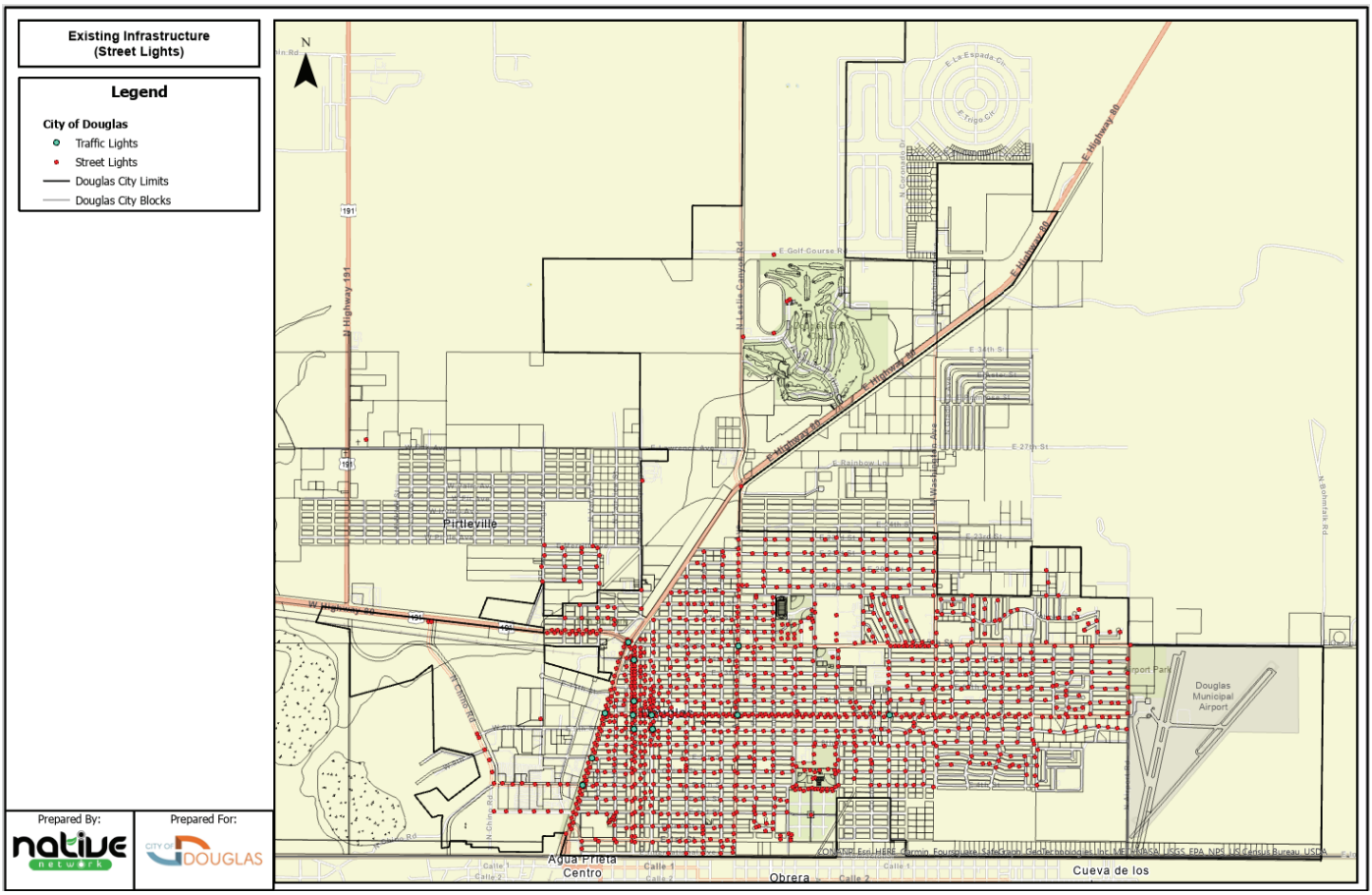
A key component of the City's water system is the existing water towers that can be leveraged in the initial phase of Telecommunications Roadmap project. The location of the existing towers provides desired coverage for the City's own networks, and 3rd parties are currently looking for tower space in the region.

Beyond the water towers, the City has 14 traffic lights that have potential to upgrade to smart traffic lights. One traffic light at E. 10th Street and A Avenue has been updated to accept smart technology, however, has not yet been networked.

An accounting of all relevant city infrastructure is documented in the map(s) below and is also included in the ArcGIS maps for interactive viewing.



Map of Current City Infrastructure



Map of Current City Infrastructure - Street Lights

3.3 | Current National Wireless Carrier Coverage

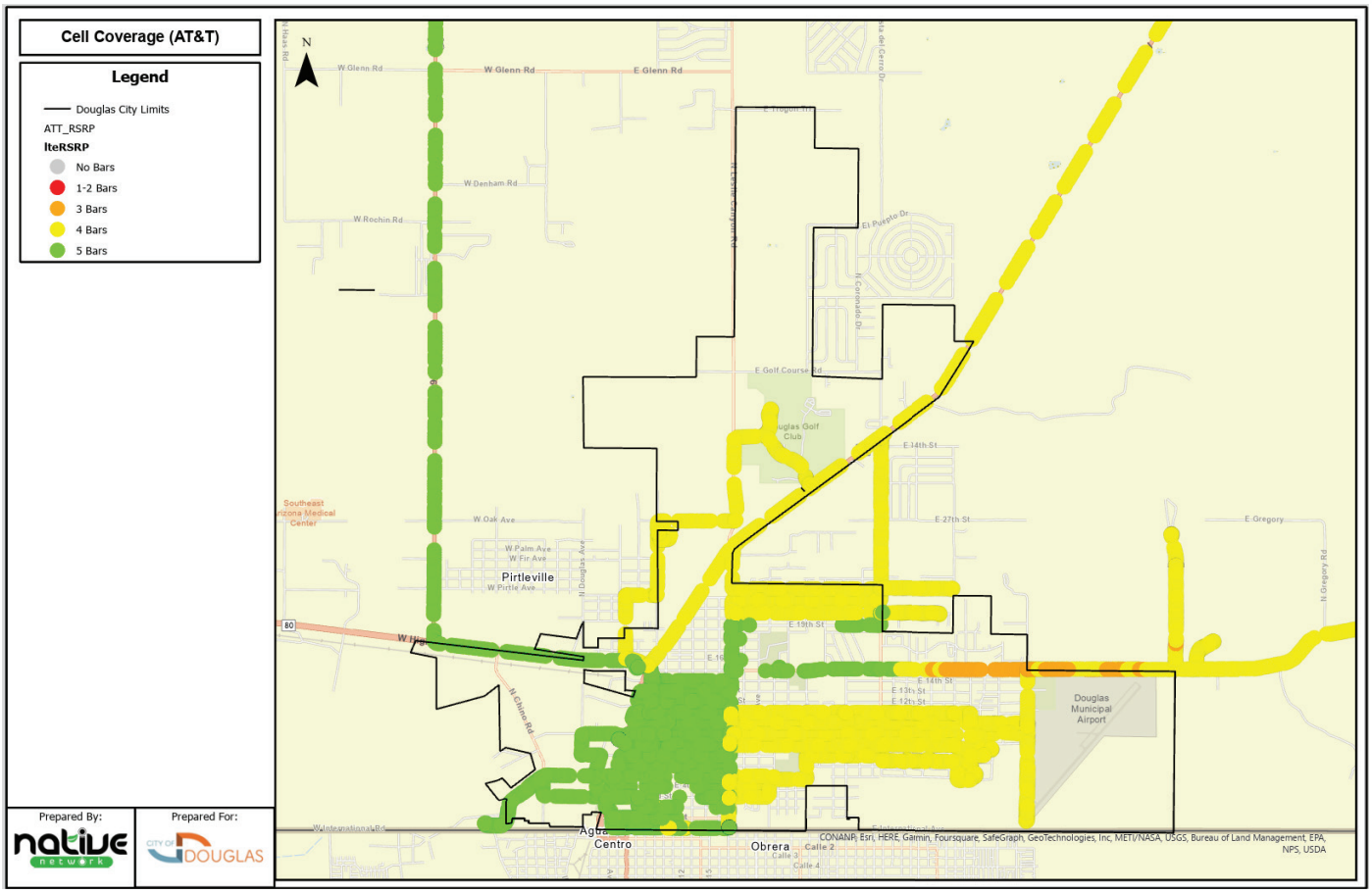
The three national wireless carriers are active in the community, with T-Mobile, Verizon and AT&T coverage currently available with room for improvement in multiple areas.

Native Network performed a drive test to document current coverage for each carrier. The street-level coverage is documented below in static maps for each carrier. It is important to understand that in-building levels are typically lower than on the street and are a major factor in overall quality of coverage. The coverage mapping is also plotted on the master ArcGIS map for interactive viewing.

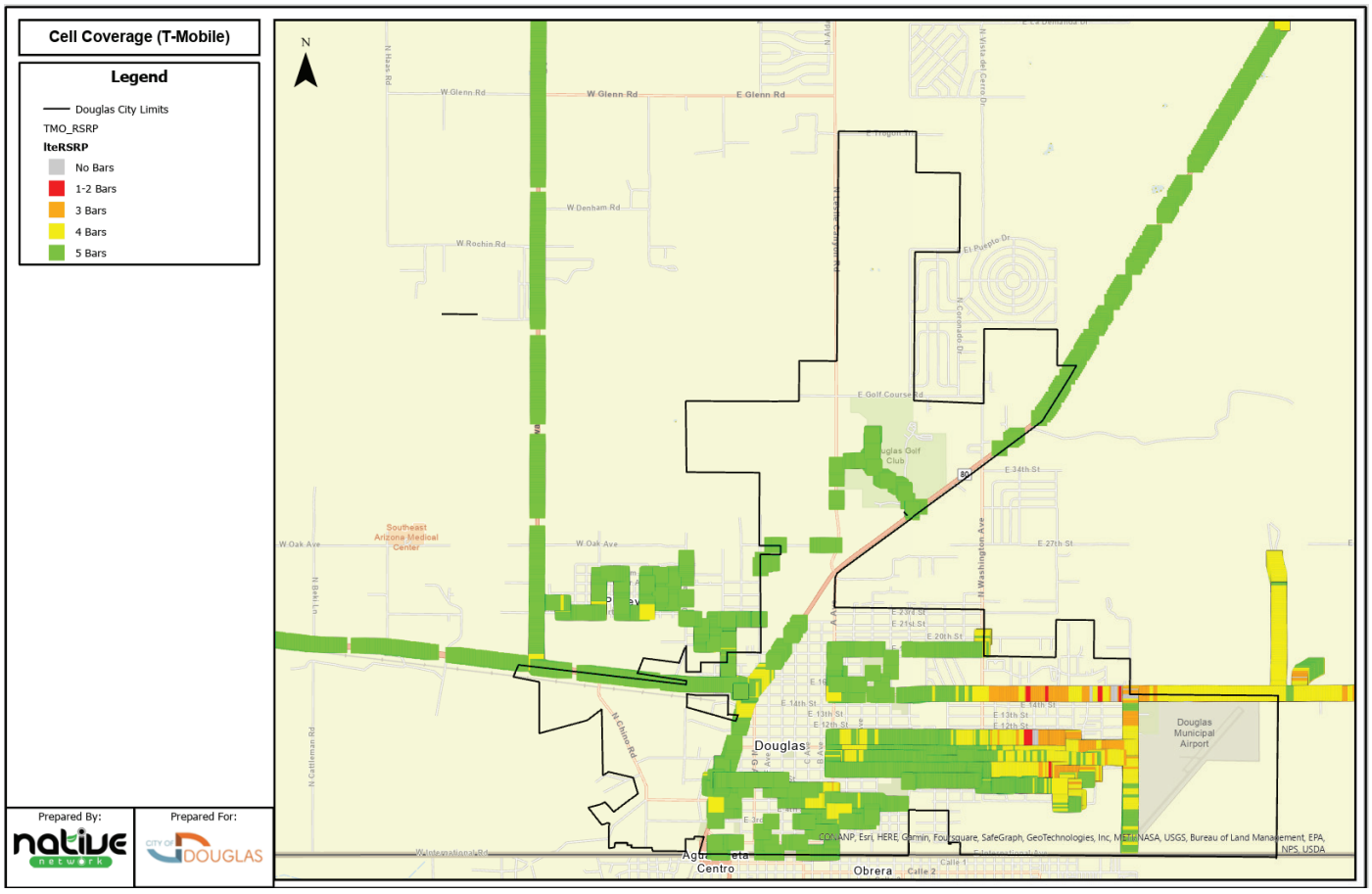
3.4 | Current Cellular Coverage Maps

The maps represent the relative signal strength of a carrier for a typical handheld device. The carrier is noted at the top of the map key.

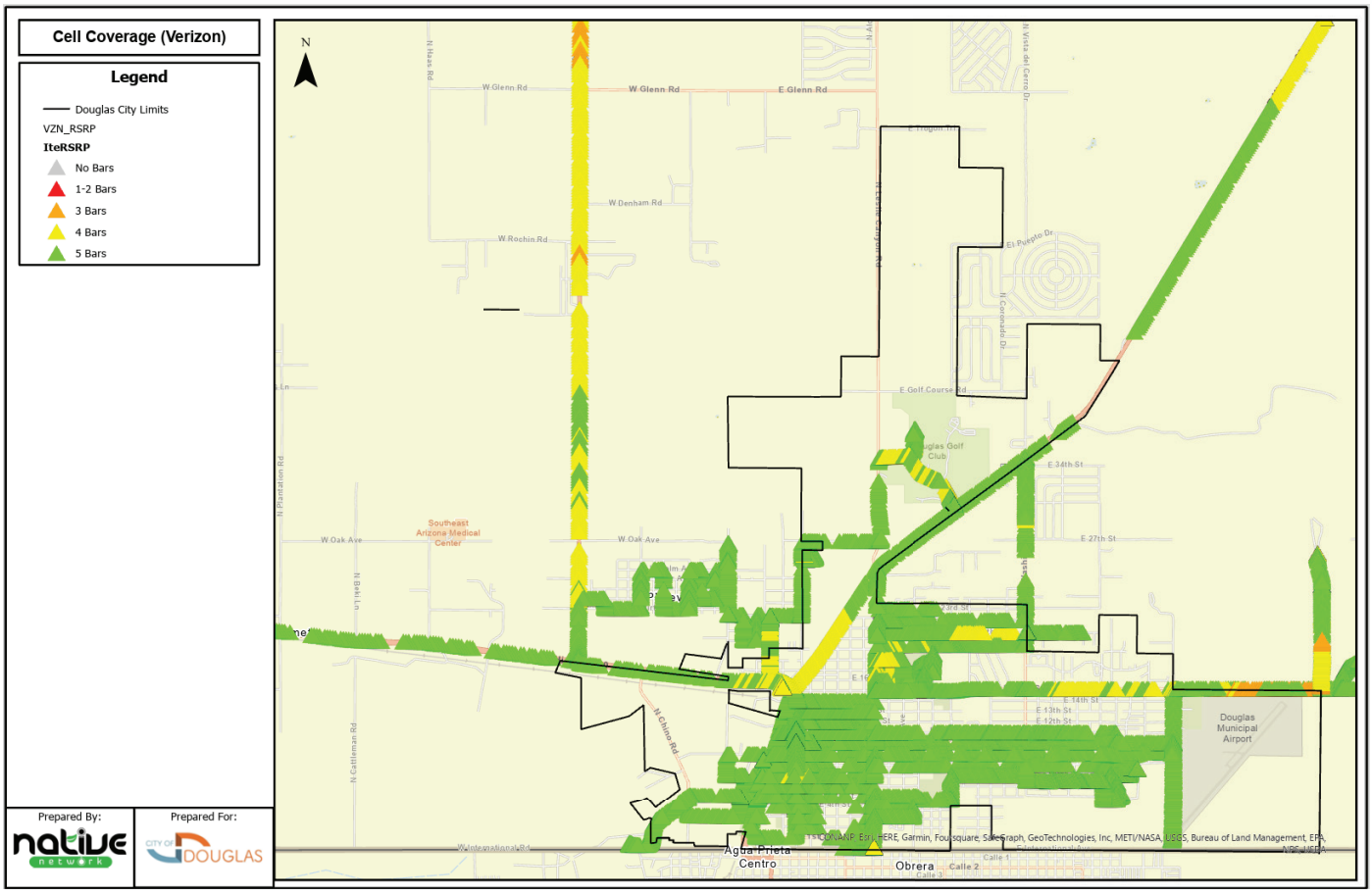
For ease of interpretation the following color code is referenced to the average bars you will see on your cell phone at that location. Signal strength can vary depending upon individual performance of the phone being used for testing.



Map of Current AT&T Cellular Coverage



Map of Current T-Mobile Cellular Coverage



Map of Current Verizon Cellular Coverage

3.5 Current SCADA System

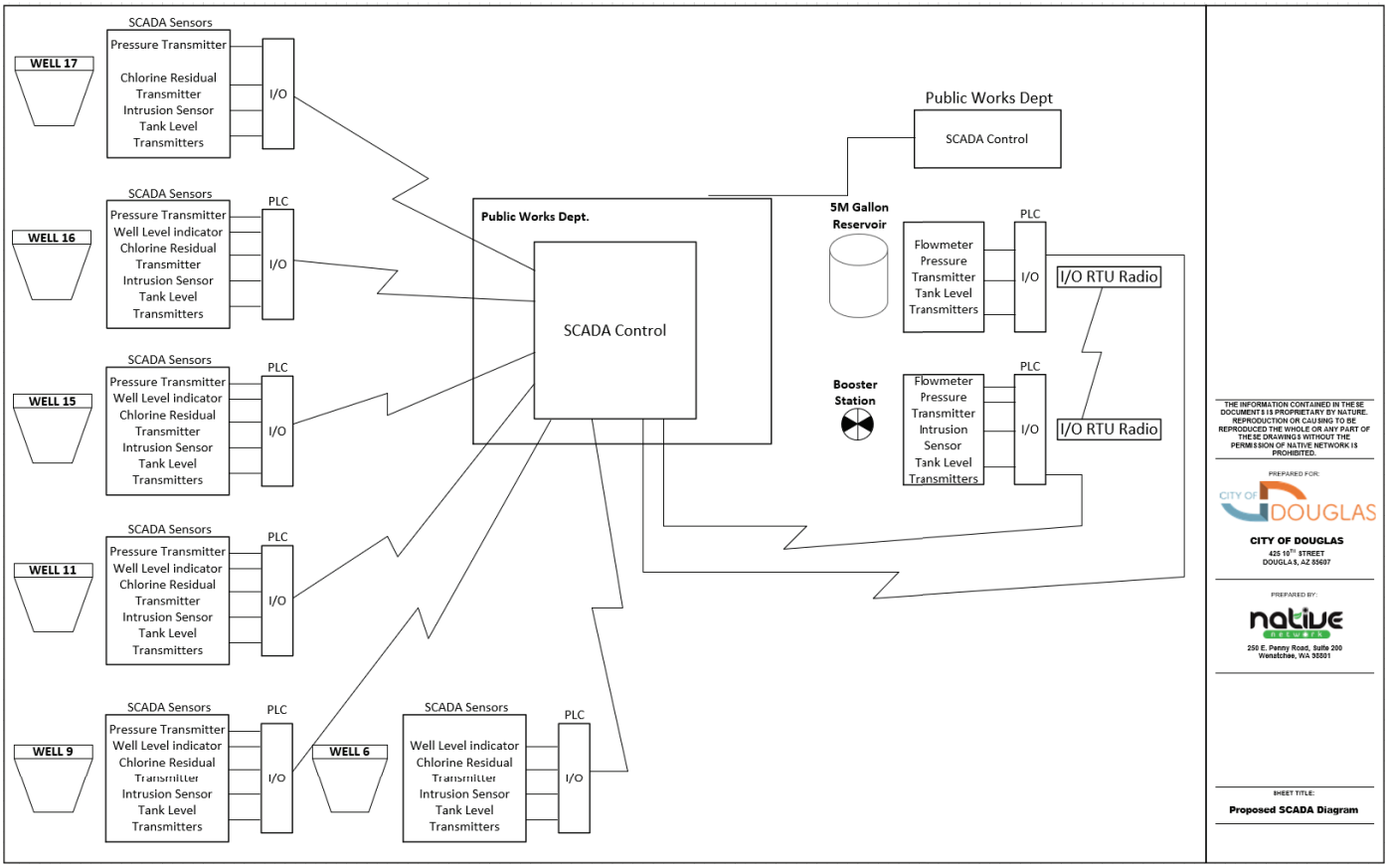
The City of Douglas is currently utilizing SCADA to monitor and manage both water and wastewater systems. A current network topology for the wastewater system was available for this report. However, it is believed to be limited to the wastewater plant and is currently without remote sensor capabilities.

The existing water management system is nearing its end of life and in need of replacement. A grant has been secured for the replacement system; however, the funding allocation appears to be insufficient to implement the current quote due to increasing pricing influenced by rising labor costs, inflation, and potential supply chain issues. The latest quote for this system is included as an attachment to this report. This vendor has verbally expressed that quote would need to be increased well beyond the current estimate.

Native Network recommends that a request for proposal (RFP) process be initiated to get accurate designs and current pricing, taking into consideration new software and sensor capabilities recently introduced, which could materially affect potential proposals. Additional information is provided in the recommendations section of this report.

The grant may have provisions for expanding the funding to cover unforeseen cost increases and should be reviewed to validate.

Below is a rendering of the City's current state SCADA system.



Current City SCADA System

3.6 Current Funding & Status of Current Projects

Douglas has committed to revitalizing and improving the City for its citizens. To that end, it has sought external funding to support the City's strategic initiatives. The following sections outline the status of current external funding and the most notable current City projects.

Funding Awarded

FUNDING TYPE	STATUS, DETAILS & COMMENTS
FY 23 Appropriations	• $2M New water well for Commercial POE • $3M Chino Road Expansion • $833,000 for SCADA
Arizona Community Foundation	• $2500 for gaming inventory
Legacy Foundation	• Gaming Tables for Castro Park • Awarded $3500
Freeport McMoRan Foundation	• $60,000 to fill in gap for transit bus purchase

Funding in Review

FUNDING TYPE	STATUS, DETAILS & COMMENTS
FY 24 Appropriations	• $3M Raul H. Castro Park improvements • $1M multimodal pathways technical assistance • $1.3M Police Department Building & Fountains Restorations • $2.9M Downtown Revitalization Streetscape • $3M Lift station for new commercial POE
AZ Recycling Coalition	• Applied for a masonry to store wood chips • Will be informed of status in January/February
RAISE	• Surface transportation grants up to $25M • $15M for road improvements for commercial truck routes • No feedback yet
EPA Solid Waste Infrastructure & Infrastructure (SWIFR) grant program for Political Subdivisions of States & Territories	• City of Bisbee lead applicant • No feedback yet
Save America's Treasures	• Applied for a masonry to store wood chips • Will be informed of status in January/February

Funding Denied

FUNDING TYPE	STATUS, DETAILS & COMMENTS
Legacy Foundation Innovation Grant	• Accreditation Manager for Police Department • Denied due to not providing any funds towards project (not a requirement) but would have showed more investment into project
T-Mobile Hometown Grant	• Cargo vans for Rec On-the-GO vehicles • Denied due to limited funding • Spoke to T-Mobile rep, advised to go for projects where carrier signal strength is strongest to increase chances of funding
APS Take Charge AZ	• City of Douglas is on waitlist • 2023 funding allocations have been made and the City of Douglas has not been approved for an award
APS Solar Communities - Parking Structure	• City of Douglas is on waitlist due to limited funding
Tohono O'Odham	• Mariachi program • Denied due to limited funding
SMART	• Battery backups for all intersections on G Avenue & Pan American Avenue and video detection systems on G Avenue to eliminate timers

PROJECT INFORMATION SUMMARY:

Douglas Port of Entry (POE) Project

The Douglas POE project encompasses the construction and operational setup of a new commercial port, bringing together several key stakeholders including the General Services Administration (GSA), the City of Douglas, Arizona Department of Transportation (ADOT), and a collection of utility providers. The project is part of the larger Douglas Two-Port Solution initiative.

The Two-Port Solution, funded by a $400M grant from the bipartisan infrastructure package signed in 2022, entails the establishment of a new commercial POE and the expansion of the existing Raul H. Castro POE to accommodate regular vehicle and pedestrian traffic.

A critical aspect of the project is the Donation Acceptance Agreement (DAA) between GSA and the City of Douglas. The City is donating an 80-acre parcel of land near the US/Mexico border for the new POE and is responsible for delivering essential utilities to the site, such as water, sewer, electric, natural gas, and broadband services. Finalization of the DAA is anticipated within the next 2-3 months.

Meanwhile, ADOT has embarked on a Design Concept Report (DCR) and environmental compliance study, funded with $1.5M, to ascertain the connector road's optimal location leading to the new commercial POE.

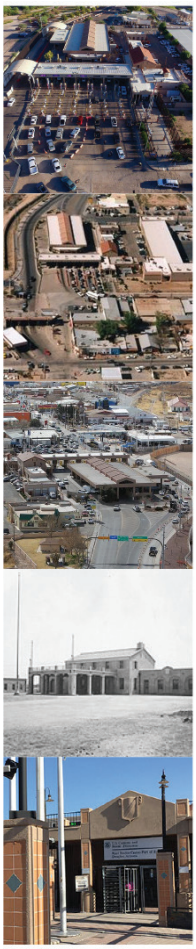
The DCR study, which commenced in January 2023, is slated for completion in December 2024.

From the utility standpoint, the City of Douglas has made progress with a 30% completion of the water/sewer/broadband conduit design and aims to proceed with the 60% design soon. Arizona Public Service (APS) is committed to delivering both temporary and permanent power to the site by March 2024, Cox will provide broadband services, and Southwest Gas is investigating how best to supply natural gas.

Supporting this project, several studies have been concluded, such as the GSA-led feasibility study, the Douglas Downtown Urban Design Study, and the Cochise County & Douglas Water/Sewer Masterplan Study. Several grants and funding partnerships have also been secured or are in application to cover the costs of design and construction.

The project has an outlined timeline:

- Planning: Environmental Impact Statement - Spring 2022 to Fall 2023. Architecture and Engineering Services Contract was awarded in July 2022.



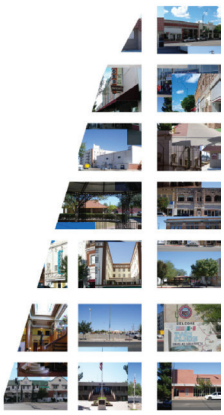
- Design: Design-Build Contract Award is projected for Fall 2024.
- Construction: Construction is expected to commence in Fall 2025 and reach substantial completion by Fall 2028.

A noteworthy feature of this project is the expected economic benefits. Once operational, the POE is projected to manage approximately $4B of annual imports and exports, significantly contributing to the local and national economy.

Furthermore, this project signifies a significant investment in infrastructure development in the City of Douglas and Cochise County, marking the most substantial federal contribution to the region in over a decade. The collaborative efforts of federal and local authorities, as well as private entities, underscores the project's strategic importance, bolstering the area's economic vitality and strengthening border operations.

PROJECT INFORMATION SUMMARY:

Downtown Revitalization Streetscape



The City of Douglas is in the process of implementing a Downtown Revitalization Plan aimed at revitalizing and redeveloping the downtown area. The Plan includes various elements such as street and sidewalk enhancements, lighting improvements, parking upgrades, landscaping, art installations, and alley improvements. The goal is to create a vibrant and active downtown for residents and visitors.

To gather input from the community, a workshop was held in October 2019 where participants ranked their preferences regarding different streetscape elements. The results of the workshop were used to publish a Request for Proposal for Downtown Streetscape Design Build. The firm awarded had the task of developing a plan and conceptual designs for enhancing the streetscape in the downtown area.

In March 2022, a public input meeting was held to gather feedback on the conceptual designs. A community survey was also published to allow residents who couldn't attend the meeting to provide their input. The feedback from these sources helped assess the viability of urban design innovations and potential streetscape improvements.

Following the public meeting, City officials met with the firm to discuss the commencement of the 30% schematic design for the G Avenue focus area. Additionally, the City requested an estimate for a 100% schematic design, which was not initially part of the scope of work. Progress on this project is a City priority in the upcoming budget cycle.

3.7 | Summary of the Current State

It is critical to understand as many facets of the City of Douglas as possible prior to designing a Telecommunications Roadmap. Understanding Douglas's current physical landscape, infrastructure, cellular coverage, SCADA system, and funding and projects maximizes our ability to create a Telecommunications Roadmap that leverages the City's assets and speaks to its unique value proposition. This current state analysis provides the foundation for a roadmap that aligns with Douglas's strategic vision and is designed to truly meet the City's needs.

4. Market Analysis

4.1 Comparable Cities Report

Typically, Smart City solutions focus on large cities and are often controlled by vendors such as Microsoft, AT&T, Verizon, US Cellular, Honeywell, Cisco and others wanting to sell products. The four key drivers for the large city focus are market size and potential, visibility and impact, political influence, and vendor-driven narratives.

Large cities have a higher population density and more significant infrastructure, which translates to a bigger market for vendors. These cities often face more complex challenges due to their size, thus creating a more pressing demand for Smart City solutions. Vendors see an opportunity to showcase their products and gain a foothold in these lucrative markets.

Implementing Smart City solutions in large cities can have a greater impact on a larger number of people. Successful case studies in these cities can significantly raise the visibility of the vendors and their products, creating a positive feedback loop that encourages further adoption.

Large cities often have more political influence, and their leaders may be more motivated to adopt innovative solutions to showcase their commitment to progress and development. Vendors can leverage this political interest to promote their products and establish partnerships with city governments.

Many Smart City case studies are vendor-driven, as companies use these stories as marketing tools to showcase the effectiveness of their products and services. This can lead to a bias towards large cities, where the potential market is more significant, and the impact of successful implementations can be more easily observed and measured.

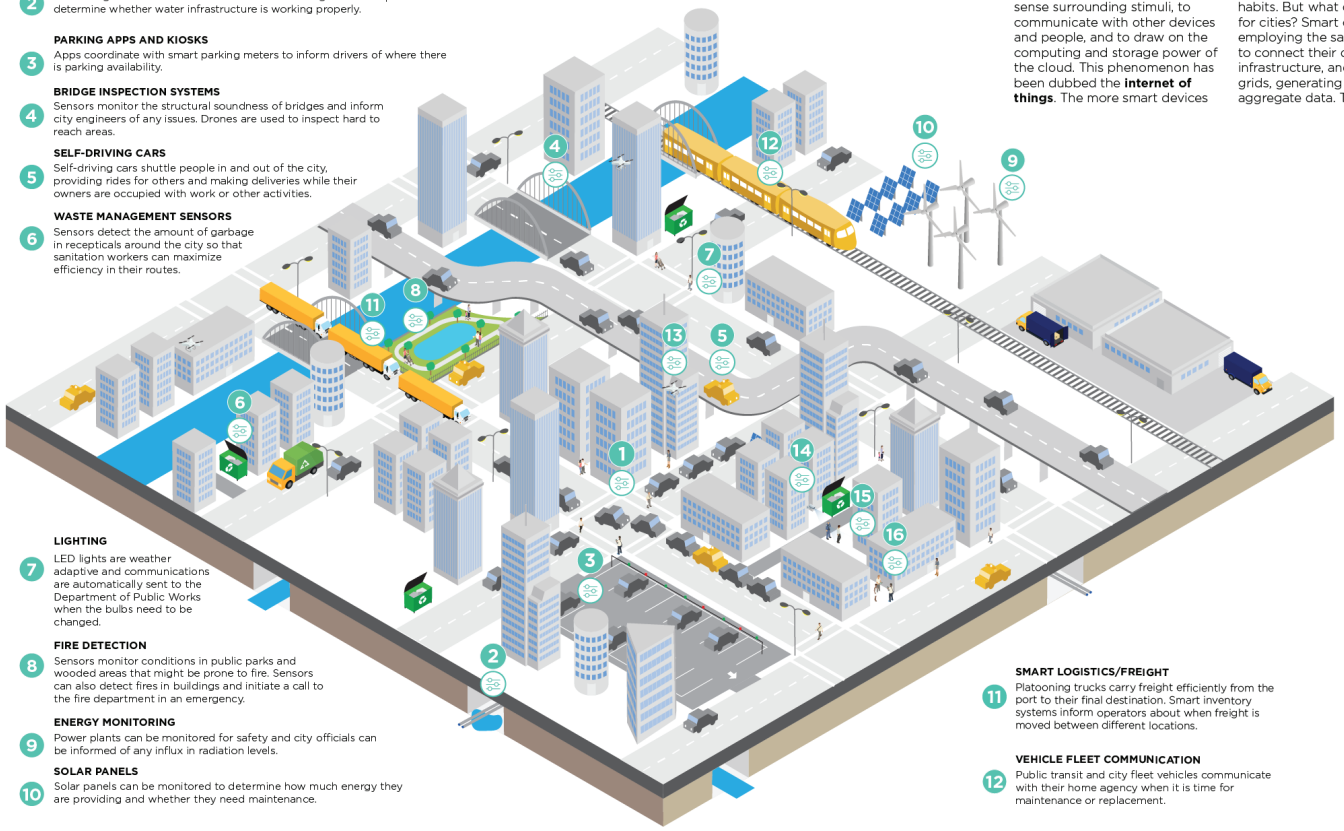
While focusing on large cities can provide valuable insights and lessons, it is essential to consider the unique challenges and opportunities faced by smaller cities as well. Diverse case studies can help create a more comprehensive understanding of how Smart City solutions can be effectively implemented across various city contexts.

Large city case studies include:

1. **CityScore in Boston, Massachusetts:** This program uses real-time data from various city departments to provide a comprehensive view of the city's performance, allowing officials to track and respond to issues such as traffic congestion, emergency response times, and air quality.
2. **Chicago Array of Things:** This project involves the installation of hundreds of sensors throughout the city that collect data on everything from air quality to traffic patterns. The data is then made available to researchers and city officials to inform decision-making and improve city services.
3. **Kansas City Smart City Initiative:** This program includes the deployment of smart streetlights, interactive kiosks, and a smart parking system. The data collected from these systems is used to improve city services and reduce costs.
4. **Sidewalk Labs in Toronto, Canada:** This project involves the development of a Smart City neighborhood in Toronto that uses sensors and data analytics to optimize energy use, traffic flow, and waste management.
5. **Smart Columbus in Ohio:** This program aims to create a connected, sustainable transportation system. It involves the deployment of electric vehicles, connected infrastructure, and a data platform to manage traffic and reduce emissions.
6. **San Diego's Smart Streetlights Program:** This program involves the installation of thousands of smart streetlights that can be remotely controlled and monitored. The lights also have sensors that can detect traffic and pedestrian activity, which can be used to optimize traffic flow and improve safety.
7. **LinkNYC in New York City:** This program involves the installation of high-speed public WiFi kiosks throughout the city. The kiosks also provide free phone calls, device charging, and access to city services.
8. **Portland, Oregon's EcoDistricts Program:** This program aims to create sustainable, equitable neighborhoods through the deployment of Smart City technologies and community engagement. It includes the use of data analytics to optimize energy use and reduce waste.
9. **City Innovate Foundation's STIR Program:** This program connects cities with technology companies to develop and implement Smart City solutions. It has led to the deployment of new technologies in cities such as San Francisco, Los Angeles, and Dallas.
10. **Indianapolis 500 "Race to Innovate":** This program is focused on using technology to optimize traffic flow and improve safety during the annual Indianapolis 500 race. It includes the deployment of connected vehicles, smart traffic management systems, and other technologies to improve the race experience for fans and participants.

INTERNET OF THINGS IN CONNECTED CITIES

Every consumer product and piece of infrastructure increasingly has the ability to sense surrounding stimuli, to communicate with other devices and people, and to draw on the computing and storage power of the cloud. This phenomenon has been dubbed the **internet of things**. The more smart devices and sharing platforms there are, the more data is generated about consumer's preferences and habits. But what does this mean for cities? Smart cities are employing the same technology to connect their disparate utility, infrastructure, and public service grids, generating real-time aggregate data. This, in turn, can help cities manage their programs and services more effectively and gauge their impact immediately. The city of the future is an interconnected one, where devices communicate with one another in a constant stream of data that provides real-time information to the public and to the municipality.



1. **TRANSPORTATION CONGESTION SENSORS**
Smart transportation systems use sensors to detect congestion and bottlenecks in traffic patterns. They also rely on cameras to enforce speed and traffic infractions. In doing so, these tools gather real time information that can be used by city DOTs to make mobility networks safer and more efficient.

2. **WATER AND WASTEWATER MONITORING**
Monitoring devices can detect leaks as well as changes in water pressure to determine whether water infrastructure is working properly.

3. **PARKING APPS AND KIOSKS**
Apps coordinate with smart parking meters to inform drivers of where there is parking availability.

4. **BRIDGE INSPECTION SYSTEMS**
Sensors monitor the structural soundness of bridges and inform city engineers of any issues. Drones are used to inspect hard to reach areas.

5. **SELF-DRIVING CARS**
Self-driving cars shuttle people in and out of the city, providing rides for others and making deliveries while their owners are occupied with work or other activities.

6. **WASTE MANAGEMENT SENSORS**
Sensors detect the amount of garbage in recepticals around the city so that sanitation workers can maximize efficiency in their routes.

7. **LIGHTING**
LED lights are weather adaptive and communications are automatically sent to the Department of Public Works when the bulbs need to be changed.

8. **FIRE DETECTION**
Sensors monitor conditions in public parks and wooded areas that might be prone to fire. Sensors can also detect fires in buildings and initiate a call to the fire department in an emergency.

9. **ENERGY MONITORING**
Power plants can be monitored for safety and city officials can be informed of any influx in radiation levels.

10. **SOLAR PANELS**
Solar panels can be monitored to determine how much energy they are providing and whether they need maintenance.

11. **SMART LOGISTICS/FREIGHT**
Platooning trucks carry freight efficiently from the port to their final destination. Smart inventory systems inform operators about when freight is moved between different locations.

12. **VEHICLE FLEET COMMUNICATION**
Public transit and city fleet vehicles communicate with their home agency when it is time for maintenance or replacement.

13. **DRONES**
Drones can be used for law enforcement and firefighting, as rural ambulances, for infrastructure inspections, and for environmental monitoring. Commercial uses include precision farming, aerial photography, and in the near future, package delivery.

14. **SURVEILLANCE CAMERAS**
Cameras ensure security by monitoring activity in areas that are not frequented by public safety officers. Areas that are not open to public access can be monitored to keep unauthorized personnel out.

15. **BODY CAMERAS**
Public safety officers can wear body cameras that capture footage of interactions between themselves and city residents to ensure safety for both parties.

16. **WEARABLE DECTECTION**
Cities can build in smartphone and wearable detection sensors so that people can be an active part of the internet ecosystem, communicating with the city, and with each other.

17. **BROADBAND INFRASTRUCTURE**
A reliable internet ecosystem is the glue that holds the internet of things together.

Some small cities (with populations of around 25,000) focus on solutions needed to cost-effectively automate tasks, usually within their transportation departments:

1. **Smart Columbus in Indiana:** This program is focused on using technology and data to improve transportation and energy efficiency. It includes the deployment of electric vehicles, charging stations, and a data analytics platform to manage traffic and reduce emissions.
2. **Eagan Smarter City in Minnesota:** This program is focused on using data and technology to improve transportation, energy efficiency, and public safety. It includes the deployment of sensors and data analytics to optimize traffic flow and reduce emissions.
3. **San Luis Valley Regional Airport in Colorado:** This program involves the deployment of a range of smart airport technologies, including automated weather stations, runway condition reporting systems, and remote tower cameras. The goal is to improve safety and efficiency at the airport.
4. **Smart Streetlights in Eastvale, California:** This program involves the deployment of smart streetlights that can be remotely controlled and monitored. The lights also have sensors that can detect traffic and pedestrian activity, which can be used to optimize traffic flow and improve safety.

Other small communities focus on opportunities to adopt and implement Smart City solutions to automate water, reduce core city costs, such as electricity, and to help build in differentiators within their respective regions:

1. **Waseca, Minnesota:** Waseca is a small city with a population of around 9,000 people that has implemented several Smart City initiatives. The city developed a smart street lighting program, which uses energy-efficient LED lights and sensors to optimize lighting and reduce energy consumption. Waseca has also implemented a smart water metering program, which uses sensors to detect leaks and reduce water waste. Additionally, the city has launched a mobile app that provides residents with real-time information on events, news, and city services.
2. **Monroe, Ohio:** With a population of around 13,500, Monroe, Ohio has implemented several Smart City solutions to enhance public safety and improve city services. For example, the city has installed a video surveillance system that covers key areas and provides real-time monitoring to law enforcement. Monroe has also implemented a smart water metering program that uses sensors to detect leaks and reduce water waste. In addition, the city has deployed a mobile app that allows residents to report issues such as potholes and broken streetlights and track the status of their requests.
3. **Independence, Oregon:** With a population of around 9,000, Independence, Oregon has implemented numerous Smart City solutions to enhance sustainability and improve city services. The city has installed smart LED streetlights that are remotely controlled and use energy-efficient lighting. Independence has also implemented a smart irrigation system for parks and public spaces, which uses sensors to detect moisture levels and optimize water usage. Additionally, the city has launched a mobile app that allows residents to report issues and receive notifications on city news and events. It has implemented a smart irrigation system to reduce water usage and costs; the city installed sensors on its irrigation system that monitor weather conditions and soil moisture levels to optimize irrigation schedules and reduce water waste. Independence has also implemented a smart parking program, which uses sensors to guide drivers to available parking spots and reduce traffic congestion.
4. **Lake Worth Beach, Florida:** Lake Worth Beach is a city with a population of around 8,000 people that has implemented various Smart City initiatives. The city developed a smart water metering program, which uses sensors to detect leaks and reduce water waste. Lake Worth Beach has also implemented a smart lighting system, which uses LED lights and sensors to reduce energy usage and maintenance costs. Additionally, the city launched a mobile app that provides residents with real-time information on city services and events.

Even though many case studies focus on larger cities, it is important to consider the unique needs, challenges, and opportunities present in smaller cities. Some smaller cities choose to problem-solve singular department issues while others take a broader approach to Smart City implementation. Learning from other cities can help to spark ideas for how cities can solve problems and realize benefits for their communities through Smart City initiatives.

5. Strategic Considerations

5.1 Overview

Strategic considerations are a way of structuring thinking, decision-making, and prioritization. Climate and community resilience paradigms are critical to incorporate into the fabric of the Smart City Plan and governance structure, as they generate long-term sustainability and increased funding opportunities. The following sections expand on the importance of strategic considerations, a basic understanding of climate resilience and its benefits, a suggested framework for incorporating climate resilience planning, and a basic understanding of community resilience and its benefits.

5.2 Importance of Strategic Considerations

In today's rapidly evolving and competitive landscape, strategic considerations are essential for organizations to navigate uncertainties, capitalize on opportunities, and achieve long-term success. Employing specific strategic decision-making paradigms yields many benefits: setting a clear purpose, maximizing and focusing resources, resilience to change, risk mitigation, enhancing competitive edge, organizational consistency and alignment, and long-term sustainability.

Strategic considerations help organizations establish a clear direction and purpose; by assessing market trends and internal capabilities, organizations can define their vision, mission, and strategic objectives. When organizations clearly communicate strategic goals and priorities, employees at all levels can align their efforts, make informed decisions, and work cohesively towards shared objectives. Clarity of purpose provides a unifying framework that guides decision-making at all levels and facilitates effective resource allocation toward common goals.

Having a unified framework for decision-making plays a critical role in optimizing resource allocation. Organizations must carefully evaluate their resource strengths and limitations to allocate them judiciously. By analyzing market dynamics, citizen needs, and internal capabilities, organizations can strategically invest in areas that offer the highest return on investment and greatest impact.

Strategic considerations also enable organizations to anticipate and adapt to changes in their organizational environment. By monitoring market trends, technological advancements, and citizen preferences, organizations can proactively identify potential disruptions or emerging opportunities. This foresight allows organizations to adjust their strategies and stay ahead of the curve, sustaining long-term growth.

Effective risk mitigation is another benefit of employing a consistent decision-making paradigm throughout an organization. By conducting thorough environmental scanning, SWOT (strengths, weaknesses, opportunities, and threats) analyses, and scenario planning, organizations can identify potential risks and develop contingency plans. This proactive approach helps minimize the impact of unforeseen events. Strategic considerations also enable organizations to identify opportunities within challenges, turning uncertainties into advantages.

A cohesive decision-making framework plays a pivotal role in creating and sustaining competitive advantage in securing funding, particularly when aligned with current federal and state funding initiatives. By analyzing market dynamics, citizen preferences, and federal and state funding priority areas, organizations can develop differentiated value propositions that effectively meet citizen and organizational needs alike. Strategic considerations also facilitate the identification of unique capabilities, innovation opportunities, and strategic partnerships that enhance the organization's competitive position in the market.

Strategic considerations are crucial for a community's long-term sustainability; they necessitate the evaluation of market trends, customer demands, and technological

advancements to stay competitive. They help anticipate disruptions, foster innovation, and develop new business models. A cohesive decision-making framework provides a roadmap for growth, resource optimization, adaptability, and risk mitigation, building a foundation for long-term success in a dynamic socio-political landscape.

To have the greatest likelihood of realizing the above benefits, we recommend employing community and climate resilience paradigms for decision-making. They are emerging areas of emphasis for federal and state funding opportunities, and decision-making with a focus on long-term resilience and sustainability will have positive impacts on the City, independent of funding measures.

5.3 Climate Resilience

What is climate resilience?

Climate resilience refers to the capacity of natural and human systems to adapt and respond to the impacts of climate change. It encompasses the ability of ecosystems, communities, and societies to withstand and recover from climate-related shocks and stresses while maintaining their essential functions and well-being.

The key aspects of climate resilience are adaptation, risk reduction, sustainable resource management, social equity, and cross-sector collaboration. This includes strategies to anticipate and reduce the impacts of climate change, such as implementing infrastructure improvements, land use planning, water management, and agricultural practices that are resilient to extreme weather events, rising temperatures, and changing precipitation patterns.

A climate resilience decision-making paradigm aims to identify and minimize risks associated with climate change impacts. Conducting risk assessments, developing early warning systems, and implementing disaster preparedness plans are all strategies to minimize climate-related risks. Risk reduction efforts focus on minimizing the potential impacts of climate-related hazards on lives, livelihoods, and ecosystems.

Climate resilience also integrates sustainable resource management practices to ensure the efficient use of natural resources and reduce the pressure on ecosystems. This includes sustainable land and water management, conservation of biodiversity, sustainable agriculture, and the protection and restoration of ecosystems that provide essential services for climate regulation and adaptation.

Ensuring that vulnerable and marginalized communities are not disproportionately affected by climate change impacts is another critical component of the climate resilience paradigm. It involves addressing social inequalities, securing access to resources and services, empowering marginalized groups, and promoting inclusive decision-making processes to guarantee climate resilience benefits for all members of society.

The climate resilience framework requires collaboration and coordination across different sectors and stakeholders and involves engaging governments, communities, businesses, academia, and civil society organizations to develop integrated strategies. Knowledge and resource-sharing are critical pieces of cross-sector collaboration. Cross-sectoral collaboration strengthens the capacity to address complex climate challenges and promotes collective efforts toward building resilience.

What are the benefits of climate resilience?

Climate resilience has many benefits: reduced vulnerability, enhanced ability to adapt, sustainable development, and improved ecosystem preservation are several of the most notable benefits. Being climate resilient reduces vulnerability to climate change impacts by enhancing the ability of ecosystems, communities, and systems to withstand and recover from climate-related hazards. It helps minimize disruptions to infrastructure, food and water systems, and economic activities, thereby reducing the risks to human lives and livelihoods.

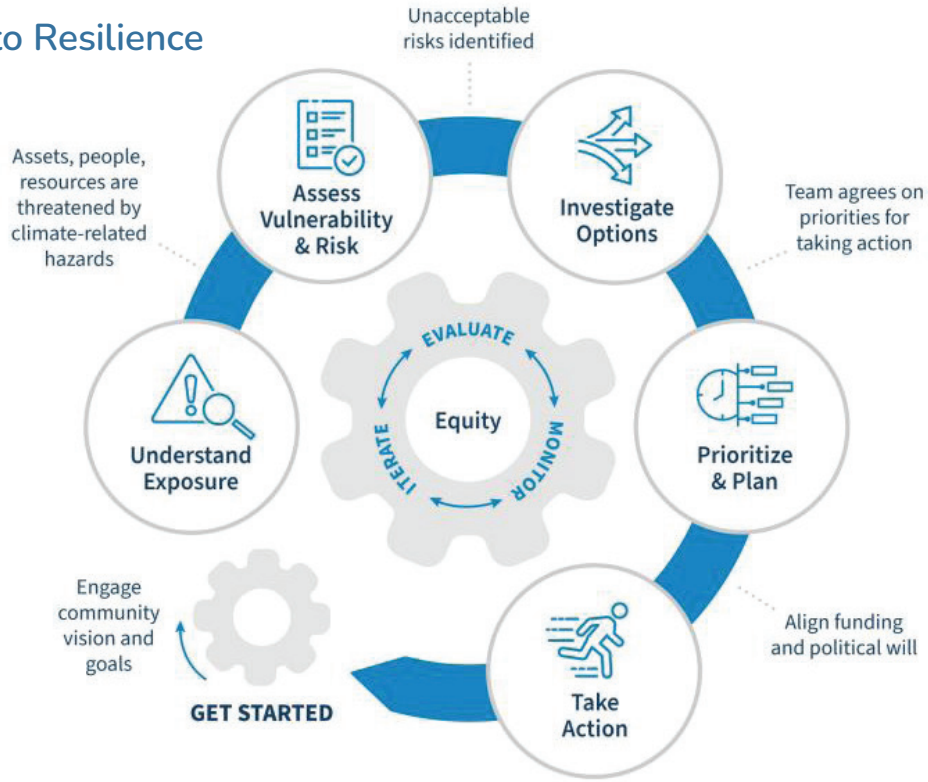
By focusing on climate resilience, communities and ecosystems are better able to adapt to changing climatic conditions. Climate resilience enables the implementation of adaptive strategies, such as diversifying livelihoods, protecting natural habitats, adopting climate-smart agricultural practices, and promoting sustainable water management, which enhance a community's ability to thrive in the face of climate uncertainties.

Climate resilience aligns with sustainable development goals by promoting sustainable resource management, responsible consumption and production, and equitable socio-economic development. It fosters long-term sustainability and helps build a more resilient and prosperous future.

The preservation and restoration of ecosystems, which provide essential services such as carbon sequestration, water purification, and natural hazard mitigation is a critical component of climate resilience. Healthy ecosystems play a crucial role in climate regulation, reducing the impacts of climate change, and supporting biodiversity and ecological balance.

By embracing climate resilience planning, communities not only minimize vulnerabilities and reduce risks but also promote sustainable development and ensure the well-being and prosperity of present and future generations in the face of a changing climate.

The Steps to Resilience



How can the City implement climate resilience decision-making?

The Steps to Resilience Framework, provided by the US Federal Government (Steps to Resilience Overview | U.S. Climate Resilience Toolkit) is a five-step process to help communities build resilience to climate change. The framework provides a structured approach to identifying and assessing climate risks, engaging stakeholders, developing a resilience plan, implementing the plan, and monitoring and updating it.

The first step in the framework is to identify and assess climate risks. This involves understanding the potential impacts of climate change on the community, such as extreme weather events, sea level rise, and changes in temperature and precipitation patterns. Communities can use a variety of tools to assess their climate risks, including climate models, historical data, and local knowledge. Once the risks have been identified, they can be prioritized based on their potential impact and likelihood.

The second step in the framework is to engage stakeholders. This involves working with community members, businesses, government agencies, and other stakeholders to build support for resilience initiatives. Stakeholders can provide valuable input on the risks and potential solutions, as well as help to identify resources and opportunities for collaboration.

The third step in the framework is to develop a resilience plan. This involves identifying strategies and actions that can be taken to reduce the community's vulnerability to climate risks. Resilience plans should be comprehensive and include a range of actions, such as improving infrastructure, diversifying the economy, and enhancing natural resources. The plan should also be flexible and adaptable, as climate risks may change over time.

The fourth step in the framework is to implement the resilience plan. This involves putting the strategies and actions identified in the plan into action. Implementation requires collaboration among stakeholders and may involve securing funding, building partnerships, and establishing new policies and regulations.

The final step in the framework is to monitor and update the resilience plan. This involves regularly evaluating the effectiveness of the strategies and actions identified in the plan and making updates as needed. Monitoring and updating the plan ensures that the community remains resilient in the face of changing climate risks.

The Steps to Resilience Framework provides a valuable approach to building resilience to climate change. By following these five steps, communities can identify and assess their climate risks, engage stakeholders, develop a comprehensive resilience plan, implement the plan, and monitor and update it over time. While building resilience requires a long-term commitment, the Steps to Resilience framework provides a structured approach to help communities achieve their resilience goals.

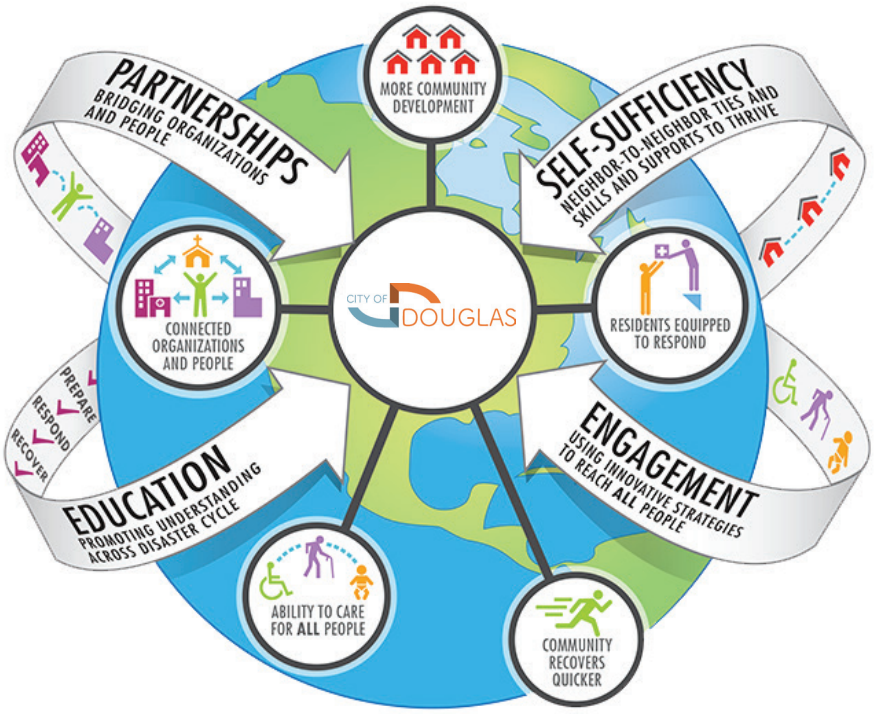
5.4 Community Resilience

How are climate resilience and community resilience related?

While community resilience may include climate resilience as a component, climate resilience focuses specifically on the impacts of climate change and the need for adaptation strategies to address those impacts. Both concepts are important in building resilient communities, but climate resilience has a narrower focus and community resilience a broader purview.

What is community resilience?

Community resilience refers to the capacity of a community to effectively respond, adapt, and recover from shocks, stresses, and disruptions; it encompasses the ability of individuals, organizations, and systems within a community to withstand and bounce back from adversity, such as natural disasters, economic downturns, social crises, or environmental challenges.



The key features of community resilience are preparedness, social cohesion and collaboration, adaptive capacity, diverse and redundant systems, and communication and information sharing. Community resilience involves proactive measures to prepare for potential hazards or disruptions. Risk assessments, emergency planning, infrastructure development, and the establishment of early warning systems are important preparedness efforts that ensure communities are better equipped to handle and respond to unexpected events.

Strong social networks and community bonds are essential for resilience. When individuals and groups within a community have strong relationships and a sense of belonging, they are more likely to support one another during challenging times. Collaboration among community members, organizations, and institutions fosters collective problem-solving, resource sharing, and effective response and recovery efforts.

Community resilience relies on the ability to adapt and adjust to changing circumstances. Communities with high adaptive capacity can quickly learn from past experiences, innovate, and implement novel approaches to address evolving risks or stressors or incorporate new information.

Resilient communities have diverse and redundant systems in place to ensure the continued functioning of critical infrastructure, services, and resources. Redundancy allows for backup mechanisms or alternative options in case primary systems fail. These types of systems help mitigate vulnerabilities and ensure that community needs can be met, even in adverse conditions.

Effective communication and information sharing are crucial for community resilience. Timely and accurate information enables community members to make informed decisions, take appropriate actions, and access necessary support. Effective methods of communication are critical, particularly in the face of emergencies, to aid in coordination, collaboration, and the dissemination of vital information throughout a community.

What are the benefits of community resilience?

Like climate resilience, a community resilience decision-making paradigm provides many benefits: decreased vulnerability, faster recovery, improved quality of life, and sustainable development. Resilient communities are better prepared to withstand and recover from shocks and stresses. By identifying and addressing vulnerabilities, communities can minimize the impacts of disasters or crises on human lives, infrastructure, and the environment. Communities with high resilience enables quicker recovery and restoration of essential functions following a disruption. These communities bounce back more efficiently, minimizing the social, economic, and environmental impacts and reducing the duration of recovery.

By investing in resilience planning, communities can enhance public safety, healthcare services, access to resources, and overall well-being. Resilient communities also foster a sense of security, stability, and confidence among their members. Once climate and community resilience paradigms are woven into the fabric of the Smart City Plan and governance, the City will collect baseline data and create goals, initiatives and strategies that include these frameworks; the federal government has highlighted these paradigms as critical priorities, and incorporating resilience frameworks will not only support Douglas's long-term sustainability but also position it to be more competitive for future funding opportunities.

6. Best Practices for Governance

6.1 Overview

Governance refers to the way organizations, communities, or societies engage in decision-making processes and reach their goals. It encompasses rules, regulations, and procedures that guide the conduct of individuals and entities within these contexts. The following sections discuss best practices in organizational governance and decision-making data gathering.

6.2 Governance, Ownership & Management Strategy Analysis

This section provides the City with knowledge and application of best practices in policy development and an organizational structure for implementing and operating broadband networks and Smart City initiatives.

Organizational Structure

The best organizational structure for a Smart City Department will vary depending on the city's size, resources, and specific needs. Best practices for successful city governance should be designed to encourage collaboration, innovation, and effective project management.

At a minimum, Douglas should structure a Smart City/Technology Department to include a Smart City Director. However, we recommend the following teams as important roles within a Smart City/Technology Department. We recognize that in a smaller city, these teams might incorporate members from other departments; the functions the teams serve are critical to cover, regardless of the way in which they are structured.

1. **Smart City Director or Manager:** This leader should be responsible for overseeing the department, setting the strategic direction, and coordinating with other departments and stakeholders. They should report directly to the City Manager, Mayor, or another top executive to ensure the department's priorities align with the City's overall goals.
2. **Smart City Plan Committee:** This team should be responsible for developing and refining the Smart City strategy, setting priorities, and ensuring the alignment of projects and initiatives with the City's goals. It should also engage with stakeholders, identify funding opportunities, and monitor progress towards strategic objectives.
3. **Project Management Team:** This team should be responsible for the day-to-day management and implementation of Smart City projects. It should work closely with other City departments, external partners, and vendors to ensure that projects are delivered on time and within budget.
4. **Technology and Infrastructure Team:** This team should be responsible for managing the technology and infrastructure components of Smart City projects, including network connectivity, IoT devices, data platforms, and other digital tools. It should also work closely with the City's IT department to ensure the smooth integration of new technologies and systems.
5. **Data and Analytics Team:** This team should be responsible for collecting, analyzing, and sharing data from Smart City projects to inform decision-making, monitor performance, and drive continuous improvement. It should work closely with other city departments to promote a culture of data-driven decision-making.
6. **Community Engagement and Communications Team:** This team should be responsible for engaging with residents, local businesses, and other stakeholders

to ensure that Smart City initiatives address their needs and concerns. It should also be responsible for communicating the department's goals, progress, and achievements to the public.

7. **Cross-Functional Task Forces:** Depending on the specific needs of the City, it might be helpful for public safety or energy efficiency initiatives, for example, to utilize cross-functional task forces. These task forces should include representatives from relevant City departments, as well as external partners and stakeholders.

A successful Smart City Department should be agile, collaborative, and focused on continuous improvement. By adopting an organizational structure that supports these principles, the City of Douglas can more effectively plan, implement, and manage Smart City initiatives that improve the quality of life for its residents.

6.3 Data Analysis Approach for Informed Decision-Making

Then data generated and used in a Smart City is vast; it is critical that the City learns how to prioritize, gather, and analyze data. Clustering data is a valuable data analysis practice that involves grouping similar data points together based on shared characteristics or patterns. In the context of Smart City solutions, clustering data can provide insights for developing resilient strategies by identifying patterns, trends, and relationships within complex city systems. This data gathering and analysis can be done internally or can be hired out to a 3rd party who specializes in this kind of data gathering and analysis. As Douglas progresses with Smart City infrastructure and initiatives, data will be more readily available to compile and utilize.

This data analysis approach helps identify common challenges faced by different areas or neighborhoods, such as traffic congestion or air pollution. By recognizing these shared challenges, City planners can develop targeted solutions that address multiple issues simultaneously. This approach maximizes the efficiency and effectiveness of interventions, resulting in more impactful outcomes.

Analyzing data with clustering on a larger scale can identify other cities that have successfully implemented resilient Smart City solutions and share similar characteristics. This facilitates the sharing of best practices and lessons learned between cities, enabling effective adoption and adaptation of proven strategies. By learning from each other's successes, cities can accelerate their progress toward resilient and sustainable udevelopment.

The practice of data analysis through clustering provides for more efficient resource allocation by identifying areas with similar resource needs or infrastructure requirements. This allows cities to prioritize investments in areas with the greatest needs or potential impact. By aligning resources with specific challenges and requirements, Douglas can optimize resource allocation and achieve better outcomes in it's Smart City initiatives.

Clustering data helps identify common challenges, facilitates the sharing of best practices, and enables efficient resource allocation. By leveraging the insights gained from clustering, the City can develop targeted and resilient Smart City solutions that address complex city challenges and improve the overall well-being of the community.

Effective governance in a smart city involves establishing an organizational structure that fosters collaboration and innovation; the establishment of cross-functional teams is critical to coordinate all departments and create buy-in for the plan, initiatives, and strategies. Using data as the foundation for the planning process leads to more community support, additional insights, and better solutions. Clustering is a data analysis process that contributes to informed decision-making by identifying common challenges, sharing best practices, and enabling efficient resource allocation. By leveraging these practices, Douglas can continue to progress in its Smart City implementation and can help its community become more resilient through best practices in governance and decision-making.

7. Core Infrastructure Design Recommendations

7.1 Overview

The infrastructure plan proposed for the City includes a complete set of building blocks to enable the city to transition to a Smart City over a period of time, likely 3-5 years, for the basic infrastructure. The completion of the process could take up to 10 years or longer as new technology is introduced. This document envisions funding being limited and sporadic, so it is critical to rely on a phased approach to placing infrastructure. This phasing is based upon criticality, dependencies, and near-term impact to the City.

The section begins with a short explanation of the proposed technology and the role it plays in the Smart City infrastructure design.

7.2 Infrastructure Design

In this section, we provide an in-depth exploration of the various components that make up Smart City infrastructure, accompanied by comprehensive maps and real-world use cases.

The Smart City Telecommunications Roadmap project designed for the City of Douglas was planned with a focus on providing a highly reliable, scalable, and secure infrastructure to support the city's Smart City initiatives for 25-30 years. This network design incorporates various components, including transport fiber, microwave backhaul, switching/routing, and the integration of both fixed wireless access (FWA) and active Ethernet (Active E) technologies. The combination of these elements ensures seamless connectivity, high-speed data transfer, efficient network management, and robust security.

The network is interconnected with four technologies: fiber, fixed wireless, microwave and Private LTE. Each of the technologies serves a specific purpose and also provides a unique capability. Because the networks are all based upon standard Ethernet protocols; any connection can interface within the system switching and routing equipment.

Fiber optic cables are capable of virtually unlimited speed and capacity, with low latency. Typical connections speeds for fiber are up to 100Gbps. Fiber optic cables are the most expensive type of connectivity however are preferred whenever possible.

Microwave systems connect remote locations, towers into the network at 10Gbps speeds and can be deployed more cost-effectively and more quickly than fiber optics. The microwave systems are designed to 99.999% reliability due to carrier-grade, multi-frequency technology.

The fixed wireless access network provides low-cost, high-speed connections to City-owned buildings and targeted locations. The fixed wireless sites are deployed at the towers to ensure up to 1Gbps connections using unlicensed frequencies.

Private LTE, also deployed on the City towers, provides a range of services including voice and data mobility and IoT applications. This network uses licensed frequency to ensure stability and reliability. The network is used as the primary interface to the SCADA/IIoT/IoT sensor networks, with thousands of potential connections per site. The Private LTE network provides voice and data capabilities city-wide, including annex and remote locations such as the New Port of Entry.

Networking equipment is standards-based, using common Ethernet protocols. This allows inter-networking between all of the proposed technologies as well as existing equipment in the City's current network. The proposed equipment offers higher capacity, scalability and advanced protocols, allowing the network to meet the needs for 5-10 years before equipment refresh; this may be desired to take advantage of current technology or performance gains.

In addition to the infrastructure design overview, there are several other elements that each contribute to the foundation of the Smart City infrastructure and warrant additional discussion: vertical assets, conduit and fiber networks, fixed wireless networks, Private LTE, public WiFi and the SCADA system.

Vertical Assets

The term vertical asset refers to any physical structure or facility that can be utilized to host wireless infrastructure and equipment. These assets are typically tall structures such as buildings, towers, poles, or other elevated points. For the purposes of this report a vertical asset will be a telecommunications tower or a water tower that is retrofitted to mount antennas on.

Constructing vertical assets (towers) begins with a comprehensive feasibility study. This initial assessment determines the need for a new tower, pinpoints the best location, and identifies the most appropriate type of tower to meet those needs. This process often includes reviewing network coverage maps, considering local terrain and weather conditions, and exploring any local zoning laws or other regulations that could impact the project. Native Network performed the preliminary study and has identified 4 locations that meet the coverage requirements and are likely candidates for 3rd party collocation.

The identified sites are all located on City-owned land, however formal internal designation of the land for tower use is required. This process may involve negotiation between City departments as well as approval by the City Council. At the same time, city zoning laws around land usage must be considered for the chosen locations.

Running in parallel with site acquisition is the process of securing necessary regulatory approvals. This often means applying for construction permits, undertaking environmental impact assessments, and complying with historic preservation laws. In some cases, this stage may also include public consultations. The timeline for this process can be significant, and it varies based on the regulations specific to the location.

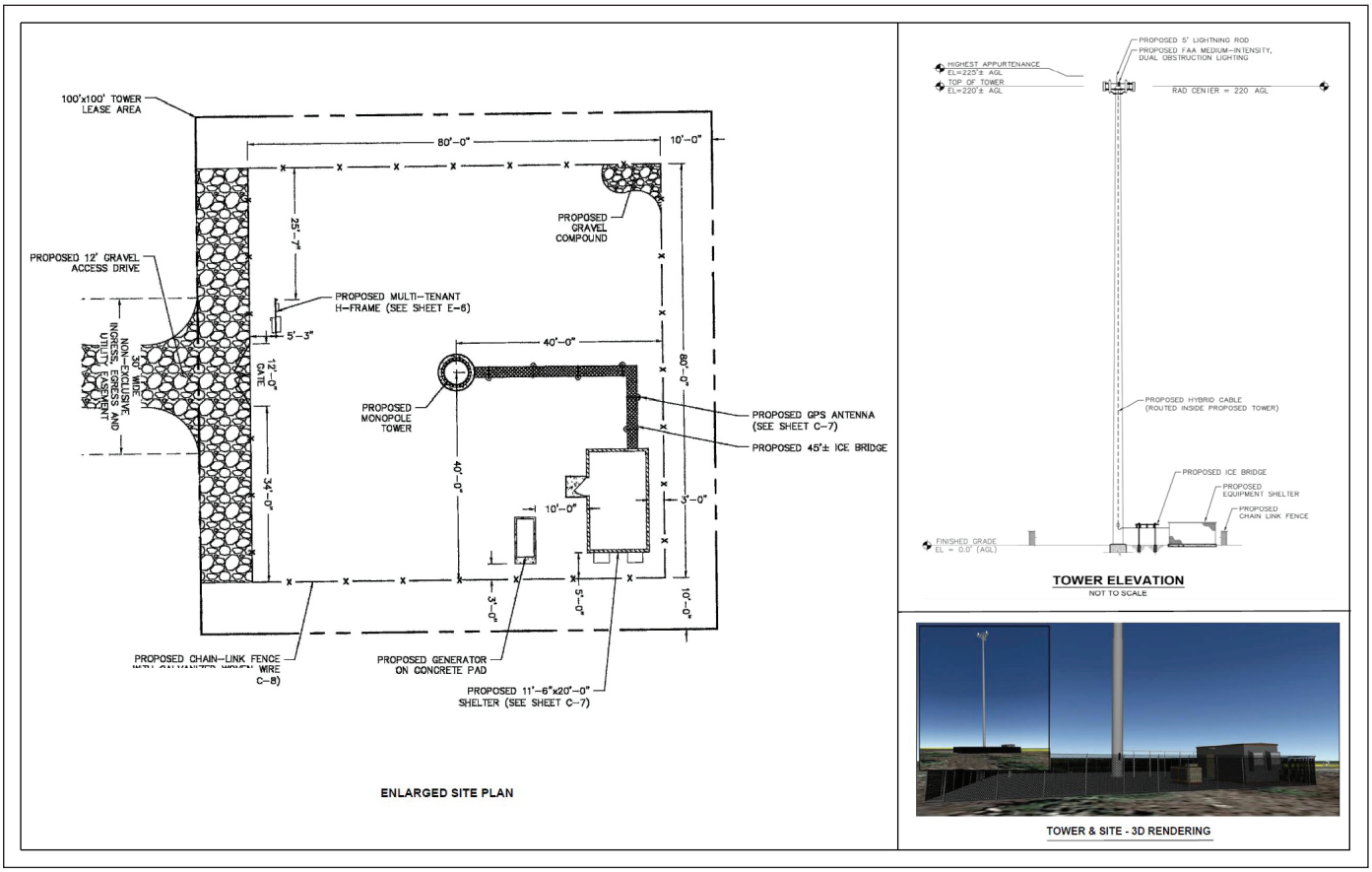
Once the location is secured and necessary approvals are in place, the design of the tower is confirmed. Factors influencing the design include the requirements of the wireless networks the tower will host, local environmental conditions, and applicable building codes. This design process is usually undertaken by a specialized engineering firm; Native Network has the ability to complete this engineering once finances are secure.

With a finalized design and all necessary permits, construction can begin. This phase involves a range of activities, from preparing the site, which may involve clearing the land and laying foundations, to assembling and erecting the tower, and then installing the necessary equipment such as antennas, transmitters, and power supply units. Specialized contractors carry out the construction, subject to regular inspections to ensure compliance with the design and safety standards. Typically, a city project manager is assigned to oversee the project, however a 3rd party project manager and quality control specialist may be utilized to effectively outsource this function.

Upon commissioning of the tower, a regular maintenance cycle will start. This requires regular inspections and preventative maintenance tasks such as rust prevention. These are key parts of the tower's lifecycle. Tower lighting is a major maintenance concern for towers identified by Federal Aviation Administration (FAA) as near an airport or in a known flight path.

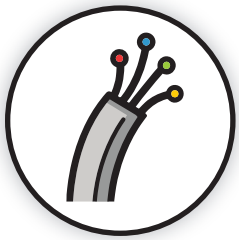
The leasing of tower space to interested parties can begin upon tower completion. An example tower lease agreement and recommendation for asset tracking have been provided as attachments to this document. As interested parties are identified, their needs are outlined in a lease questionnaire. The City's local engineer or a 3rd party is consulted to ensure tower capacity; a structural analysis is typically performed prior to the approval of new tower lessees.

An example of a typical monopole tower, compound drawing and communication tower is provided on the next page. Specific tower type and height specifications are also provided for the proposed tower locations in this report.



Example of a typical monopole communications tower drawing, compound/site plan drawing & 3D rendering

Fiber Optic & Conduit Network



The fiber optic networks are typically constructed underground to ensure long-term survivability and ease of access to key assets. A dual conduit system is planned to accommodate the current needs of the City as well as future network requirements for both the City and 3rd parties interested in constructing additional fiber networks. The addition of this second conduit isolates government from commercial networks and serves to reduce multiple disruptions of the same streets in the future.

Native Network recommends leasing conduit space only, not fiber optic cables. This eliminates any repair issues for carriers except actual damage to the conduit itself.

Two four-inch conduits should be placed wherever possible during any kind of ground disturbance to maximize cost-efficiency and minimize construction disuption. These conduits have space for multiple sub-ducts ranging from .5 to 1.5 inches. One conduit is reserved for the city's use and potential lease to other government or quasi-government type entities. The other conduit is leased out to commercial telecom carriers, Internet Service Providers or others interested in private networks.

The leasing of conduit creates a revenue stream to offset the ongoing costs of the Smart City network. A summary of potential revenue is included in the Financial Section of this document.

The Fiber optic network is the preferred transport technology as it is capable of virtually unlimited bandwidth. Optronics (Optical Electronics) are improving rapidly relying on technologies such as Dense Wave Division Multiplexing (DWDM), to allow for infinite speeds to meet any scalability requirements well into the future.

A 288 fiber count fiber in a dedicated sub-duct is the recommendation for the City's network. If additional fiber were to be needed in the future an additional sub-duct could be allocated. This fiber connectivity provides bandwidth to city owned facilities, buildings and towers. Other commercial networks provide individual homes with Internet access.

The following are conduit and fiber matrices, identifying the materials needed, giving a description of each, and laying out the specifications.

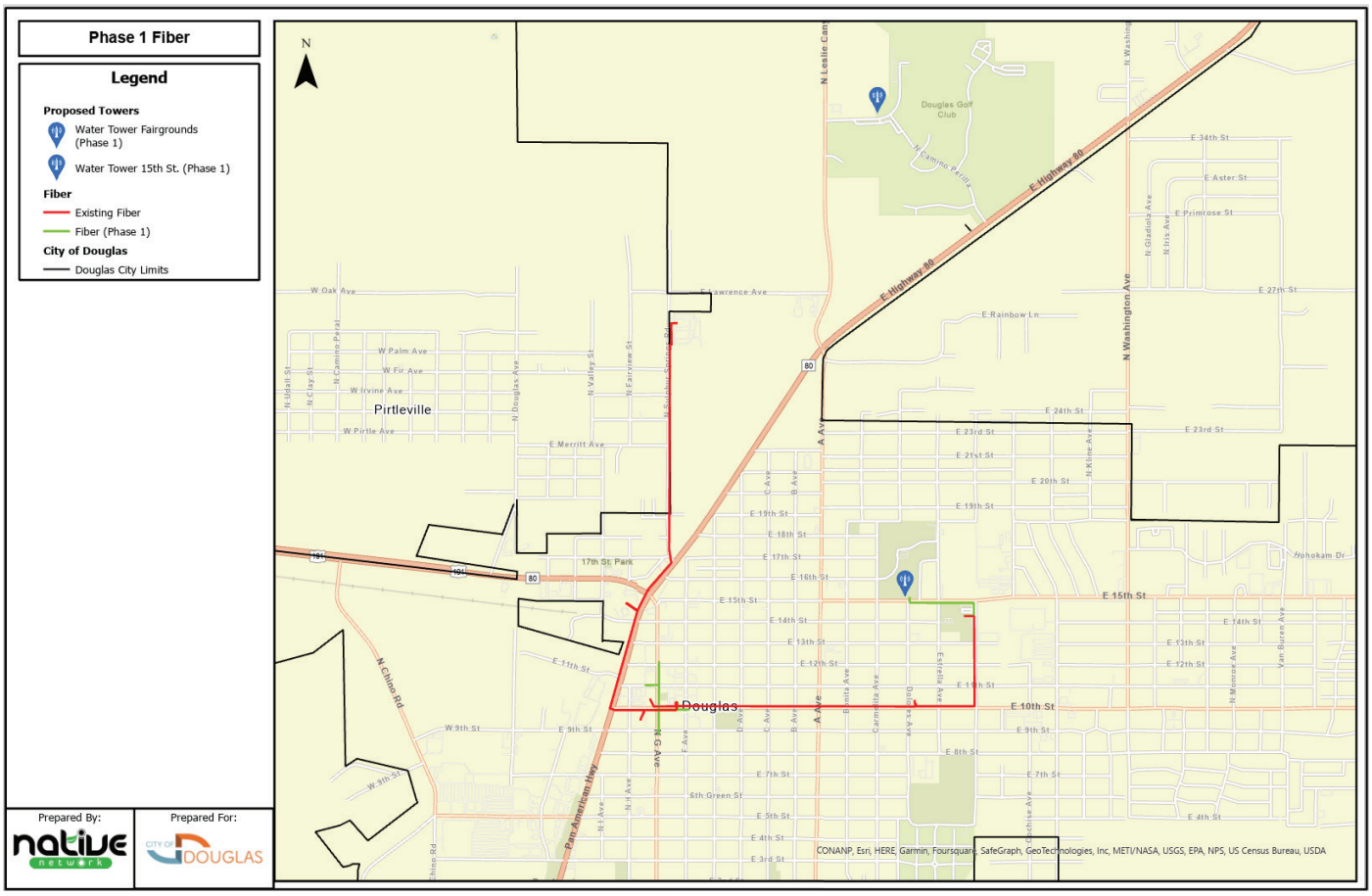
Conduit Network

MATERIALS	DESCRIPTION	SPECIFICATIONS
Conduit	A conduit refers to a protective tube or pipe used to house and protect fiber optic cables (FOCs). It provides a pathway for routing and organizing the cables, shielding them from external elements such as moisture, dust, and physical damage. Conduits can be made of various materials, including PVC, metal, or fiberglass, and they are commonly used in both underground and aboveground installations to ensure the longevity and reliability of the fiber optic infrastructure.	FOC: 2x 4" HDPE conduit (1 for City of Douglas, 1 for leasing to interested 3rd parties) POW: 1x 2" HDPE Conduit
Subduct	Subducting is the process of installing smaller ducts within a larger conduit or duct bank. Subducts are used to create additional pathways or channels for future cable installations or for segregating different types of cables within the same conduit system. By using subducts, network operators can plan for future expansion or upgrades without the need for extensive trenching or disruptive installations. Subducts are typically smaller in size and are often color-coded for easy identification and management	1"-1.5" subduct lease spaces 3rd parties to install themselves
Vault	A vault refers to an underground enclosure or chamber used to house and protect fiber optic equipment, cables, and splices. Vaults are typically located at strategic points along the network, such as street intersections or building entry points. They provide a secure and accessible location for technicians to access and maintain the fiber optic infrastructure. Vaults are often constructed with reinforced concrete or other durable materials to withstand environmental factors and ensure the safety and reliability of the equipment and cables within.	Minimum size ROW: 24" x 36" x 36" meets AASHTO H-20 load rating non-ROW: 24" x 36" x 36"
Cabinet	A Cabinet is a secure housing used to store and protect active network equipment, such as switches, routers, or power supplies, in fiber optic networks. Cabinets are typically installed in indoor or outdoor locations and are designed to provide physical protection, climate control, and cable management for the equipment. They often feature lockable doors, cooling systems, cable entry points, and other features to ensure the efficient and reliable operation of network equipment in a fiber optic infrastructure.	Clearfield Cabinet

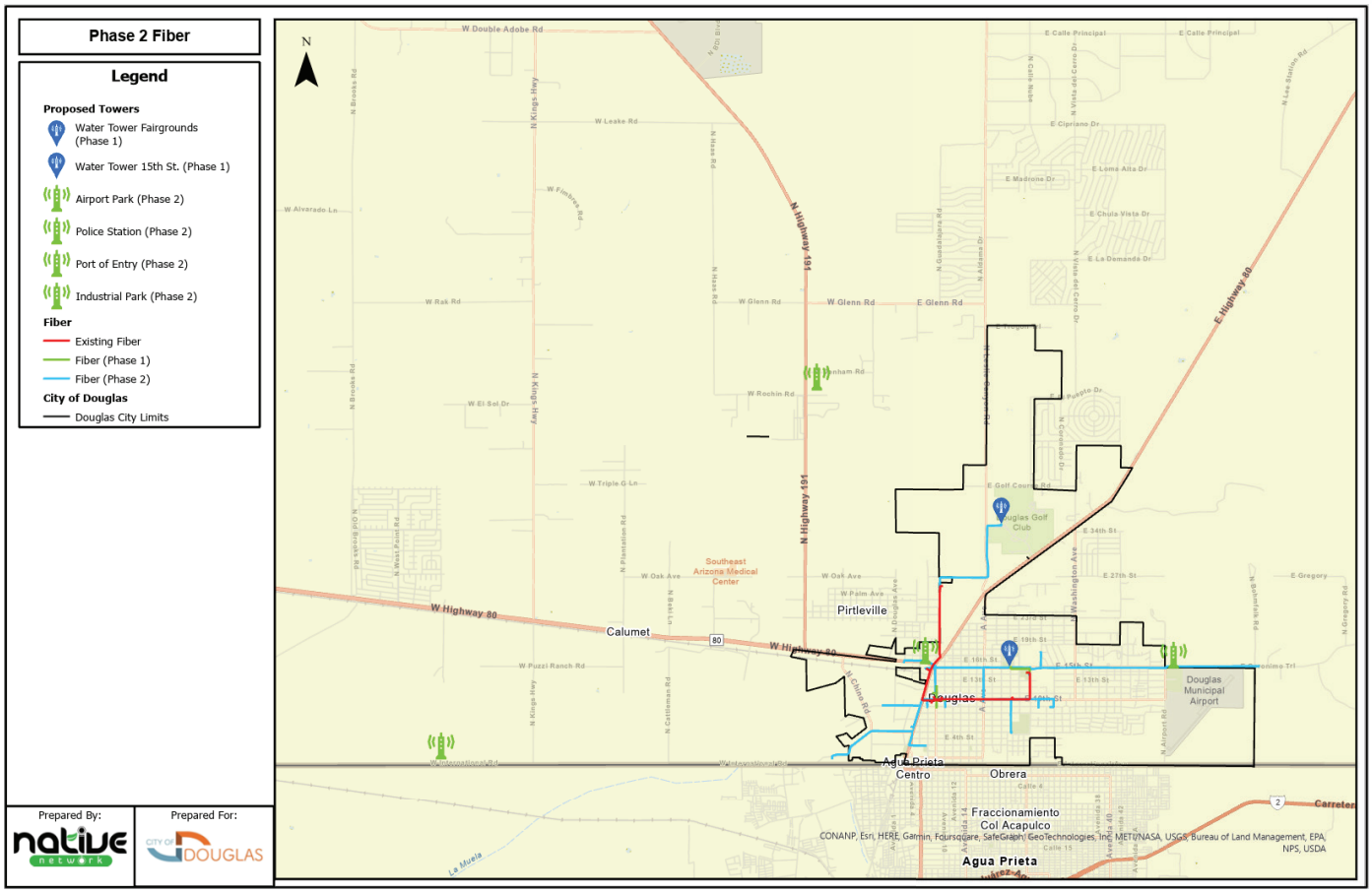
Fiber Optic Network

MATERIALS	DESCRIPTION	SPECIFICATIONS
Backbone	"Backbone" refers to the main high-capacity network infrastructure that forms the core of a telecommunications system. It consists of primary fiber optic cables (FOCs) that carry a large volume of data over long distances, connecting major locations such as cities, campuses, or data centers. The backbone network serves as the central pathway for transmitting data and supporting various services and connections within a network	288 ct FOC
Lateral	"Lateral" typically refers to a secondary or branching fiber optic cable (FOC) that extends from the main backbone to individual buildings, floors, or rooms within a network. Lateral cables are used to distribute connectivity to specific areas or endpoints, providing localized access points for data transmission and network connectivity	36 or 72 ct FOC
Drop	"Drop" is a term used to describe the portion of fiber optic cable (FOC) that connects an individual subscriber or end-user to a larger network. It is the final segment that brings connectivity from the lateral cable to the specific location or device, often referred to as the "last mile" connection. Drops are typically shorter in length compared to backbone or lateral	1 ct FOC pre-connectorized
Slack Loop	Slack loops provide a practical solution for managing excess cable length in fiber optic networks, enabling flexibility, scalability, and efficient maintenance of the infrastructure.	50'-150' slack loops in every vault
Splice Case	A "splice case" is a protective enclosure or housing used in fiber optic networks to house and protect splices between optical fibers. When two fiber optic cables need to be connected or joined together, the process is called splicing. The splice case provides a secure and controlled environment for the spliced fibers, protecting them from external elements such as moisture, dust, and physical damage. It typically includes trays, holders, or organizers for managing and organizing the spliced fibers, as well as access points for routing and connecting the fibers to other network components.	450 D - 288 ct 350 D -72 ct

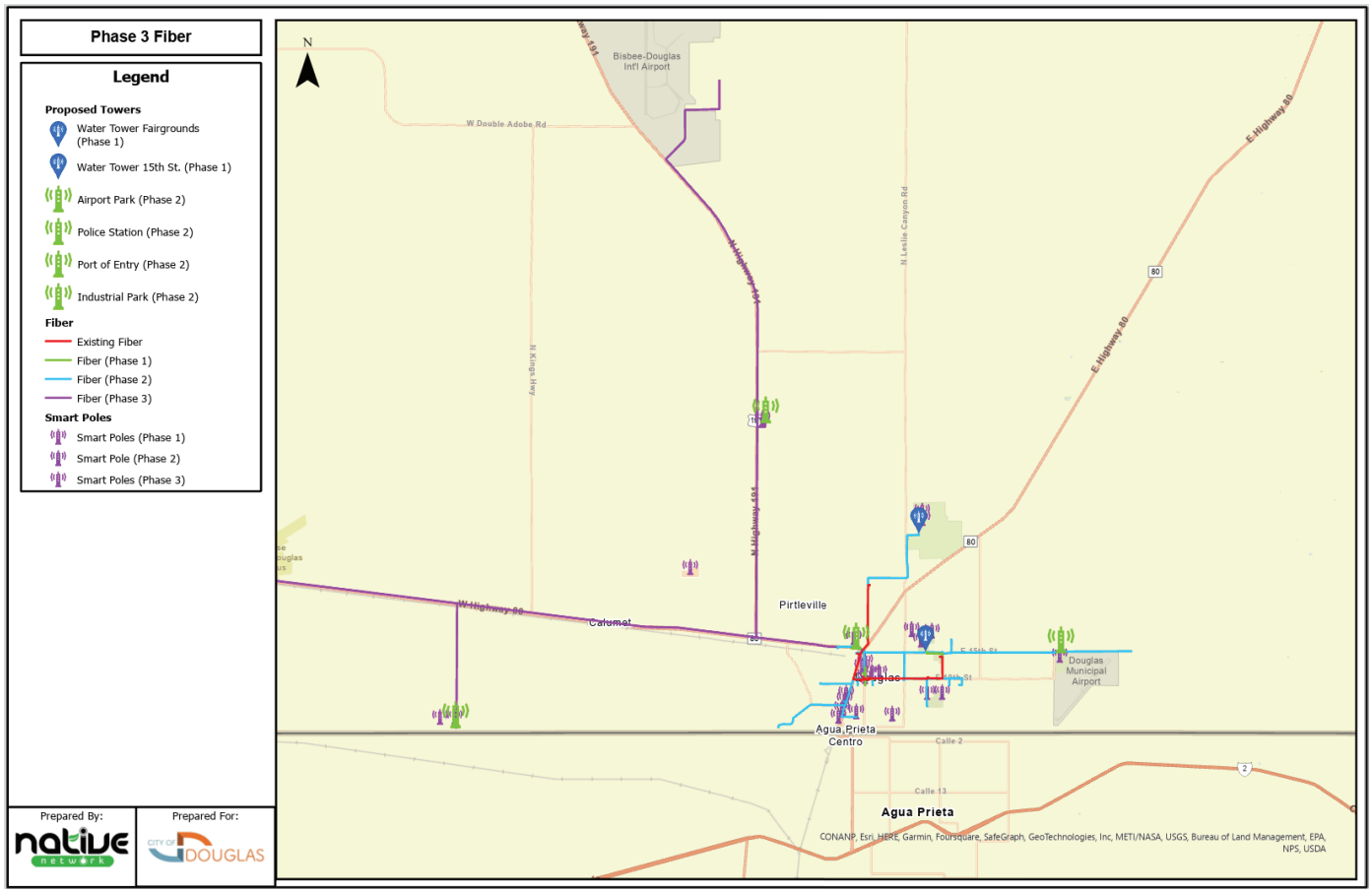
The **Fiber** maps show the routes for fiber and conduit through the various phases in the infrastructure development of the City. It is assumed that wherever there is fiber, there is conduit. The fiber will be used as the City's high speed transport network, capable of symmetrical 1Gbps upload/download speeds and scalable to 10Gbps in the future.



Map of Phase 1 - Fiber - Infrastructure Design

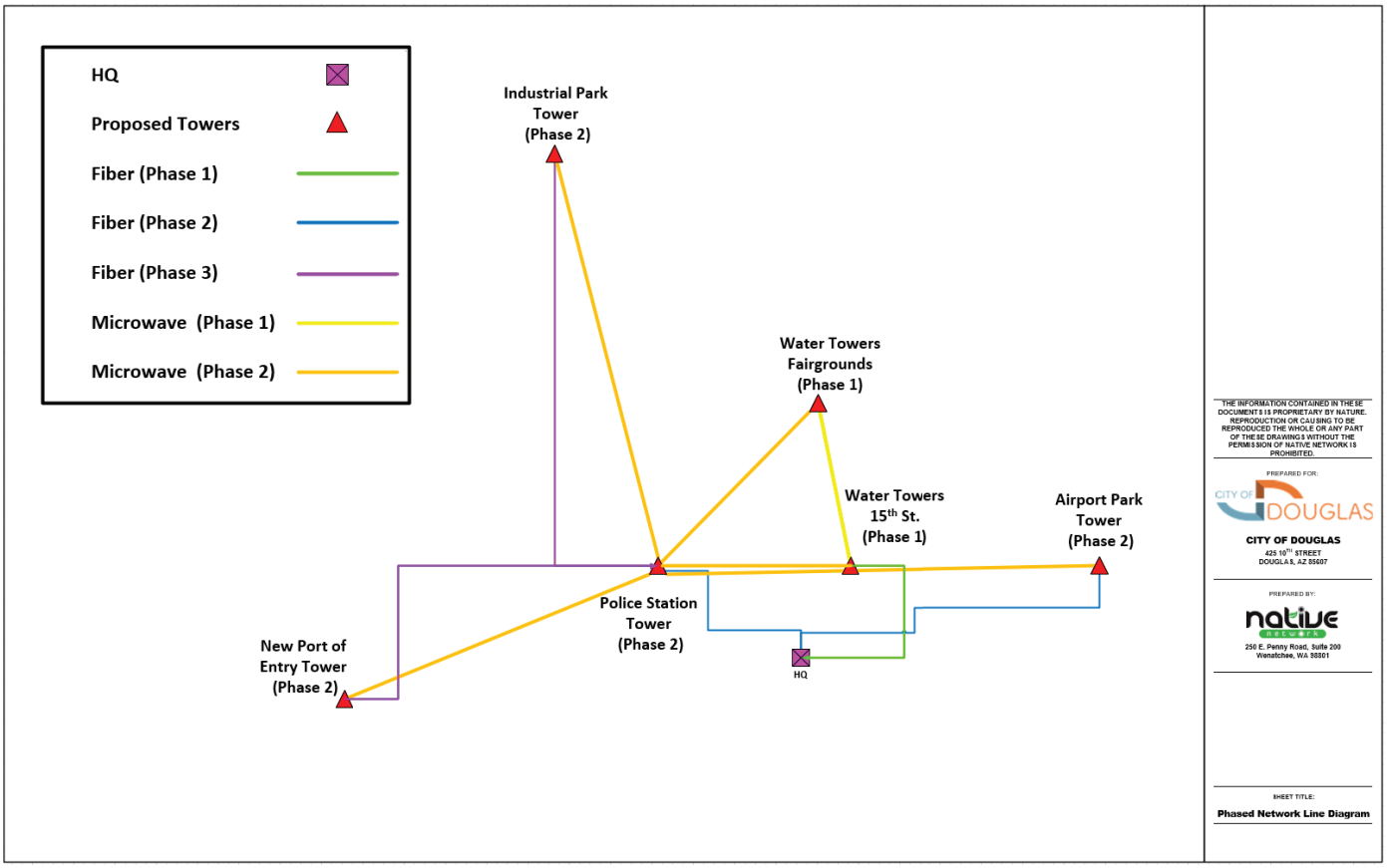


Map of Phase 2 - Fiber - Infrastructure Design



Map of Phase 3 - Fiber - Infrastructure Design

This diagram shows fiber and microwave connections to each proposed tower and HQ; HQ is considered the location of the network operations center, where the VM stack and all main equipment is located.



Phased Network Line Diagram

Microwave Backhaul

Microwave transport technology is a method of transmitting information or data from one place to another using electromagnetic waves with wavelengths ranging from approximately one meter to one millimeter. These are in the same family as radio waves and infrared waves and are categorized as non-ionizing radiation. Microwave transport technology is a wireless means of extending a network as an alternative to fiber optic cables when fiber is unavailable or difficult to install.

Microwave links, for the purposes of this report, are utilized to quickly implement network backbone connections to remote towers and buildings but are intended to be overbuilt by fiber optic cables later in the Smart City build-out, which will likely extend over multiple years.

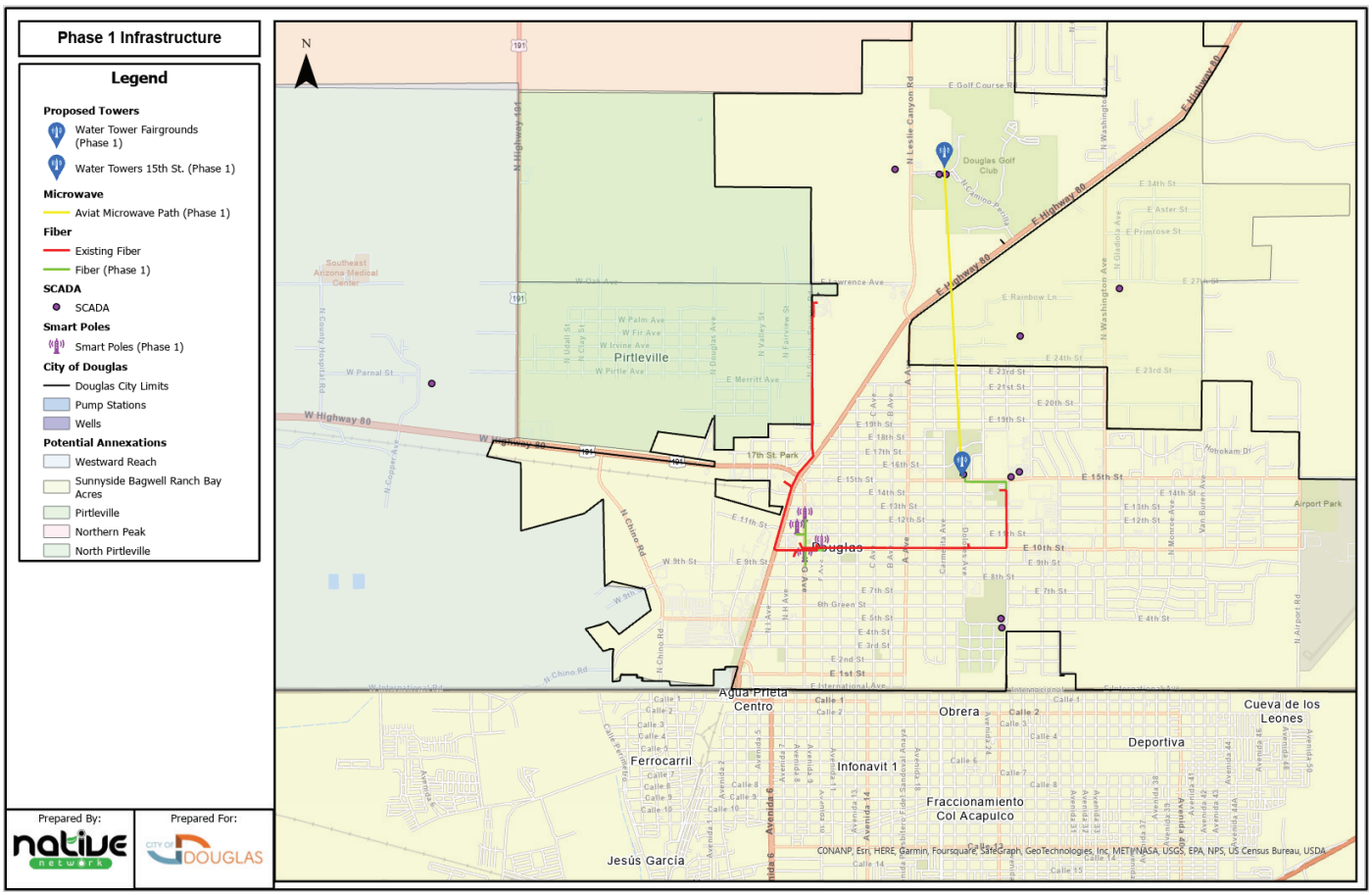
Microwave links are established using existing water towers and new towers installed at key locations. The network data is converted into microwave signals, and these signals are transmitted between towers. Because microwaves operate in high frequencies and can be blocked by ground clutter in the microwave path, it is important that the towers are in line of sight of each other, without any significant obstructions. The systems used in the backhaul design for the City operate at two frequencies simultaneously, 80Ghz for high throughput up to 10Gbps and 11Ghz to ensure operation of 1Gbps during severe weather, which can affect the higher frequency for short durations.

Microwave transport technology has several advantages that make it a viable alternative to fiber optic connections. It can be deployed quickly compared to the time-consuming process of laying down fiber optic cables. This is especially valuable in situations where Smart City services are extended before fiber can be placed; they are used as redundant connections once future fiber is constructed. This provides a layer of network dependency and resiliency.

Aviat Networks (www.aviat.com) is a global provider of microwave transport and backhaul solutions, providing public and private operators with communications infrastructure to accommodate the growth of IP-centric, multi-gigabit data services. A merger with the Harris Corporation in 2007 established Aviat as a leading provider of microwave equipment to government, quasi-government and public safety entities around the world. The specific technology recommended for the Smart City application is the AVIAT MT518M49VH radio which operates at the 18Ghz licensed common carrier band and the 80Ghz unlicensed band.

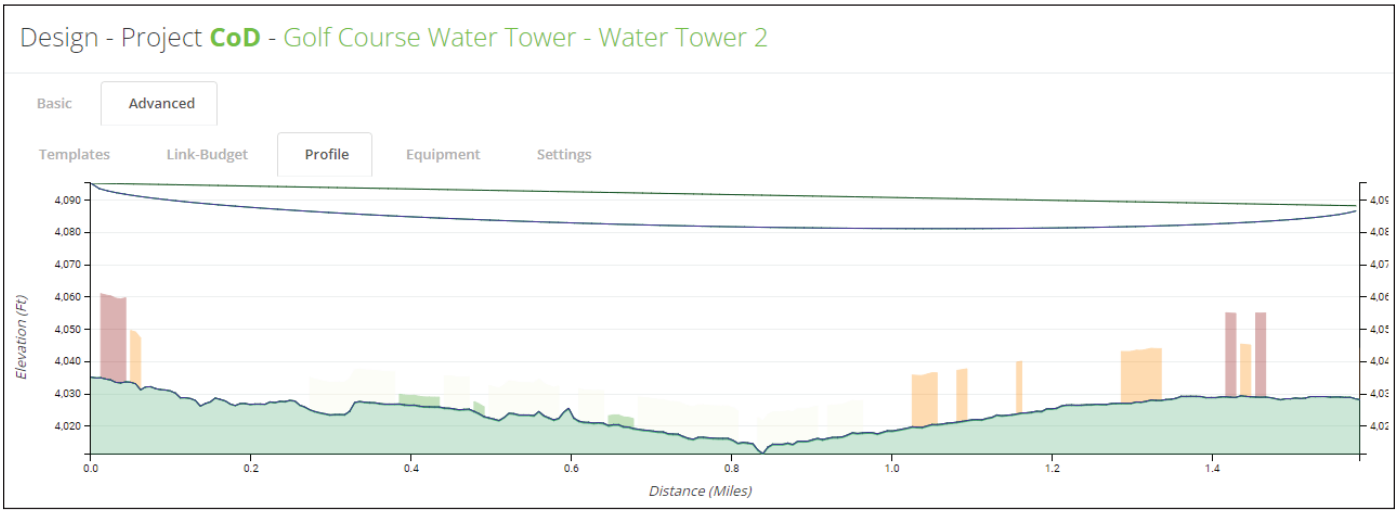
The planned microwave network is completed in the first two phases of the Telecommunications Roadmap project. Initially a single connection joins the 15th Street Water Tower to the Golf Course Water Tower to establish the phase one network.

Infrastructure maps below include proposed locations of towers, SCADA, and SmartPoles along with the routes for fiber, and microwave backhaul. The phased implementation begins in the downtown corridor, expands to the city limits, and finally reaches the potential annex areas as the City inevitability expands. The infrastructure is the backbone for the Smart City applications.

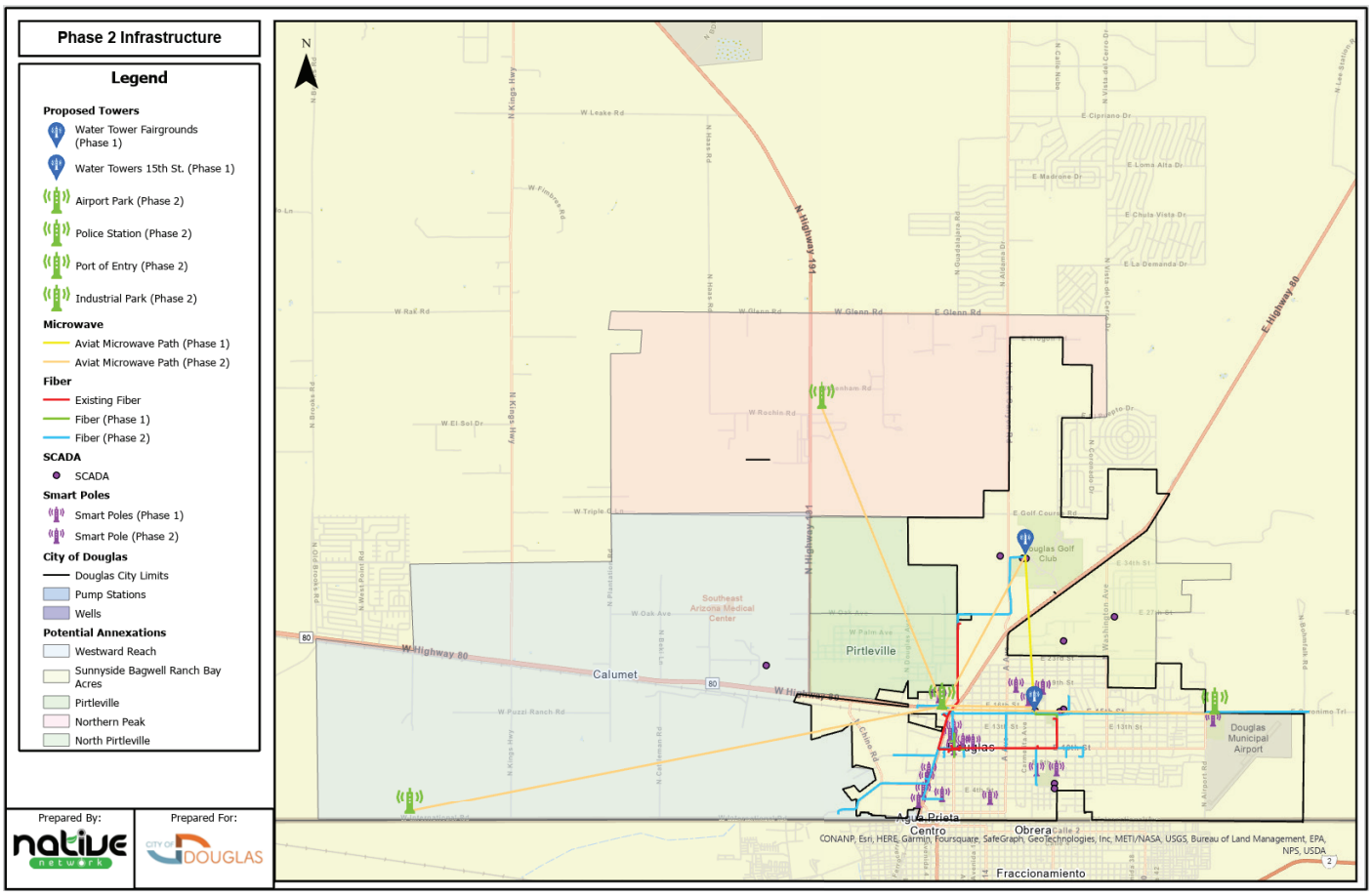


Map of Phase 1 - Downtown Corridor & SCADA - Infrastructure Design

Signal Path diagrams show the microwave path and any possible clutter (buildings, trees, etc.) which might get in the way of the link between towers. This determines the viability of a proposed tower-to-tower microwave link connection. The far left shows the signal path from the starting height of the antenna on the tower to the connection point on anther antenna on the far right of the diagram. Green represents the ground elevation, and the colored bars represemt the level of clutter or possible signal inteference, with yellow being low, red being medium, and gray being high.

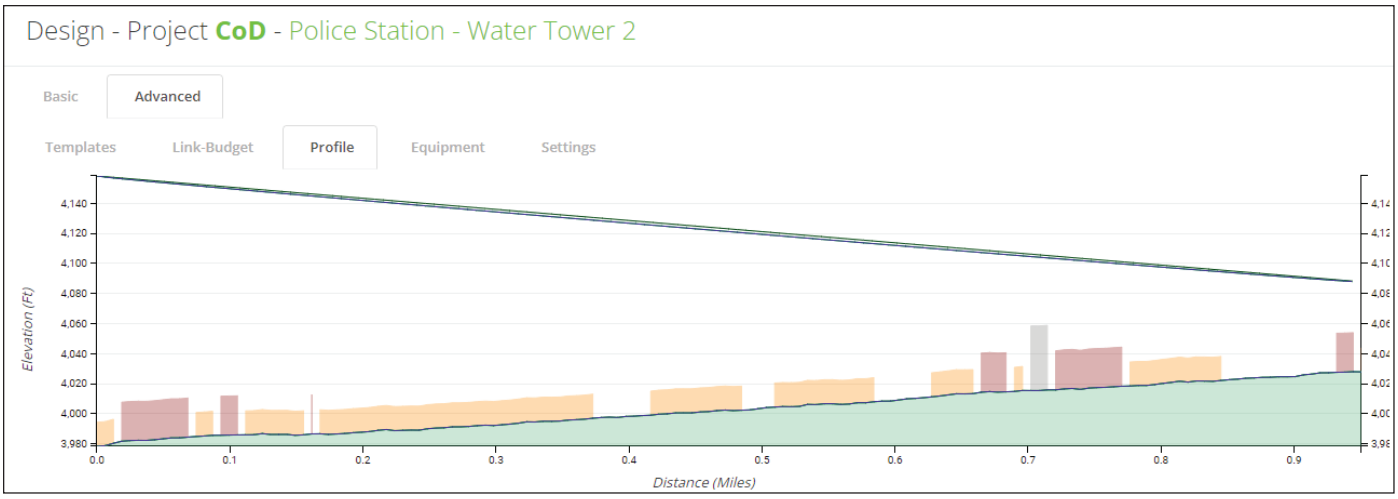


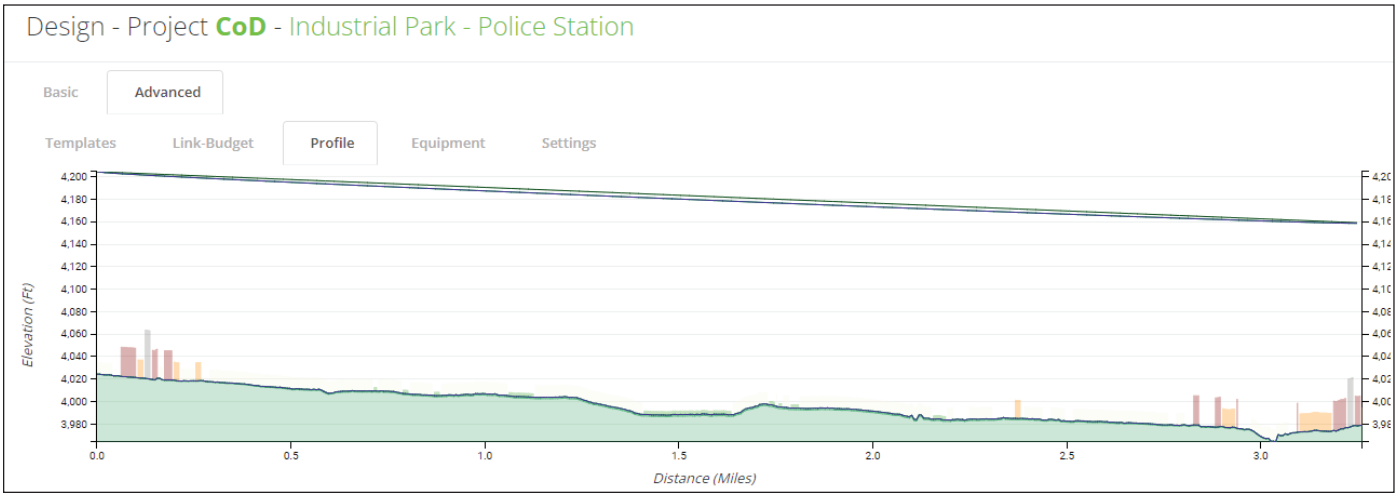
The second phase links connect the new towers at the airport, industrial park and new port of entry to the police department, including redundant links from the golf course water and 15th St. water towers.

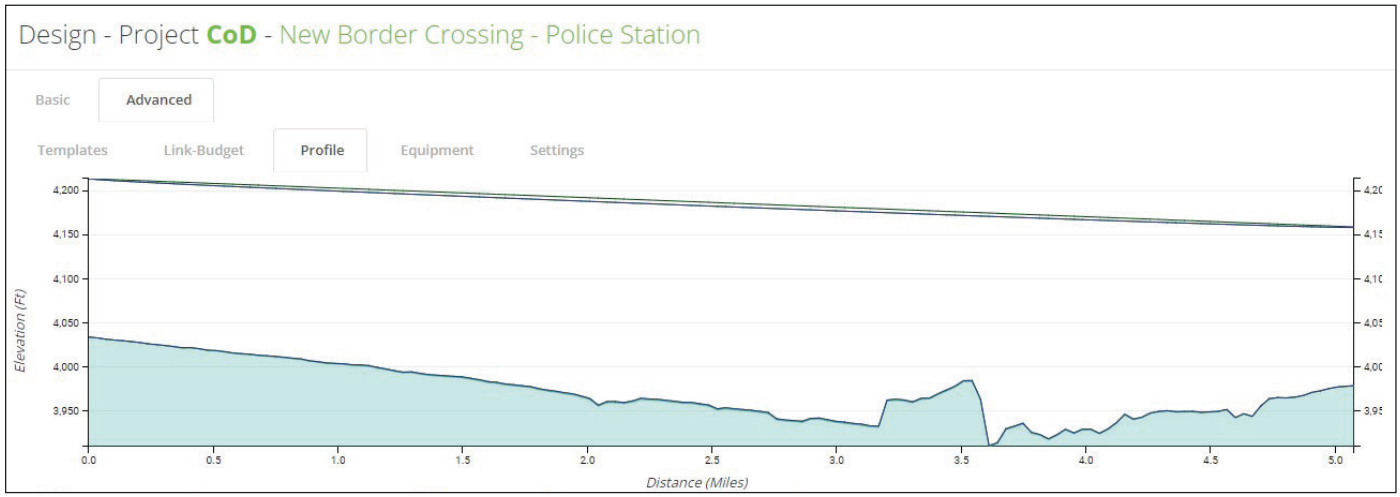


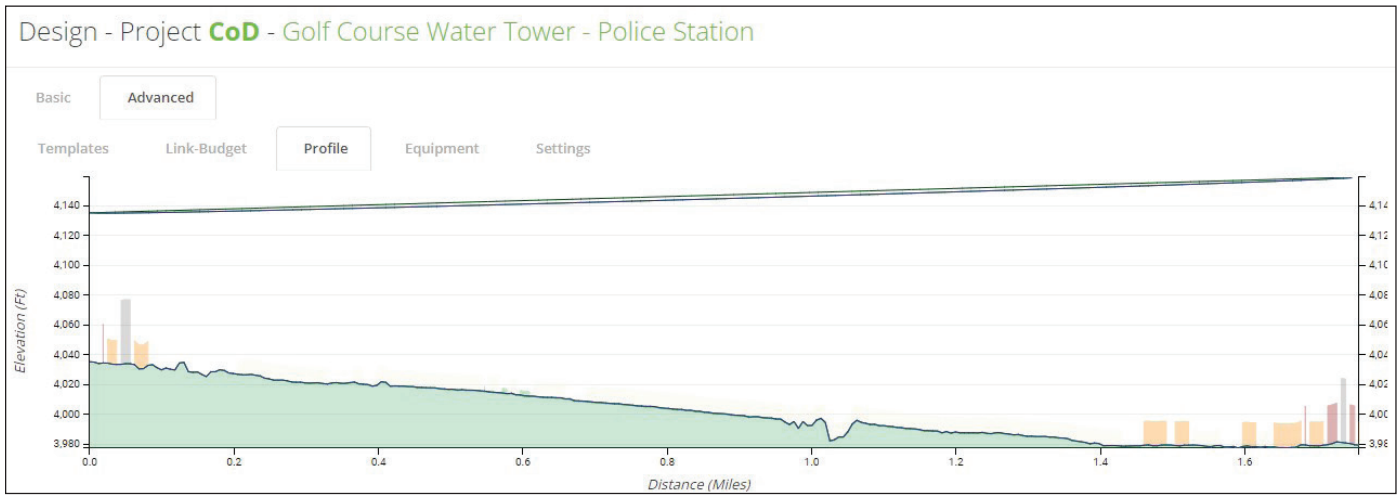
Map of Phase 2 - City-Wide - Infrastructure Design

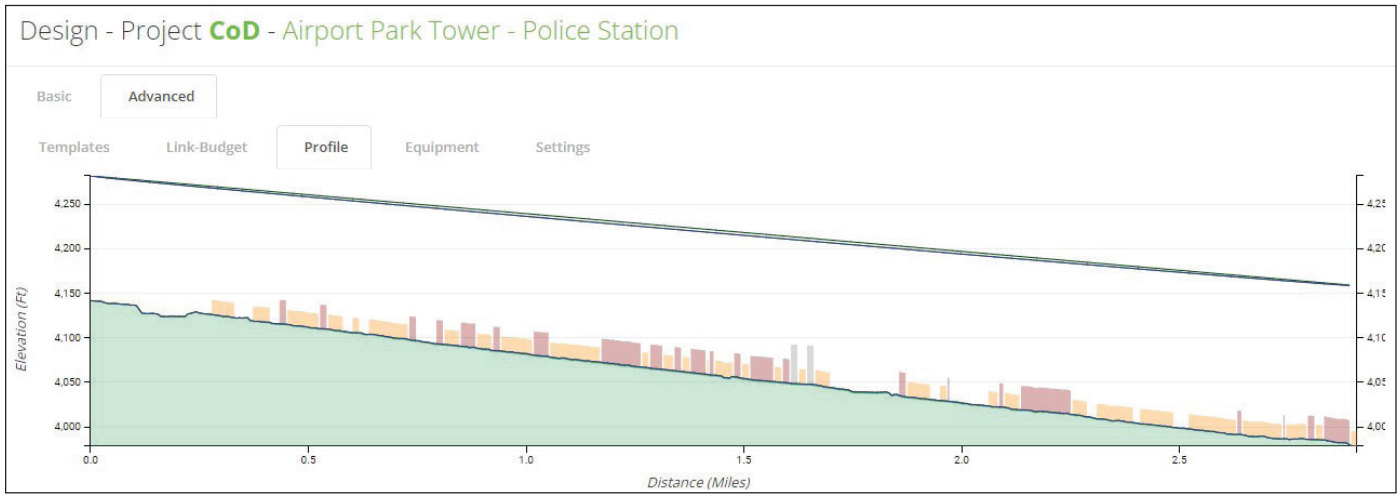
Signal Path diagrams show the microwave path and any possible clutter (buildings, trees, etc.) which might get in the way of the link between towers. This determines the viability of a proposed tower-to-tower microwave link connection. The far left shows the signal path from the starting height of the antenna on the tower to the connection point on anther antenna on the far right of the diagram. Green represents the ground elevation, and the colored bars represemt the level of clutter or possible signal inteference, with yellow being low, red being medium, and gray being high.



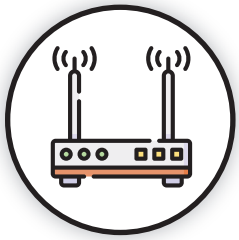



Design - Project CoD - New Border Crossing - Police Station
Basic
Advanced
Templates
Link-Budget
Profile
Equipment
Settings
Elevation (Ft)
Distance (Miles)


Design - Project CoD - Golf Course Water Tower - Police Station
Basic
Advanced
Templates
Link-Budget
Profile
Equipment
Settings
Elevation (Ft)
Distance (Miles)


Design - Project CoD - Airport Park Tower - Police Station
Basic
Advanced
Templates
Link-Budget
Profile
Equipment
Settings
Elevation (Ft)
Distance (Miles)

Fixed Wireless



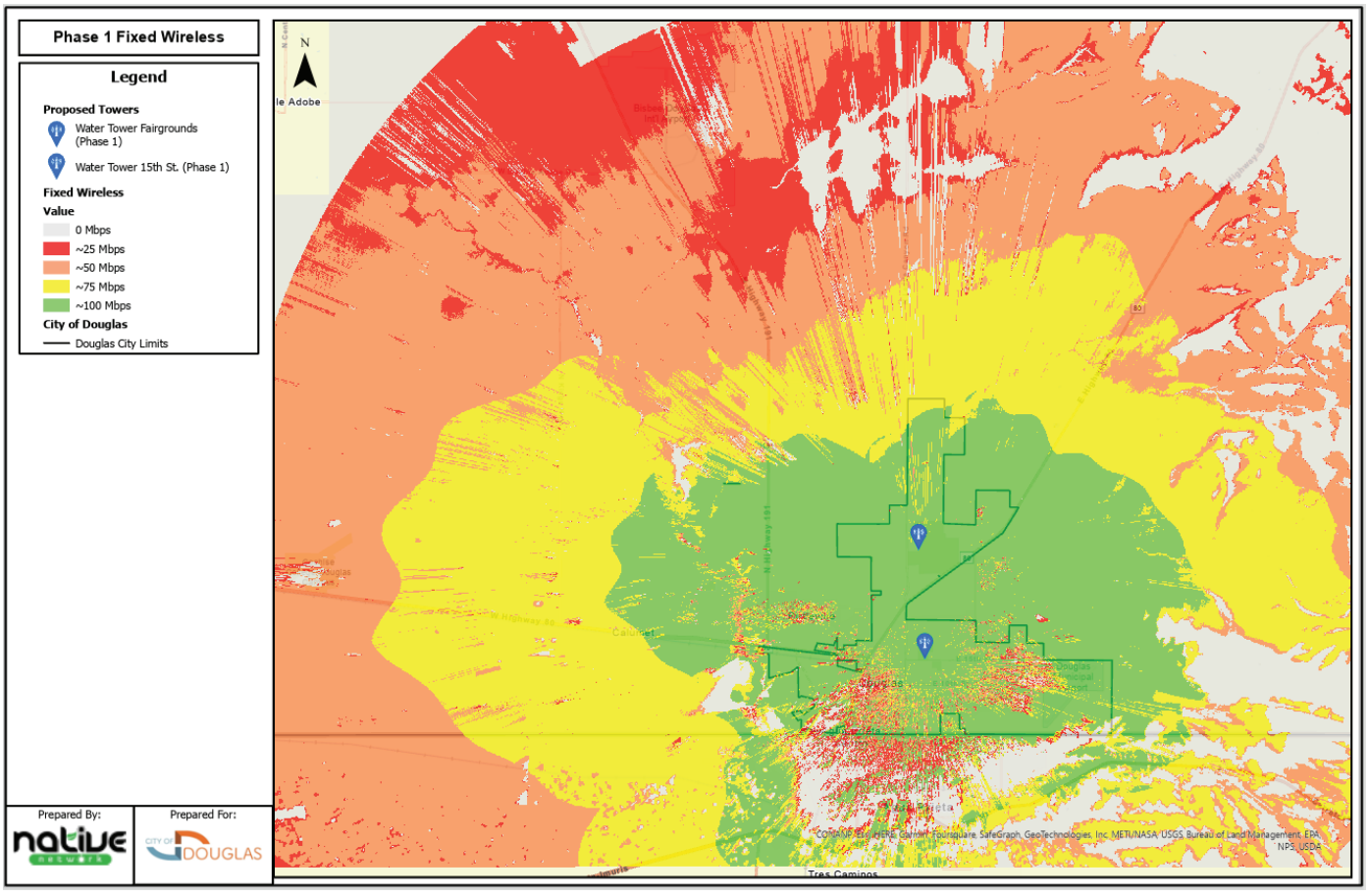
Tarana Platform for Core City Infrastructure

The fixed wireless network is a point to multi-point radio system designed to cost effectively connect City properties and other critical infrastructure, including SCADA and public WiFi nodes, that will not be covered by fiber optic networks in the near-term plan. Utilizing the Tarana Wireless platform, operating in the unlicensed bands in the 5Ghz range, the network is designed to provide 100Mbps – 1Gbps highly-reliable wireless connections. The benefit to the City is immediate connectivity to the various City facilities and Smart City sensors, devices, and services. This supports efficient data transmission and communication for improved city management and service delivery.

The fixed wireless network is anticipated to be constructed in the first 2 phases, with completion of the network in Phase 2.

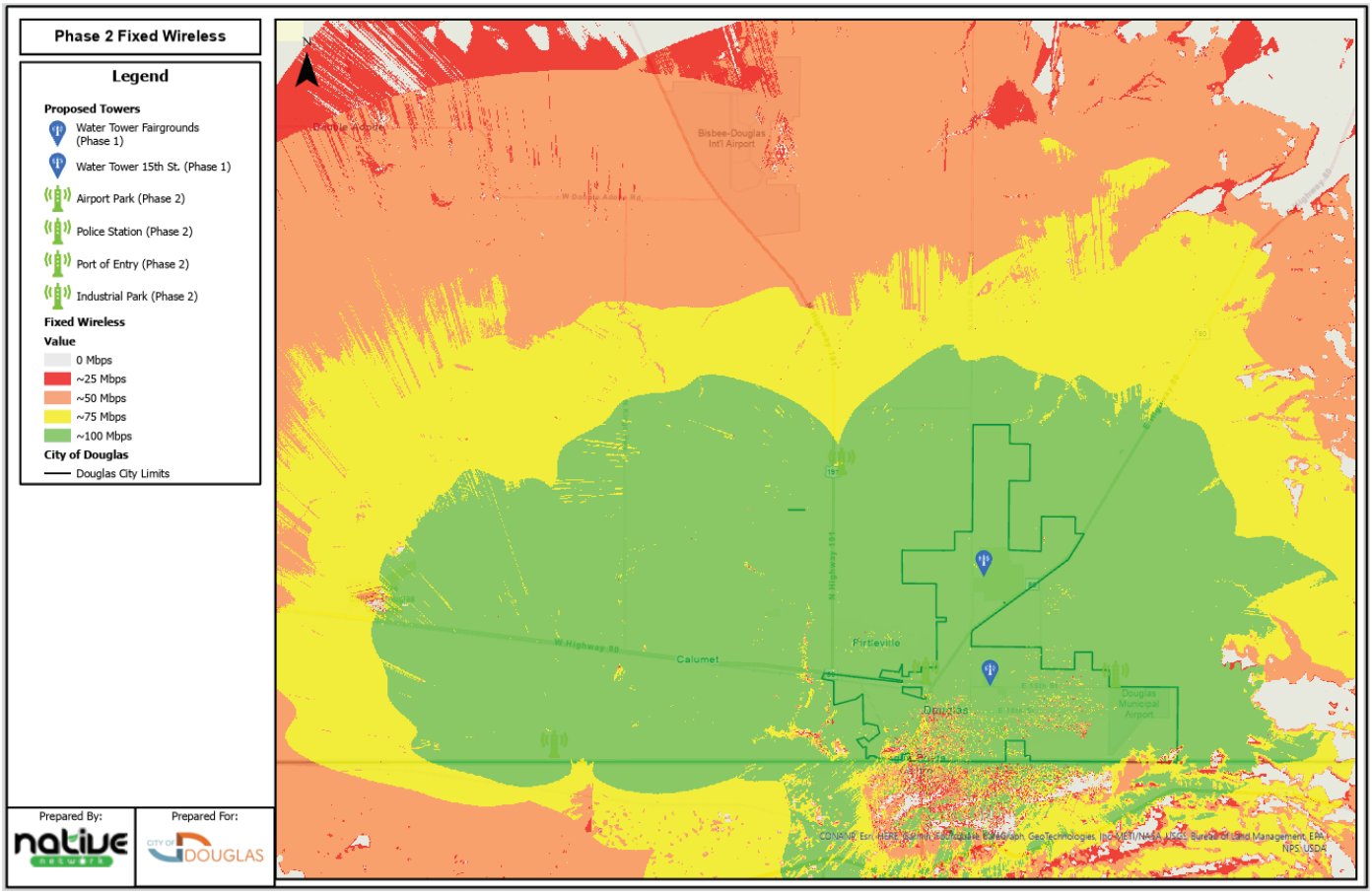
Phase 1 – Utilizes existing water towers on 15th Street and at the fairgrounds to provide a base coverage corridor, including the majority of the city and extending north to fairgrounds.

The Fixed Wireless maps display the power of the radio frequency received (RSRP). This has been calculated into throughput in megabits per second (Mbps), or available bandwidth capacity for data transfer.



Map of Phase 1 - Fixed Wireless - Infrastructure Design

Phase 2 – Adds microwave network to newly constructed towers at the airport, police station, Industrial Park, and New Port of Entry. This expands coverage to a wide area, including the fringes of the City and the newly annexed areas.



Map of Phase 2 - Fixed Wireless - Infrastructure Design

Native Network has completed a pre-engineered network design based on Tarana's G1 PMP product. This design includes an initial propagation study, network interconnection and Bill of Materials (BoM). The network was designed to be deployed on existing water towers as well as take advantage of the new towers proposed in the Telecommunications Roadmap.

The network design is flexible and could accommodate leased towers or other locations available to the City in the event City-owned towers are delayed or not constructed.

Design Topology:

A hub and spoke design is employed, using microwave interconnections between sites, prior to fiber networks being available. This wireless network is a multi-point design allowing for hundreds of connections per radio base station antenna. Factors considered in the design included location of potential connections, line of sight, tower heights, ground clutter and other obstructions.

Vendor Information:

Tarana Wireless is a relatively new entrant into the fixed wireless market but has quickly gained a reputation for high-quality, highly-technical solutions to ensure clear operations in the unlicensed bands.

The Tarana equipment was selected based on a network cost analysis, Native Networks' experience with the vendor, and overall radio frequency (RF) performance of the equipment. The equipment has proven to be robust, reliable, highly secure, easily manageable, and meets the design criteria. Substitutions are possible with several vendors available with alternative solutions.

The Tarana equipment is readily available with a 4–6-week delivery timeframe as of the writing of this report. The Bill of Materials (BoM) provides sufficient details to understand costs and required components of the network.

INSTRUCTIONS & IMPORTANT NOTES

Deployment and Integration:

The deployment of the Tarana system includes installing Base Nodes (BN) at pre-determined tower locations, connecting units to backbone network(s), programming the network, and installing Remote Nodes (RN) on the target locations. The installation of the BN requires a 3rd party company however the RN links are relatively simple to install and can be handled internally if desired.

Premise Installation:

- Configure the wireless links to establish reliable and high-capacity connections between Smart City devices, sensors, and services.
- Integrate the Tarana links with existing infrastructure, such as surveillance systems, traffic management systems, and other relevant applications.

Network Security:

- Implement robust security measures to protect the fixed wireless links and the data transmitted over the network.
- Utilize encryption protocols, authentication mechanisms, and firewalls to ensure secure and private communication.
- Regularly update security systems and conduct audits to identify and mitigate potential vulnerabilities.

Network Management & Monitoring:

- Implement a centralized network management system to monitor and manage the fixed wireless links and associated equipment.
- Monitor link performance, signal strength, and connectivity status in real-time to ensure optimal network operation.
- Establish proactive maintenance practices, including regular inspections, firmware updates, and troubleshooting procedures.

Training & Documentation:

- Provide comprehensive training to City staff responsible for managing and maintaining the fixed wireless links.
- Develop detailed documentation, including network diagrams, operational procedures, and troubleshooting guides, to ensure effective network management and support.

Future Expansion:

- Tarana allows for easy expansion and scalability of the network to accommodate growing infrastructure, annexation, increase capacity requirements of emerging Smart City applications.

By deploying a fixed wireless network using the Tarana platform, the City can establish a robust and scalable connectivity infrastructure to support its Smart City initiatives, establish high-speed links to all City-owned or related properties, and spread fiber construction out longer while still meeting Smart City objectives. The wireless links will enable efficient data transmission, real-time monitoring, and seamless integration of various Smart City services, enhancing city management and improving the quality of life for residents.

Private LTE Solution

A private network is a City-wide (regional) dedicated network that provides communication connections to people or things belonging to the City or its constituents and provides specific services necessary for the business of the organization.

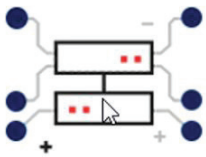
The City operates its own network and uses it exclusively. Unlike public networks, only allowed people and devices can access this network, and data generated within the organization is processed locally within the organization's dedicated network, ensuring high security and data privacy.

The network will serve voice and data functions as well the Smart City infrastructure backbone, connecting various Smart City sensors and services, enabling efficient data collection, analysis, and communication for improved city management and service delivery.

A Private LTE system is comprised of six integral components, all critical to its operation:

- The first essential element is the Enhanced Packet Core (EPC), or in more advanced cases, the 5G Core Network (5GC). This includes various subcomponents such as the IP Multimedia Subsystem (IMS), which facilitates multimedia services over IP networks, the P-Node that serves as a processing point, the Charging Node responsible for billing and tariff-related functions, and the Home Location Registry (HLR) that houses information about network subscribers.
- Secondly, there is the Radio Access Network (RAN). This component connects devices to the network and can vary depending on the network's generation. For an LTE system, an eNodeB or Long Term Evolution node serves as the connection point, whereas a gNodeB 5G-NR or New Radio performs this role for a 5G network.
- The third cornerstone is the range of customer devices, which can include a broad array of items. These devices could be IoT or IIoT sensors, SCADA PLCs used in industrial applications, ubiquitous mobile phones, WiFi hotspots providing broader access, fixed internet routers for wired connections, or even tablets and laptops for portable but substantial computing power.
- The fourth element of a Private LTE system involves the use of frequency. This can either be licensed or pseudo licensed, with frequencies such as 2.5Ghz and 3.5Ghz commonly employed, but other frequencies can also be used depending on availability.
- The fifth component, the backhaul, is crucial, as it interconnects the core network to the RAN. This connection can be established through various means, with a fiber network providing high-speed, high-capacity connections, or a microwave network offering a more flexible and faster-to-deploy solution.
- Finally, the sixth vital component is roaming. This allows for seamless transitions from private to public networks and ensures voice interconnection, maintaining communication even when users move beyond the range of the private network.

Private Core



Evolved Packet Core (EPC)

Highly scalable 4G LTE EPC Core Network platform, easy to deploy for a wide rage of applications

5G Core Network (5GC)

Cloud-native, highly integrated & simplified design 5GC for mobile industry

IP Multimedia Subsystem (IMS)

An agile & virtualized session vIMS core, support variety of voice application such as VoNR, VoLTE, VoWiFi services

Separate core function for 4G & 5G.

INSTRUCTIONS & IMPORTANT NOTES

Radio Assess Network Requirements:

- Conduct a comprehensive assessment of the City's current infrastructure, including sensors, surveillance cameras, streetlights, and other connected devices that require network connectivity.
- Identify the specific requirements of each Smart City application and determine the coverage area and capacity needed for optimal network performance.

Design Network Architecture:

- Develop a network architecture plan that includes strategically placed LTE base stations and associated network equipment to cover the entire city area and critical infrastructure locations.
- Consider the deployment of small cells and distributed antenna systems (DAS) to ensure seamless connectivity in densely populated areas and areas with high network traffic.

Vendor Selection & Equipment Procurement:

There are many providers of LTE network solutions; Baicells Radios and Druid Core are utilized in this report to provide a sense of system costs. The biggest difference in the cost of LTE networks is the Radio Access Network.

Larger manufacturing vendors include Nokia and Ericsson. These radios are utilized by commercial cellular carriers and can cost many times more than more enterprise-grade equipment like Baicell. The functionality, warranty, support and useful life of the Baicell radios are similar to the more expensive radios, making the City's network more cost-effective.

An evaluation of vendor RFP responses should be utilized for final network design and based on factors such as network performance, scalability, security, and compatibility with existing infrastructure and price.

Deployment & Integration:

- Deploy LTE base stations and associated equipment according to the network architecture plan.
- Integrate the private LTE network with existing Smart City infrastructure, including sensors, surveillance systems, traffic signals, and other relevant applications.
- Ensure proper configuration and testing of network components to guarantee seamless interoperability and data exchange.

Network Security:

- Implement robust security measures to safeguard the private LTE network from unauthorized access and potential cyber threats.
- Utilize encryption protocols, authentication mechanisms, and firewall solutions to protect data transmitted over the network.
- Regularly update network security systems and conduct security audits to identify and address vulnerabilities.

Network Management & Monitoring:

- Implement a centralized network management system to monitor and manage the private LTE network.
- Monitor network performance, traffic patterns, and connectivity status in real-time to ensure optimal network operation.
- Implement proactive network maintenance practices, including regular equipment inspections, firmware updates, and troubleshooting procedures.

Training & Documentation:

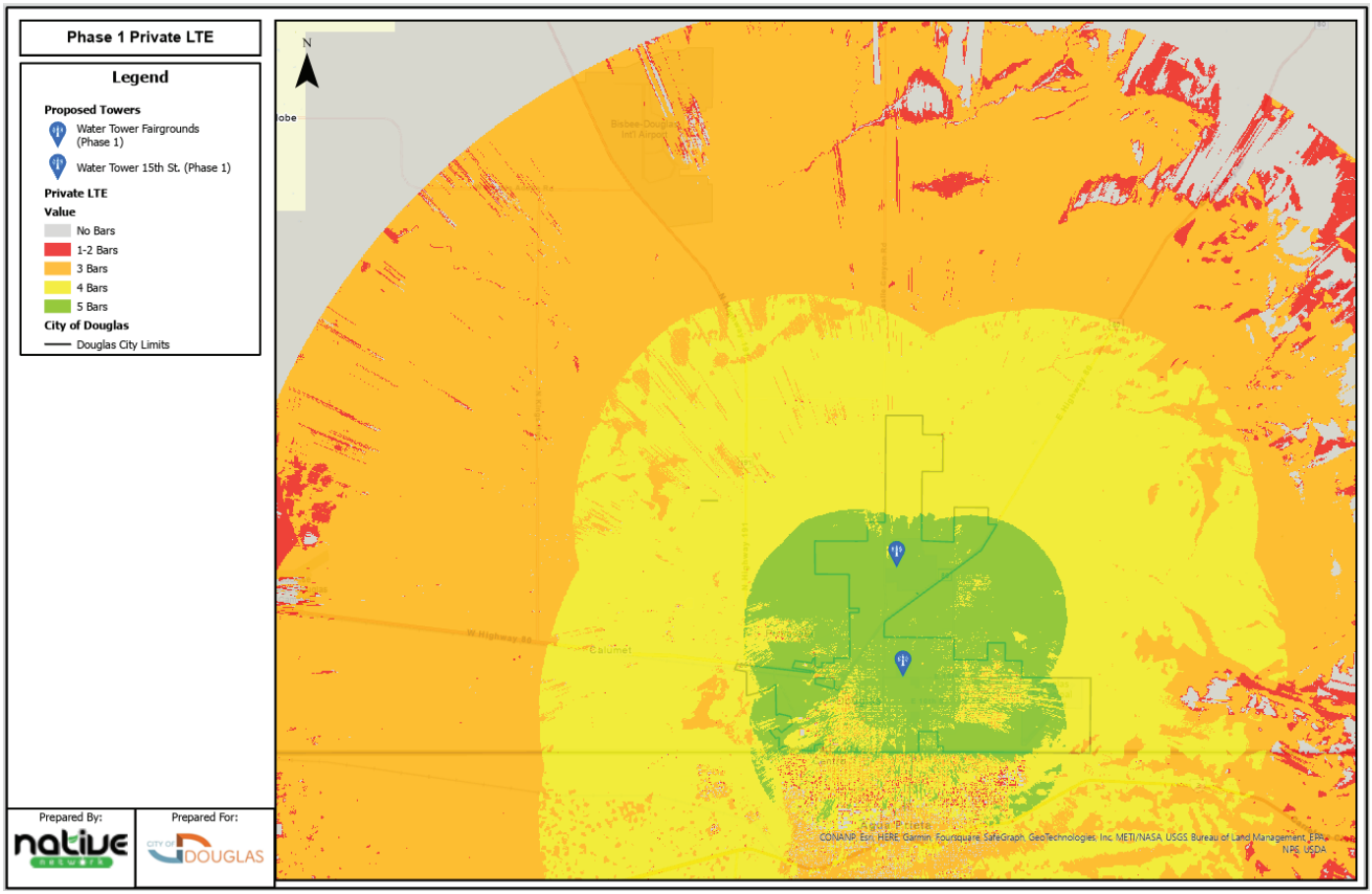
- Provide comprehensive training to City or 3rd party network management staff responsible for managing and maintaining the private LTE network.
- Develop detailed documentation, including network diagrams, operational procedures, and troubleshooting guides, to ensure effective network management and support.

Regular Evaluation & Future Expansion:

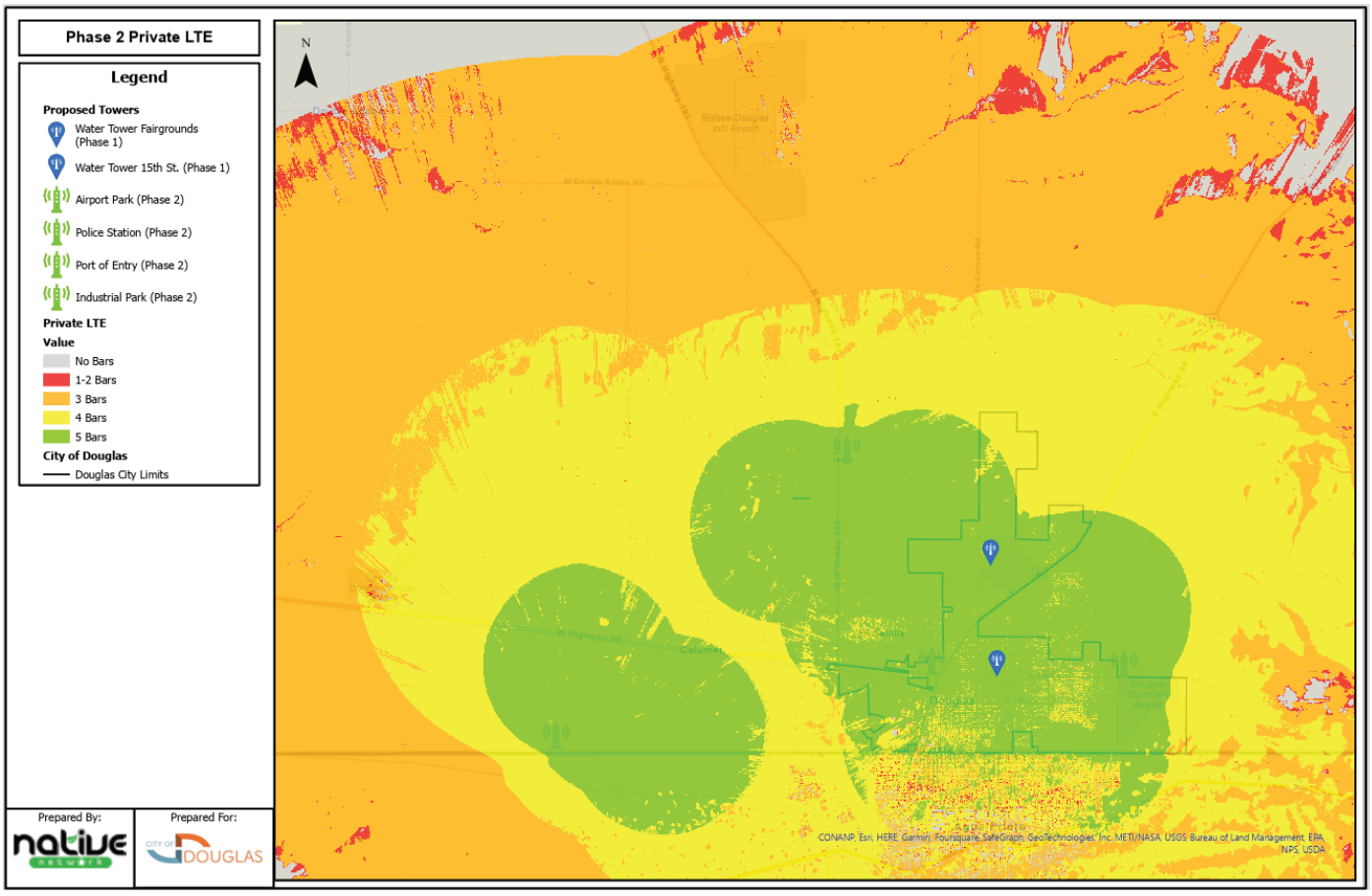
- Establish a framework for continuous evaluation and performance monitoring of the private LTE network. Voice and data quality are monitored on a continuous basis with technical interaction to ensure maximum performance and quality.
- Collect feedback from City departments utilizing the network and conduct periodic assessments to identify areas for improvement and optimization.
- Plan for future expansion and scalability of the private LTE network to accommodate growing city infrastructure and emerging Smart City applications.

Private LTE is initiated in Phase 1 with core City coverage from the two initital water towers. Phase 2 of the project installs this equipment on the 4 new towers being completed in Phase 2.

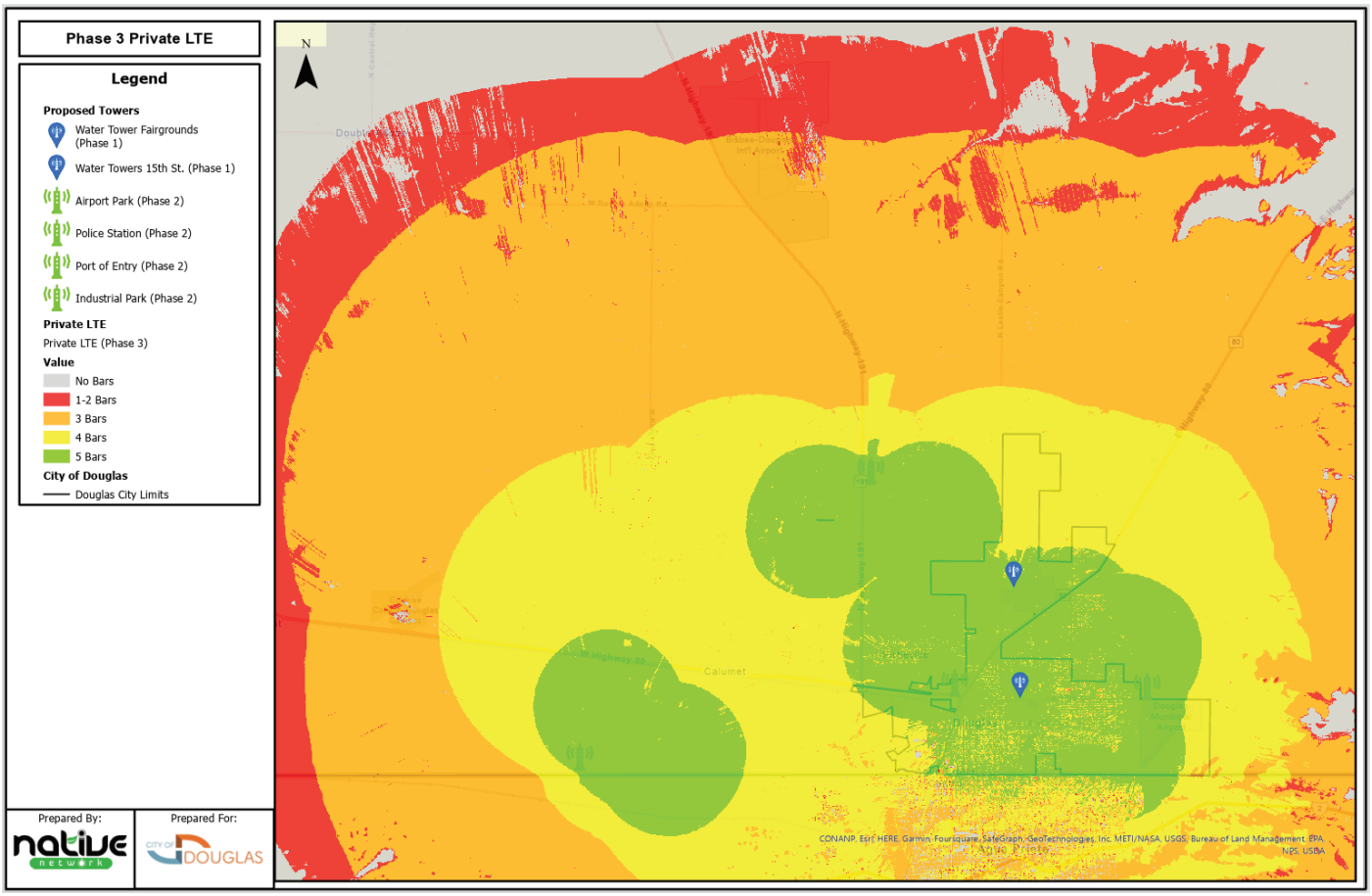
The Private LTE maps display the power of the radio frequency received (RSRP) throughout the map, this is shown in number of bars you would find on your cellular device.



Map of Phase 1 - Private LTE - Infrastructure Design



Map of Phase 2 - Private LTE - Infrastructure Design



Map of Phase 3 - Private LTE - Infrastructure Design

Private LTE Access Devices to accommodate Smart City Applications

The implementation of Private LTE wireless networking solutions can initiate a revolution in digital infrastructure, offering numerous benefits across diverse sectors, ranging from city systems management, administration and public safety to education, public health, and education.

While the Private LTE system is an amazing network, it is useless without the myriad of devices available to connect with and utilize its capabilities. Mobile phones, push-to-talk terminals, mobile data routers, and LTE to WiFi Hotspots, they all serve different applications utilizing the same core network. Private LTE provides security, connectivity in challenging locations, and benefits to public safety and trasnportation, healthcare, and education.

Secure mobile and critical fixed wireless terminals for Private LTE network access

- Mobile Voice and Data
- SCADA remote data access
- City Systems – Outdoor signage, IT and IoT driven applications
- Public Safety – Police Fire and City Management
- Public Transportation
- Education HotSpots

Secure and efficient administration is a requirement in the era of rampant cyber threats, safeguarding a city's digital assets is paramount. A secure networking solution that provides robust protection for the City's sensitive data. Leveraging advanced network segmentation, the platform separates corporate and IoT systems, forming a virtual shield around the City's crucial infrastructure. As the City progressively embraces digital technologies for administration, such segmentation is pivotal to thwart cyber-attacks.

Security capabilities need to provide for multi-role administration, allowing various departments from public safety to utilities, to manage their network segment effectively. This enables enhanced inter-departmental collaboration while maintaining a stringent digital security environment. A strong improve efficiency and safeguard critical data and systems.

Connectivity is a prerequisite for equitable access to digital resources. Network access must have the capacity to establish stable connections in challenging locations, this will significantly benefit the City by facilitating internet access in remote or underserved areas. Public establishments like libraries, schools, and community centers can reap substantial advantages from such connectivity, providing wider digital services and resources.

SCADA, IIoT and IoT sensors require access to the core network and the software management systems. While the connectivity can be fiber optic cables, which is preferred in critical locations, the lowest cost solution is to tap into the Private LTE system, with its ubiquitous coverage of the region. Thousands of connections to multiple systems are capable of being connected rapidly, efficiently and effectively when using hardened LTE end-point devices.

Public Safety benefits from swift, coordinated responses, a task made easier with enhanced connectivity. Providing remote, mobile or transportable solutions can revolutionize the City's public safety and emergency services. By transforming vehicles into mobile connectivity hubs, these services can transmit real-time data from an active scene to the command center. For instance, an ambulance can share live patient data with a hospital en route, ensuring the medical team is ready to provide immediate care upon arrival.

These capabilities can significantly improve emergency response times and overall public safety. Moreover, the improved connectivity allows for more effective communication among different public safety departments, further bolstering the City's emergency preparedness and response.

Public transportation systems benefit when buses and shuttles are equipped with network access via Private LTE, to provide public WiFi, transforming a daily commute into a productive period. Additionally, the vehicles' real-time data can inform route and schedule adjustments, optimizing the public transportation system.

Enhanced connectivity can also improve communication between transport services, leading to more coordinated operations. Overall, this can improve the commuting experience for Douglas's residents, making public transportation a more attractive and efficient option.

Healthcare is another sector where specific end-user access solutions can be transformative. They can facilitate telemedicine, remote patient monitoring, and digital health records. Such services, once made mainstream, can make healthcare more accessible and efficient, improving patient outcomes and fostering a healthier community.

Expanding educational opportunities is a key function of Private LTE and can provide Douglas's educational institutions with reliable internet access for remote digital learning. In doing so, students gain access to an extensive range of online resources, enhancing their learning experience. These tools equip students with the necessary skills for the digital age, preparing them for future opportunities.

The advanced wireless solutions and myriad of network access devices available hold the potential to provide the end-user with the devices that will enable digital transformation. The secure, reliable and mobile connectivity can enhance public services, stimulate economic growth, improve public safety, and foster a more

connected community. The end-user experience with the Smart City technology will shape the Smart City today and support future challenges and capitalize on emerging opportunities.

Access Device Vendor Information

Vendor Recommendations:

Cradlepoint: Cradlepoint is an American technology company that specializes in 4G and 5G wireless network edge devices. Its products and services are designed to provide municipalities with secure and reliable connectivity, particularly for distributed and mobile networks. Cradlepoint's solutions are primarily used in transportation, healthcare, and public safety sectors, where organizations require robust, secure, and flexible connectivity solutions. - *www.cradelpoint.com*

BEC Technologies: BEC is a prominent designer and producer of 4G/LTE, and 5G wireless broadband networking solutions. They cater to a variety of sectors, including mobile operators, municipalities, enterprise, and industrial markets. Their product line is diverse, comprising multi-service gateways, robust outdoor, industrial/M2M connectivity, public safety, fleet/telematics, and cloud-based remote device management. - *www.bectechnologies.net*

Equipment:

Smart Phones: Nearly all smart phones less that 3 years old support Band 41 (2.5Ghz Spectrum). This allows the majority of phones to utilize the Private LTE network natively. The Enhanced Packet Core in conjunction with MDA software provide the SIM and configuration information allowing access, control and potential roaming with other Private LTE networks and the National Wireless Carriers.

SmartPoles: SmartPoles are an innovative fusion of modern technology and city infrastructure, integrating several key features that collectively create an intelligent and connected urban environment.

At the core of the SmartPole concept is the integration of Smart LED lighting. This not only serves the fundamental purpose of illuminating streets and public spaces but also energy-efficient, making SmartPoles an environmentally friendly choice for cities. Furthermore, these LED lights can be remotely controlled and monitored, enhancing their versatility and responsiveness.

A vital element of SmartPoles is their capacity for wireless technology. They can host 4G, LTE, or even 5G equipment, thus becoming vital nodes in the wireless network. This function aids in expanding network coverage and capacity, improving signal strength and network speed for connected devices in the vicinity.

SmartPoles also serve as hosts for various sensors and IoT devices. This function allows for an array of city applications, such as environmental monitoring by assessing air quality or noise levels, traffic management by tracking vehicle and pedestrian movement, or providing public WiFi hotspots and the integration of electric vehicle charging stations. As cities strive for cleaner transportation solutions, the provision of conveniently located EV charging stations becomes increasingly crucial. With SmartPoles, these stations can be seamlessly incorporated into the existing cityscape, contributing to the broader efforts towards green transportation.

To enhance public safety, SmartPoles can be equipped with surveillance cameras, emergency call buttons, and other security-oriented features. This integration can boost the effectiveness of city security efforts, providing real-time monitoring and quick response capabilities.

Despite their advanced functionalities, SmartPoles are designed to blend harmoniously with the cityscape. Their sleek and modern design can enhance the City's visual appeal while minimizing the visual clutter often associated with traditional pole-mounted equipment.

SmartPoles represent a convergence of technology and infrastructure, designed to enhance city living through improved connectivity, environmental consciousness, public safety, and urban aesthetics.

Public WiFi

A public WiFi system is a critical component of a smart city and a valuable asset to the community. WiFi is the most common protocol used in the world today. It is projected that by 2025 over 30 billion devices will be connected to the internet, with the majority of these devices support WiFi connections. Essentially every cellphone, laptop and hot spot can access a WiFi network, and it is essential to enable users to access the internet, city services, and community and local business web services.

Applications:

The central business districts, shopping districts, and commercial areas of a city often attract a large number of people. Providing free WiFi in these areas can enhance the experience for shoppers, workers, and visitors, as well as encourage longer stays.

- Public parks, gardens, and recreational areas are popular gathering spots for people of all ages. Offering free WiFi in these areas enables visitors to stay connected, access information, and share their experiences.
- Airports, train stations, bus terminals, and subway stations serve as major transit points for commuters and travelers. Installing free WiFi in these locations can help passengers stay connected while waiting, access real-time transit information, and make their travel experience more convenient.
- Public libraries, universities, and schools are critical centers for learning and research. Free WiFi in these locations enables students, researchers, and visitors to access educational resources, conduct online research, and collaborate with others.
- Areas with significant tourist attractions, such as historical sites, museums, art galleries, and monuments, can greatly benefit from free WiFi. Visitors can access information about the attractions, share photos and experiences online, and explore the city more effectively.
- Business centers, office complexes, and commercial areas attract a large number of professionals and entrepreneurs. Providing free WiFi in these areas can enhance productivity, enable remote work, and facilitate business interactions.
- Community centers, including cultural centers, social service organizations, and government offices, serve as important hubs for community engagement. Offering free WiFi in these locations can promote digital inclusion, provide access to online services, and support community development.

It is important to consider the specific needs and demographics of a city to determine the areas that would benefit most from a free WiFi system, Native Network has provided a proposed starting network for WiFi services.

INSTRUCTIONS & IMPORTANT NOTES

Infrastructure & Network Setup:

Conduct a comprehensive assessment of the downtown G Avenue area and public parks to determine the optimal placement of WiFi access points for adequate coverage and signal strength. Native Network has provided a sample network for the initial network rollout.

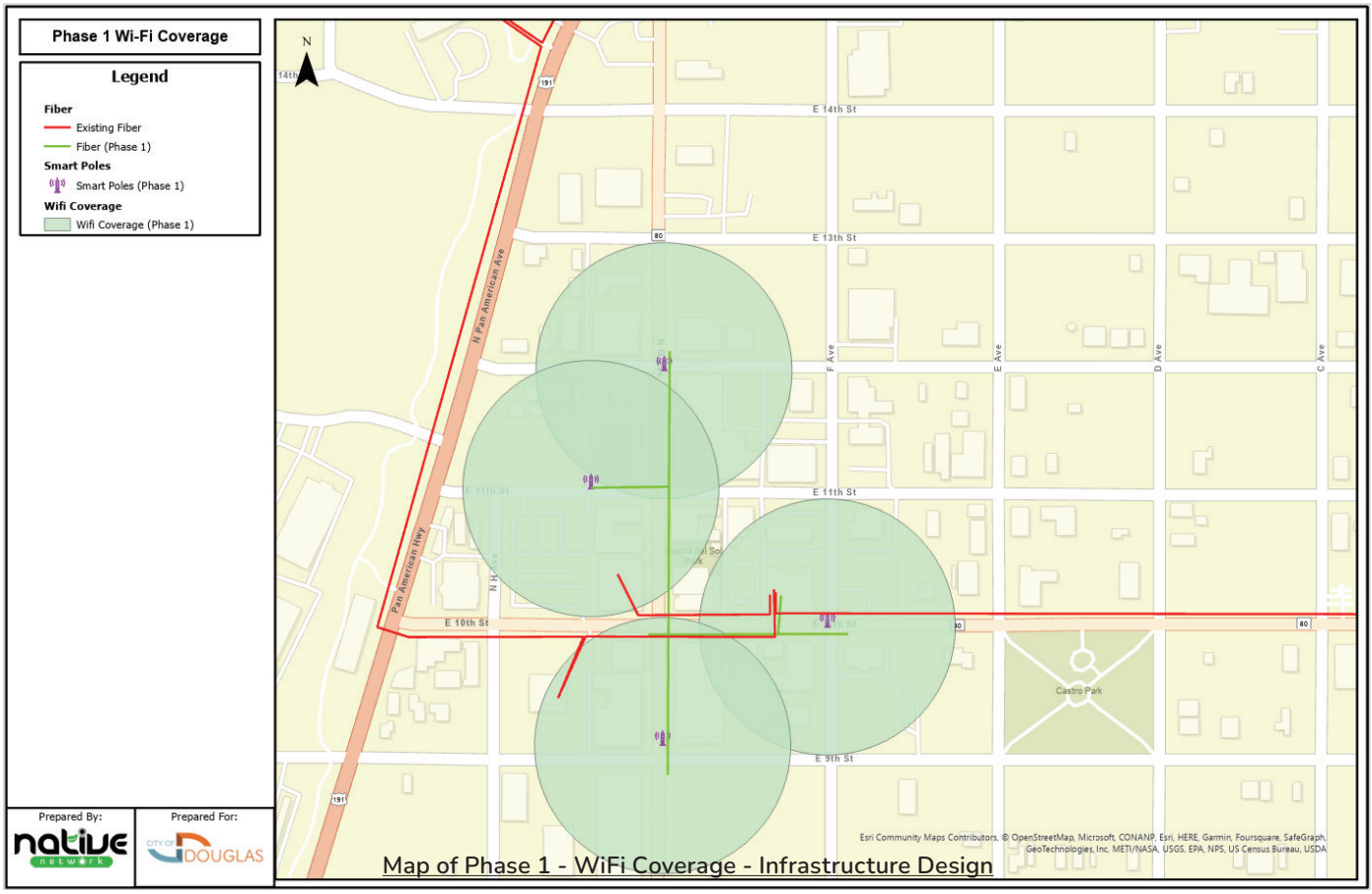
All areas have been analyzed and planned for later phases of the Smart City build out. Typically, smart light poles and traffic light installations are a good infrastructure base to build upon, however any building or light pole can be utilized. Using the private LTE or fixed wireless network, internet can be provided to virtually any location within the city boundaries and annexation targets.

Native Network has simulated a network design plan considering factors such as area coverage, capacity requirements, and network scalability. We have determined the number and strategic placement of WiFi access points to ensure essential coverage in a three-phase rollout schedule.

The **Public WiFi** Infrastructure to be constructed in each phase is provided below. The technology corresponds with the placement of SmartPoles within the region.

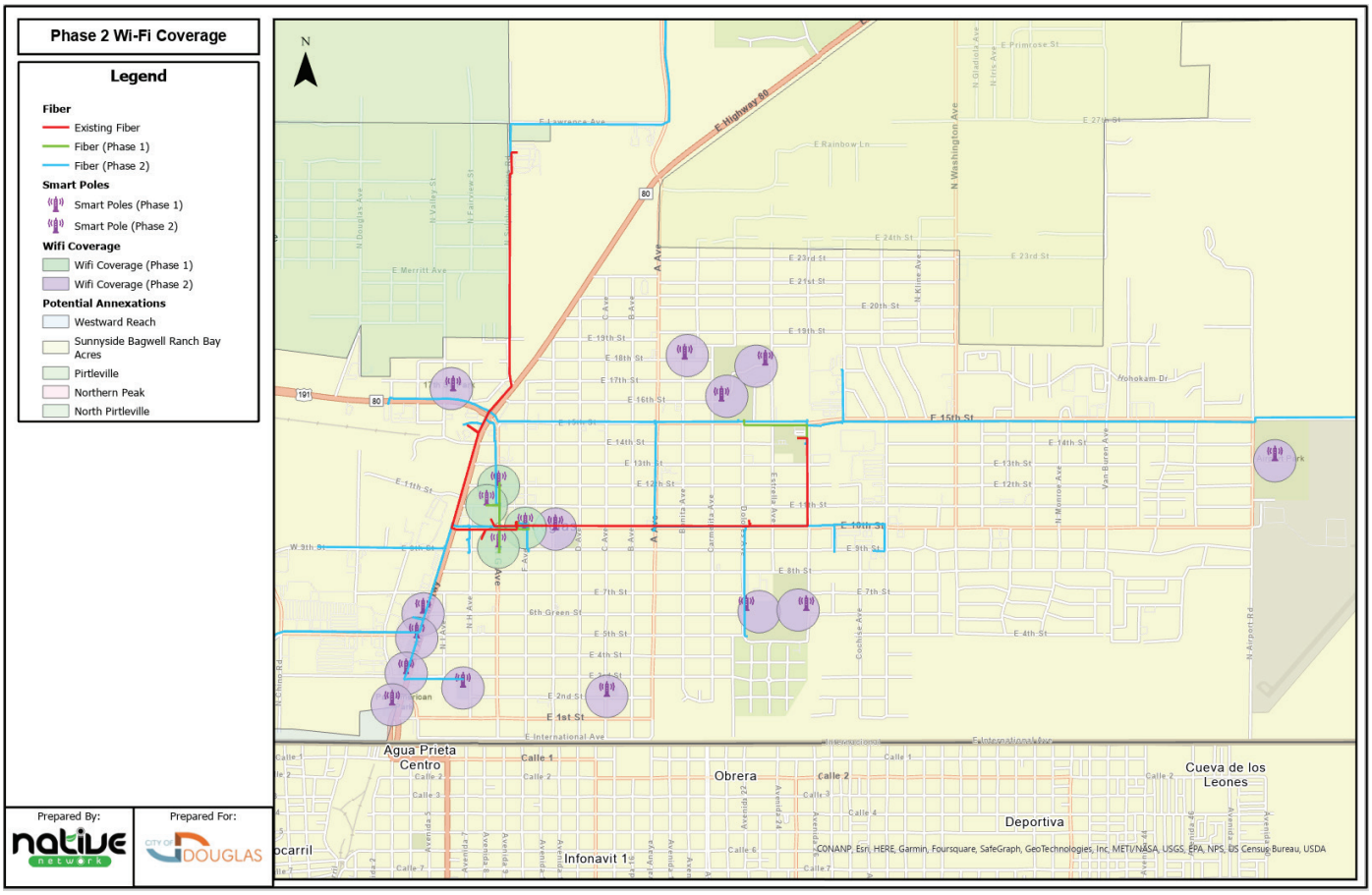
The Public WiFi maps display the estimated coverage each node is capable of broadcasting.

Phase 1 includes deploying the WiFi infrastructure, including access points, at designated locations in the downtown G Avenue area and public parks.



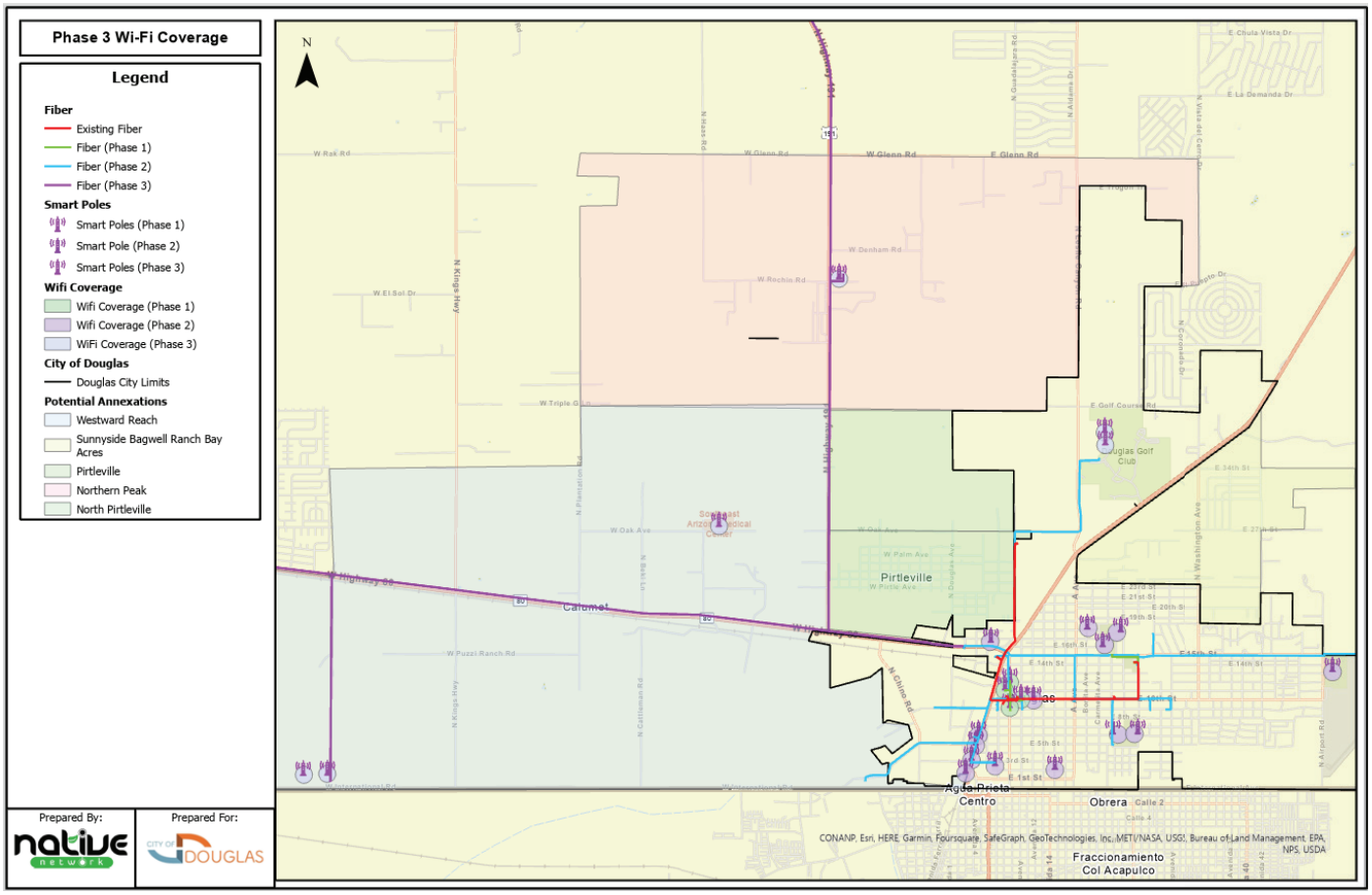
Map of Phase 1 - WiFi Coverage - Infrastructure Design

Phase 2 extends the WiFi network to critical locations within the city, such as parks, other concentrated business locations, and slow traffic areas such as leading up to the New Port of Entry.



Map of Phase 2 - WiFi Coverage - Infrastructure Design

Phase 3 further extends the network to include the additional locations both in the city and potential annexation targets such as the New Port of Entry, Industrial Park, fairgrounds, and golf facilities.



Map of Phase 3 - WiFi Coverage - Infrastructure Design

Vendors:

There are many WiFi vendors to choose from; Native Network has selected Cambium Networks (www.cambiumnetworks.com) as the vendor to base the proposed design on. It is critical to identify reputable vendors from which to procure the necessary WiFi equipment, including access points, routers, switches, and related networking components. When ready to deploy the network an RFP is recommended so the city may consider multiple vendors with proven track records with deploying indoor and outdoor public WiFi networks.

Network Configuration & Security:

Configure the WiFi network to provide to provide easy-to-access, high-speed internet to users, with seamless roaming between access points; a WiFi access controller is used to manage AAA functionality: authentication, authorization and accounting. Additionally, appropriate bandwidth management techniques must be implemented to ensure fair usage and consistent performance for all users.

The controller implements a user authentication system to verify access to the WiFi network. A splash page with city information and EULA (end-user license agreement) will initiate the service. For City residents, the City can developa verification process that confirms their residency status.

Implement a payment system for non-residents who wish to access the WiFi network and set up a secure payment gateway that accepts credit/debit card payments or other convenient methods such as Venmo or PayPal. Users will be able to create an account, select a subscription plan and make the necessary payment to access the network. This is typically priced in tiers with a lower very affordable tier with a high bandwidth option for power users. A splash page directs the user through the process.

Employ reobust security measures to protect the WiFi network and users' data. Employ encryption protocols (such as WPA2 or WPA3) to secure wireless communications. It is critical regularly update network firmware and security patches. Conduct regular security audits to identify and address any vulnerabilities.

Public Awareness & Promotion:

Launch a comprehensive public awareness campaign to inform residents and visitors about the availability of City-owned WiFi. Utilize various communication channels, including the City's website, social media platforms, local news outlets, and informational flyers in public places.

Highlight the benefits of the WiFi network, such as affordable access for non-residents and free access for City residents. Emphasize the network's reliability, speed, and suitability for various online activities.

Collaborate with local businesses and organizations in the downtown G Avenue area and public parks to promote the Wi-Fi network. Encourage them to display promotional materials and inform their customers about the availability of free or affordable WiFi.

Establish a dedicated helpdesk or support channel to address user queries, troubleshoot connectivity issues, and assist with user authentication or payment-related concerns. Offer clear instructions on how to connect to the Wi-Fi network and access support when needed.

Monitoring & Maintenance:

Implement network monitoring tools to proactively monitor the WiFi network's performance, connectivity, and user experience. Regularly analyze network statistics, identify potential bottlenecks, and optimize network resources to ensure consistent service quality.

Conduct regular maintenance activities, including firmware updates, equipment inspections, and repairs. Plan for periodic network upgrades to keep up with technological advancements and increasing user demands.

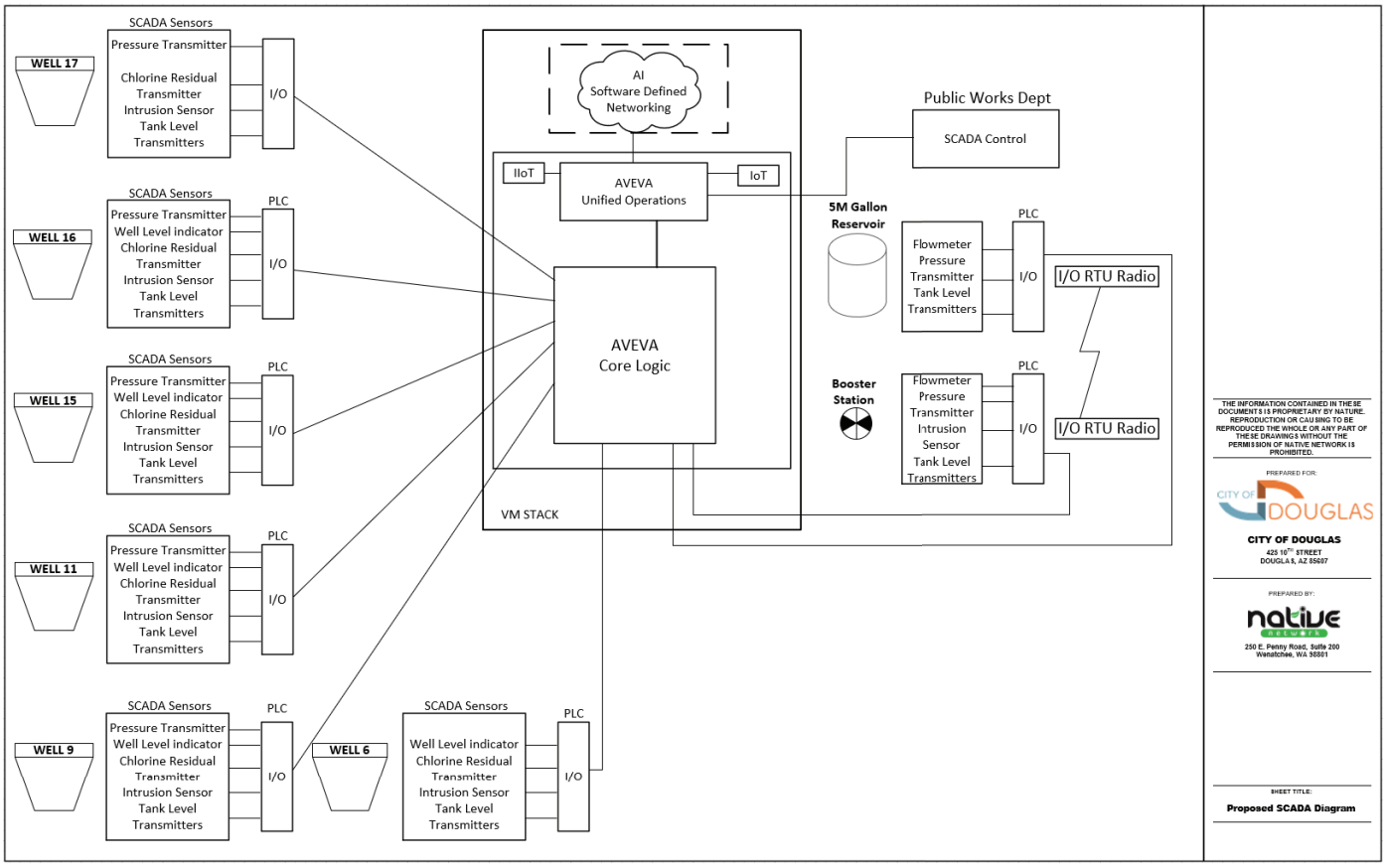
User Feedback & Improvement:

Utilize feedback forms to gauge their satisfaction levels and identify areas for improvement. Use this feedback to enhance the network's performance, address user concerns, and make informed decisions for future enhancements.

The City can successfully deploy a city-owned WiFi network that caters to the needs of both City residents and visitors using the provided network design and rollout plan. The network's availability in the downtown G Avenue area and public parks will enhance connectivity, promote digital inclusion, and contribute to the City's overall Smart City transformation. WiFi can be expanded throughout the City as desired, utilizing existing and new infrastructure as the Smart City Plan is implemented over the course of time.

7.4 SCADA Platform

SCADA (Supervisory Control and Data Acquisition) is a system used to monitor and control industrial processes and critical infrastructure. In the context of Smart City networks, SCADA plays a crucial role by providing centralized monitoring, efficient resource management, automation and control, integration of systems, and enhanced resilience and security. It enables real-time data acquisition, analysis, and visualization, allowing City administrators to make informed decisions and optimize the functioning of diverse infrastructure components. SCADA serves as a backbone for smart cities, facilitating the implementation of advanced technologies to enhance efficiency, sustainability, and livability in cities.



Schneider EcoStruxure:

Schneider Electric's EcoStruxure platform is utilized by Native Network to create a baseline SCADA, IIoT and IoT integrated and open architecture that enables digital transformation and Smart City management solutions for various infrastructure sub-systems. It encompasses a range of technologies and software applications to optimize energy efficiency, sustainability, and operational performance.

EcoStruxure is designed to connect and collect data from diverse systems, devices, and sensors within a facility or infrastructure. It utilizes advanced analytics, cloud computing, and artificial intelligence to process and analyze this data, providing valuable insights and actionable information to improve operational efficiency and decision-making.

The platform is divided into three layers:

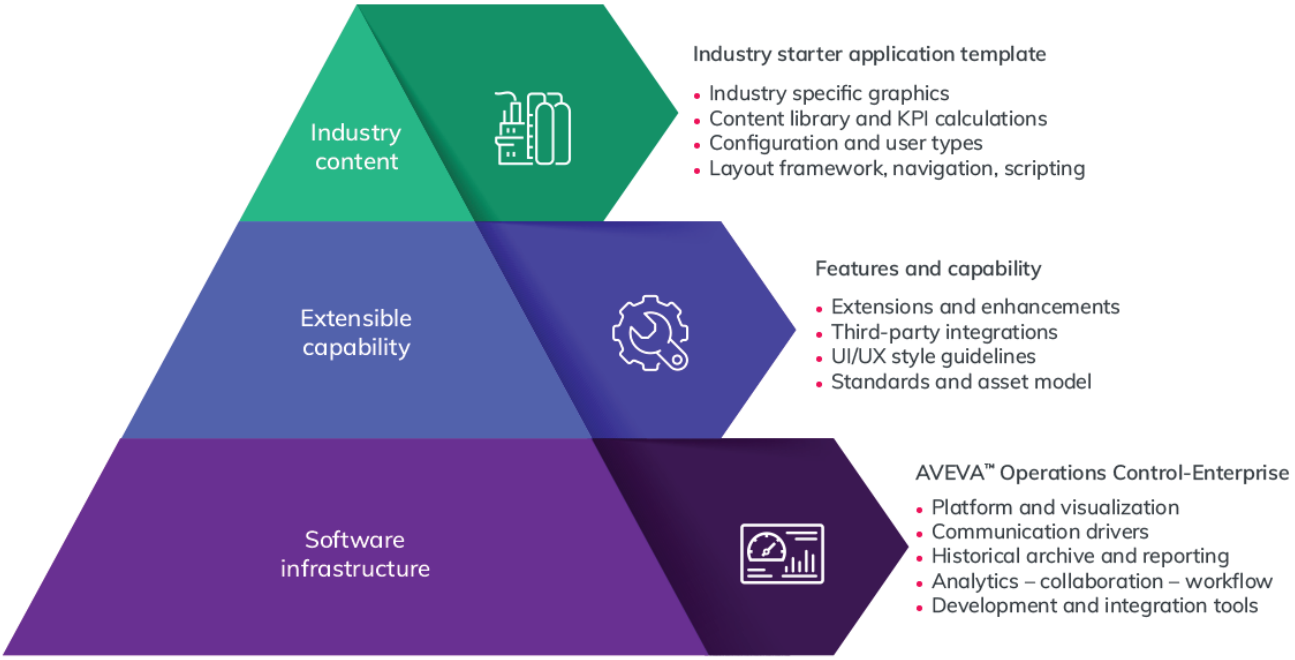
- **Connected Products:** Schneider Electric's IoT-enabled devices and equipment form the foundation of EcoStruxure. These devices, such as sensors, meters, and controllers, gather data from different systems and transmit it for further analysis. There are thousands of tested sensors, data collection and control devices that can be utilized by SCADA systems. Some of the critical devices in the proposed SCADA solution for the city include water valve control, tank capacity indicators and water flow meters.
- **Edge Control:** At the edge layer, EcoStruxure includes local control systems and edge computing capabilities. This allows for real-time data processing, reducing latency and enabling quicker response times. It also ensures data security and compliance with industry standards. Edge control allows for baseline control and management of critical SCADA systems, by engineers and field technicians.
- **Apps, Analytics & Services:** The top layer of EcoStruxure consists of software applications, analytics tools, and services. These overlayed applications leverage the data collected to provide insights, monitor performance, optimize operations, and enable predictive maintenance. They support various domains like energy management, building automation, industrial automation, and more.

The EcoStruxure platform offers benefits such as improved energy efficiency, reduced maintenance costs, enhanced safety and security, and increased overall productivity. It is scalable and adaptable, making it suitable for buildings, data centers, industries, and infrastructure projects of all sizes.

Schneider Electric continues to expand and evolve the EcoStruxure platform, incorporating emerging technologies and collaborating with partners to drive innovation and deliver sustainable solutions for a wide range of industries.

Building blocks of AVEVA Unified Operations Center

AVEVA Unified Operations Center comprises several AVEVA software components combined into a comprehensive enterprise visualization solution. These are supplemented by industry-centric starter templates that provide a jumpstart on development for customers focused on that industry.



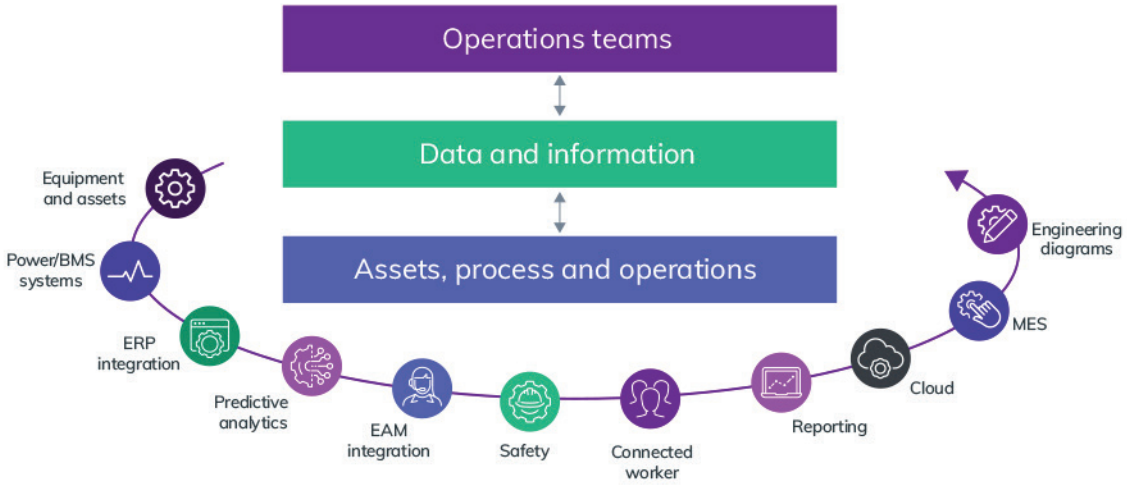
Aveva Software, a Schneider company:

Aveva provides the core SCADA software with the Unified Operation Center (UOC) option the IIoT and IoT integration.

The main purpose of UOC is to enable real-time operational performance management by consolidating and visualizing information related to process metrics, maintenance analytics, engineering documentation, financial performance, and more. By offering a centralized view, UOC helps organizations make informed decisions and facilitates strategic operational activities.

UOC serves as a foundation for enterprise visualization, allowing teams to access a wide range of data and leverage it to achieve organizational goals. By combining data from different sources, UOC enhances operational intelligence and provides a holistic understanding of the operations. This comprehensive view enables teams to identify trends, optimize processes, improve efficiency, and respond to operational challenges more effectively.

Smart City Visualization



Unified Operations Center (UOC) for Smart City Operations:

AVEVA Unified Operations Center for Smart Cities (UOC) can bring end-to-end operational visibility across city services to maintain operational conditions, achieve greater situational awareness and improve crisis response.

A whole team can be empowered with a centralized view to help make informed decisions, fast. Unified Operations Center for Smart Cities is based upon a system of systems approach that converges OT and IT technology into a single pane-of-glass solution.

This contextualizes actionable information, providing an overall perspective on process and non-process departments and the sub-systems that manage specific areas of city functions such as power, building management, water & sewer, traffic, and environmental.

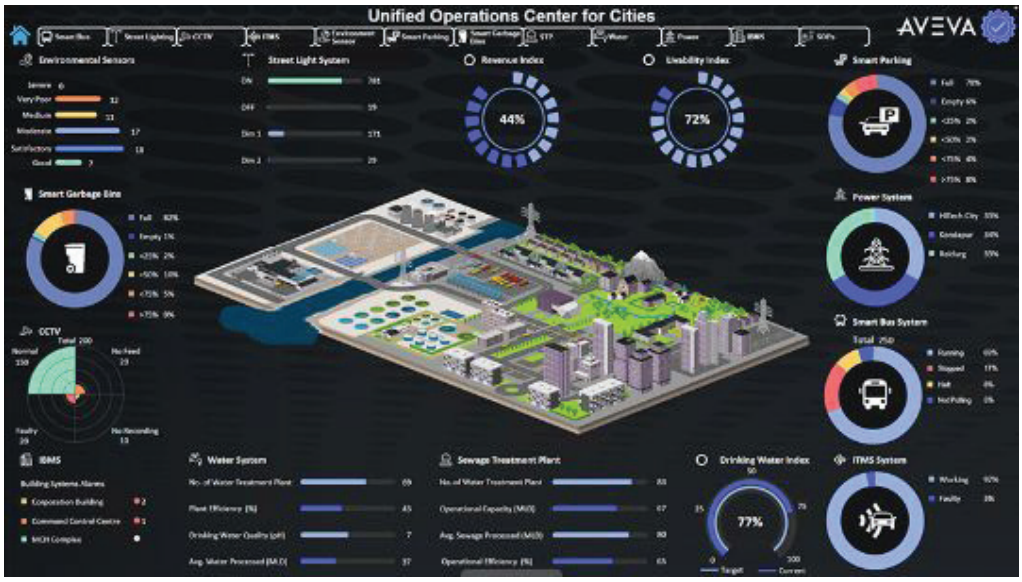
The Smart City application comes with pre-built content and connectors applicable to the equipment, processes workflow and specific use cases for your city operations environment. Adding the water management application provides a solid base for water and waste water management.

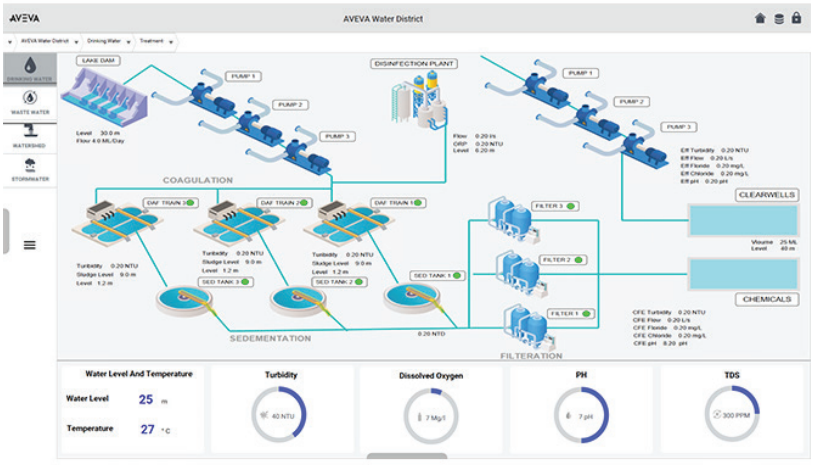
Using AVEVA Unified Operations Center to connect people with data from across the organization empowers your strategic teams. The rich intelligence offers a high-level perspective in a consolidated software environment that brings new value across complex and multi-site operations, increases agility responding to performance opportunities, and optimizes operations with teams making decisions in parallel to each other.

Additional applications can be added to take advantage of low-cost sensor technology such as IoT and IIoT. It is an integrated experience, providing detailed information for engineering and public works departments as well as overall visibility via the Smart City application.

While the software has many software-defined network features, upcoming capability based upon artificial intelligence (AI) will add significant power to the overall management of the systems.

The **Unified Operations Center (UOC)** dashboard displays every connected aspect of the Smart City. The images below are a representation of how all of the connected applications of the Smart City can be integrated into one program; the power to monitor, control, and analyze information from every sensor is incredibly powerful.





8. Smart City Applications

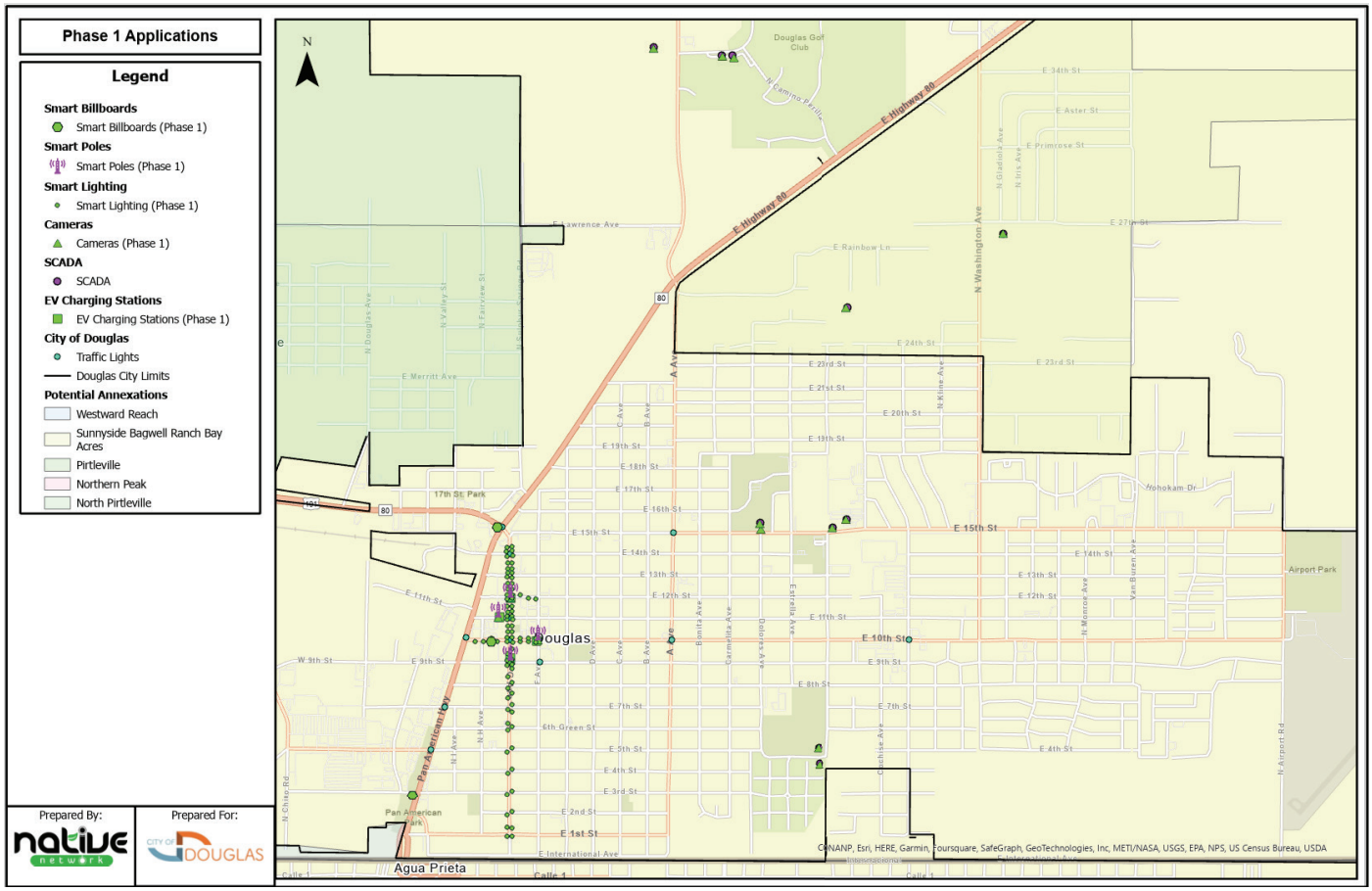
8.1 Overview

Smart City initiatives encompass a range of innovative approaches and technologies aimed at improving the quality of life, sustainability, and efficiency of city environments. These initiatives leverage advancements in technology, data analytics, and connectivity to transform cities into more livable, resilient, and economically prosperous spaces.

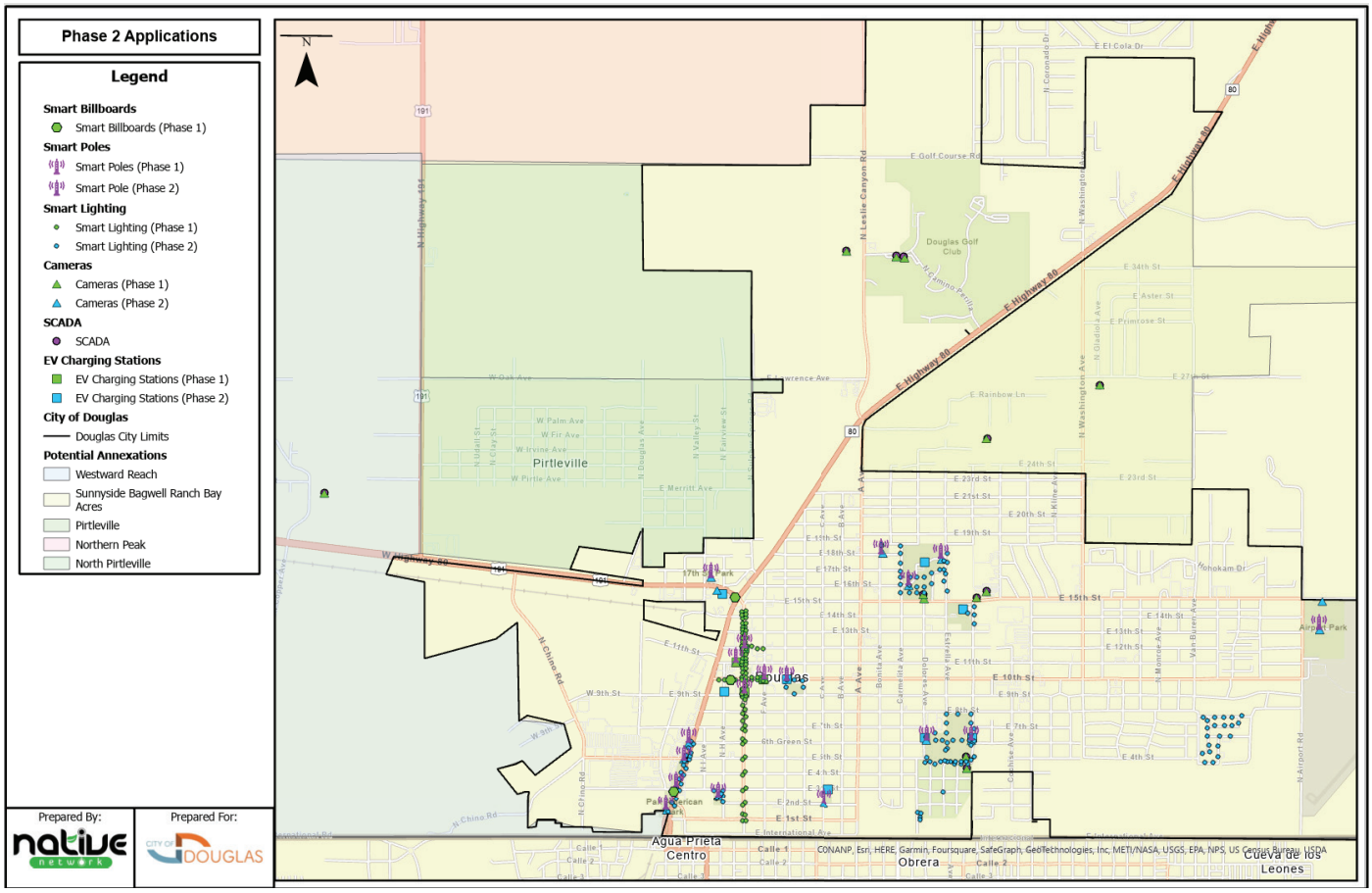
The applications are planned to roll out in phases, with critical applications rolled out first and in key locations. The phased plan follows the same phasing naming convention as the infrastructure rollout, as the applications are dependent upon the infrastructure.

Smart Applications are rolled out progressively as the phases proceed. The most intense phase is Phase 1 where the majority of the heavy lift on applications occurs. Installing on servers, programming and integration require significant resources. The second and third phases of the Telecommunications Roadmap essentially increase the footprint of the original applications. Some applications are introduced in Phase 2 to take advantage of the City's capacity to provide these additional services. It is important to note that application selection was limited to the most popular applications for smaller cities. There are hundreds of additional Smart City applications that can be introduced to take advantage of the new infrastructure.

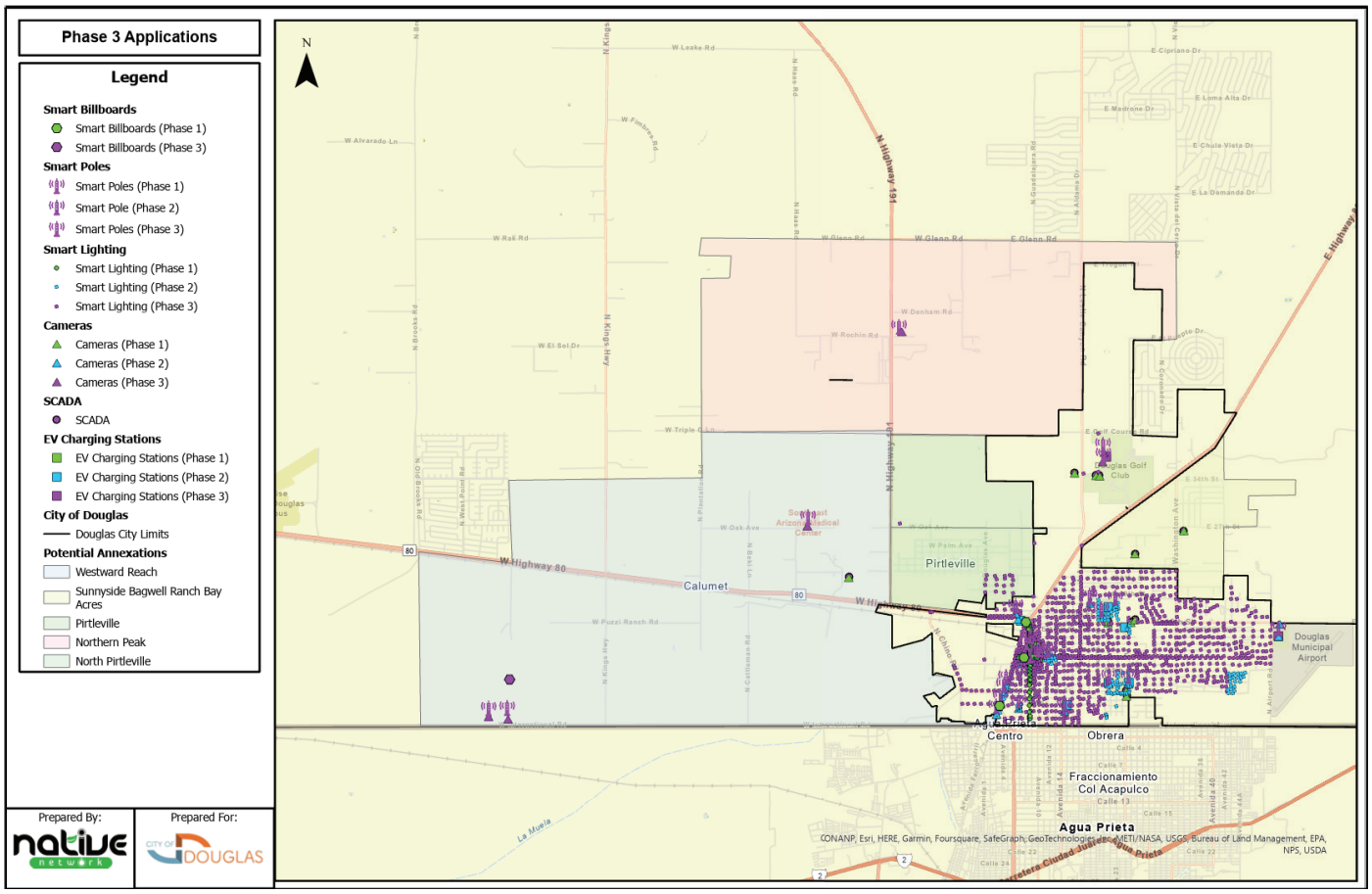
Application maps (shown on the next few pages) include proposed locations of smart billboards, smart lighting, EVchargers, and smart surveillance. The phased implementation begins in the downtown corridor, expands to the city parks, and finally reaches the potential annex areas as the City inevitability expands. The applications are what make a city a Smart City and will provide the community the most perceptible benefits.



Map of Phase 1 - Smart Applications



Map of Phase 2 - Smart Applications



Map of Phase 3 - Smart Applications

8.2 Edge Analytics & A.I.

What is edge analytics?

Edge analytics is a technology that is increasingly being used in smart cities to process data in real-time, close to the source of the data. It involves the use of algorithms and data analysis tools to process data at the edge of the network, as opposed to transmitting data to a centralized data center for processing.

What are the benefits of edge analytics?

In the context of smart cities, edge analytics is particularly useful for processing large amounts of data generated by sensors and smart devices installed in buildings, roads, and other public spaces. By analyzing this data at the edge of the network, near the source of the data, edge analytics can provide insights and respond to events in real-time, making Smart City systems more efficient and effective.

One of the key advantages of edge analytics for smart cities is its ability to reduce the amount of data that needs to be transmitted and stored. By processing data at the edge of the network, less data needs to be transmitted to central data centers for analysis. This can help to reduce the costs associated with data transmission and storage, making Smart City systems more cost-effective.

Another benefit of edge analytics for smart cities is its ability to improve the responsiveness of Smart City systems. By processing data in real-time, edge analytics can provide insights and respond to events more quickly. This can help to improve the efficiency of Smart City systems and ensure that resources are used more effectively.

Edge analytics can also help to improve the accuracy of data analysis in smart cities. By using machine learning algorithms, edge analytics can identify patterns and insights that might not be apparent to human analysts. This can help to improve the effectiveness of these smart city systems and provide better insights for decision-making.

One area where edge analytics is especially useful in smart cities is in the management of traffic flow. Analyzing data from sensors and cameras installed on roads, intersections, and highways, edge analytics can identify patterns and predict traffic congestion. This information can then be used to optimize traffic flow, reduce congestion, and improve safety.

Edge analytics can also be used in the management of energy consumption. By analyzing data from sensors and smart devices installed in buildings, edge analytics can identify areas of high energy consumption and recommend measures to reduce it. This can help to reduce energy costs and improve the sustainability of the city.

Edge analytics is an important technology for the development of smart cities. It can improve the responsiveness of Smart City systems, reduce data transmission and storage costs, and provide better insights for decision-making. As smart cities continue to evolve, edge analytics is likely to become even more important in the development of sustainable, livable, and efficient cities.

What is AI?

Artificial Intelligence (AI) refers to the ability of machines to perform tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation. In essence, AI involves the development of computer systems that can learn, reason, and adapt to new situations, much like humans do.

AI is made possible by a combination of computer science, mathematics, and engineering. The field of AI encompasses several subfields, including machine learning, natural language processing, robotics, computer vision, and expert systems. Each of these subfields involves the development of algorithms, models, and tools that can be used to train machines to perform specific tasks.

One of the key features of AI is its ability to learn from data. Machine learning algorithms are designed to analyze large volumes of data, identify patterns, and use these patterns to make predictions and decisions. This is often done through neural networks, which are modeled after the structure of the human brain.

Another important aspect of AI is its ability to reason and make decisions. Expert systems, for example, are designed to mimic the decision-making processes of human experts in specific domains, such as medicine or finance. These systems can analyze complex data sets and provide recommendations based on their analysis.

AI is used in a wide range of applications, from voice assistants like Siri and Alexa to self-driving cars, medical diagnosis, and financial analysis. In the context of business, AI is being used to automate repetitive tasks, analyze customer data, and improve decision-making.

What are the benefits of AI?

Some of the key benefits of AI include automation, improved decision-making, increased efficiency and productivity, personalization, improved healthcare, enhanced security, and environmental sustainability.

One of the most significant benefits of AI is its ability to automate repetitive and time-consuming tasks. This can save businesses and individuals a significant amount of time and resources, allowing them to focus on more important tasks and priorities. For example, AI can be

used to automate data entry, generate reports, and handle customer inquiries.

Another key benefit of AI is improved decision-making: AI can analyze large amounts of data, identify patterns and insights, and provide recommendations or predictions based on its analysis. This can help individuals and organizations make more informed and data-driven decisions. For example, AI can be used to analyze financial data and identify trends that may not be visible to humans, leading to better investment decisions.

AI also provides the opportunity for increased efficiency and productivity. By automating tasks and providing insights, AI can increase efficiency and productivity in many industries. For example, AI can be used to optimize supply chain management, streamline manufacturing processes, and improve customer service.

The ability to personalize customer experiences is another benefit AI offers. For example, AI-powered chatbots can provide personalized recommendations to customers based on their browsing history and preferences. This can improve customer satisfaction and loyalty.

AI can improve healthcare. It can be used in healthcare to analyze patient data and provide personalized treatment plans. AI can also be used to assist with medical research, drug discovery, and diagnosis. This can lead to better health outcomes and improved quality of life for patients.

AI can also be used to improve security in many industries, from financial services to transportation. For example, AI-powered fraud detection can help detect and prevent fraudulent transactions, while AI-powered surveillance can help identify and respond to security threats.

Lastly, AI can contribute to environmental sustainability. It can be used to help reduce waste and improve sustainability in many industries. For example, AI can be used to optimize energy consumption in buildings, reduce emissions in transportation, and improve waste management.

How do edge analytics and AI work together to make a city smart?

Utilizing edge analytics and AI together can help to reduce data transmission and storage costs. By processing data at the edge of the network, less data needs to be transmitted to central data centers for analysis. This can help to reduce the costs associated with data transmission and storage, making Smart City systems more cost-effective.

Edge analytics and AI can work together to make a city smart by providing real-time insights and data-driven decision-making. By analyzing data at the edge of a network and using AI to make predictions and recommendations, cities can become more efficient, safer, and more sustainable.

8.2 Smart City Surveillance

What is smart city surveillance?

Intelligent city surveillance refers to the use of advanced technologies, such as artificial intelligence (AI), machine learning (ML), computer vision, and data analytics, to monitor and analyze activities in public spaces within a city.

The primary aim of smart city surveillance is to improve public safety and prevent crime. The technologies used in smart city surveillance include video cameras, sensors, and other connected devices that can collect data on people's movements, behavior, and activities.

However, the use of smart city surveillance also raises concerns around privacy and surveillance. It is important that these systems are designed and implemented with appropriate safeguards to protect individuals' rights and freedoms. This includes ensuring that data is collected and analyzed in a manner that respects privacy, and that individuals are informed about the use of surveillance technologies in public spaces.

What are the benefits of smart city surveillance?

There are numerous benefits to using smart city surveillance, including enhancing public safety, optimizing traffic flow, improving waste management, reducing energy consumption, and enhancing the overall efficiency of a city.

One of the primary benefits of smart city surveillance is the ability to enhance public safety. By monitoring public spaces with video cameras and other sensors, smart city surveillance systems can quickly identify and respond to potential security threats, such as individuals carrying weapons or acting suspiciously, and alert law enforcement agencies. This can help prevent crime and enhance public safety, making citizens feel more secure when out in public spaces.

In addition to improving public safety, smart city surveillance can also help optimize traffic flow, improve waste management, and reduce energy consumption, thereby enhancing the overall efficiency of a city. For example, traffic cameras can be used to monitor traffic flow and detect accidents, which can help reduce congestion and improve response times for emergency

services. Similarly, sensors can be used to monitor waste levels in public bins and optimize waste collection routes, reducing costs and improving efficiency.

Another benefit of smart city surveillance is improved emergency response times. When an emergency occurs, such as a fire or natural disaster, smart city surveillance systems can quickly identify the location and severity of the incident. This enables emergency services to respond more quickly and effectively, potentially saving lives and minimizing damage.

Finally, smart city surveillance can provide valuable insights into city operations and infrastructure. By analyzing data on traffic patterns, waste levels, and energy consumption, city officials can identify areas for improvement and make more informed decisions about how to allocate resources. This can lead to more efficient and effective use of city resources, resulting in cost savings and improved services for residents.

Smart city surveillance offers numerous benefits, including enhancing public safety, optimizing traffic flow, improving waste management, reducing energy consumption, and enhancing the overall efficiency of a city. While there are concerns around privacy and surveillance, these systems can be designed and implemented with appropriate safeguards to protect individuals' rights and freedoms. As cities continue to adopt smart city surveillance technologies, it will be important to ensure that they are used in a responsible and ethical manner, and that the benefits of these technologies are balanced against the potential risks to privacy and civil liberties.

How does this initiative meet the City's needs?

Smart City surveillance systems offer advanced technologies and data-driven approaches to enhance security, improve situational awareness, and ensure the safety of residents and visitors in cities like Douglas. These intelligent systems leverage video analytics, real-time monitoring, and integration with other Smart City components to provide comprehensive surveillance capabilities.

These systems utilize video analytics algorithms to automatically analyze video feeds, detect suspicious activities, and generate real-time alerts. This provides the opportunity for more proactive security measures, rapid response to incidents, and enhanced crime prevention in key areas of the City of Douglas.

Integrating surveillance systems with other Smart City components, such as smart lighting, environmental sensors, and traffic management systems, enhances overall situational awareness. For example, integrating surveillance cameras with environmental sensors can provide early detection of hazards, while integrating with traffic management systems can facilitate real-time incident response and traffic control.

Smart City surveillance systems can incorporate facial recognition and license plate recognition technologies for enhanced identification and tracking. These capabilities enable efficient monitoring of individuals of interest, vehicle identification, and access control, contributing to improved public safety.

Storing surveillance video footage in the cloud offers advantages such as scalability, remote access, and data redundancy. Cloud-based video management platforms provide secure storage, easy retrieval, and seamless integration with analytics tools, enabling efficient investigation and evidence gathering.

Smart surveillance brings numerous benefits to a rural community like Douglas, promoting safety, security, and effective management of resources. The City can leverage the technology to monitor and protect it's environment; smart surveillance can create a safer and more resilient community for residents and visitors alike while supporting real-time public and school safety requirements and event logging.

Types of sensors used for Smart City surveillance

Smart City surveillance systems utilize various types of sensors to capture and monitor different aspects of city environments. These sensors play a crucial role in collecting data and providing insights for effective surveillance and security. Here are some common types of sensors used for Smart City surveillance:

1. **Closed-circuit television (CCTV) cameras** are the most widely used sensors for surveillance in smart cities. They capture visual data from public spaces, roads, buildings, and other key areas. CCTV cameras can be fixed, pan-tilt-zoom (PTZ), or equipped with advanced features such as facial recognition, license plate recognition, and video analytics for real-time monitoring and analysis.
2. **Thermal Cameras:** Thermal cameras detect infrared radiation emitted by objects and people, allowing surveillance in low-light or no-light conditions. They provide heat-based imagery that helps identify anomalies, detect movement, and monitor temperature variations. Thermal cameras are particularly useful for perimeter security, border control, and critical infrastructure surveillance.
3. **Motion Sensors:** Motion sensors detect movement within their range and trigger alerts or activate other surveillance systems. They are commonly used for intrusion detection, activating lights, and controlling camera movements. Motion sensors can be based on different technologies, including passive infrared (PIR), microwave, and ultrasonic.
4. **Sound Sensors:** Sound sensors, also known as acoustic sensors, capture audio data from the environment. They can detect and analyze sounds such as gunshots, explosions, breaking glass, or unusual noises. Sound sensors help in identifying

potential security threats, incidents, or abnormal behavior in public spaces.

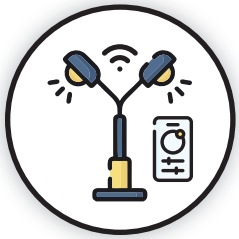
These are just some examples of sensors used in Smart City surveillance. The specific sensors employed depend on the surveillance objectives, the nature of the environment being monitored, and the desired level of data collection and analysis. Integrating multiple sensor types allows for comprehensive surveillance and situational awareness in Smart City environments.

Vendor Recommendations:

1. **Axis Communications:** Axis Communications is a leading provider of Smart City surveillance solutions. Their portfolio includes high-quality surveillance cameras, video analytics software, and network infrastructure. Axis Communications' expertise in IP-based surveillance systems can support the implementation of an advanced surveillance infrastructure in Douglas.
2. **Genetec:** Genetec offers a comprehensive suite of video management and security solutions. Their unified platform, Security Center, integrates video surveillance, access control, and other security systems. Genetec's advanced video analytics and flexible deployment options make them a suitable vendor for Smart City surveillance projects.
3. **Avigilon:** Avigilon specializes in high-definition video surveillance solutions. Their advanced cameras, video management software, and analytics capabilities provide powerful surveillance and situational awareness. Avigilon's expertise in high-resolution imaging can enhance security and surveillance effectiveness in Douglas.
4. **Hanwha Techwin:** Hanwha Techwin offers a range of surveillance products, including cutting-edge cameras and video management solutions. Their WiseNet series incorporates advanced features such as AI-based video analytics, cybersecurity measures, and thermal imaging. Hanwha Techwin's offerings can enhance security and provide comprehensive surveillance coverage.

Smart City surveillance systems play a crucial role in enhancing security and safety. By harnessing video analytics, integrating with other Smart City components, and incorporating advanced recognition technologies, can create a comprehensive surveillance infrastructure. Partnering with vendors like Axis Communications, Genetec, Avigilon, and Hanwha Techwin can provide the necessary expertise and solutions to implement an effective and future-ready Smart City surveillance system, ensuring the well-being and security of its residents and visitors.

8.4 Smart Lighting



What is smart lighting?

One of the key components of a smart city is smart lighting, which involves the use of intelligent lighting systems to improve energy efficiency, enhance safety and security, and create a more comfortable city environment. Smart lighting systems are designed to adapt to changing conditions and user needs, such as varying weather conditions, pedestrian and vehicle traffic, and the time of day. These systems utilize a range of sensors, including motion detectors, ambient light sensors, and occupancy sensors, to detect changes in the environment and adjust the lighting accordingly.

What are the benefits of smart lighting?

Smart lighting provides benefits that include energy savings, improved safety and security, and a more appealing city environment. For example, a smart lighting system might dim streetlights during periods of low traffic to save energy but brighten them when a pedestrian or vehicle is detected to improve safety. It can also improve security: by utilizing motion detectors and other sensors, these systems can detect suspicious activity and alert authorities or emergency services. This can be especially useful in public spaces such as parks, where traditional lighting systems may not be effective in deterring criminal activity.

Another benefit of smart lighting systems in smart cities is the ability to create a more comfortable and appealing city environment. By adjusting the lighting to reflect the time of day, weather conditions, and user needs, these systems can create a more pleasant and inviting atmosphere for residents and visitors. For example, smart lighting systems might adjust the color and intensity of streetlights to reflect seasonal changes, such as the colors of fall foliage or the festive lights of holiday celebrations.

To realize these benefits, smart lighting systems rely on advanced technologies such as cloud computing, artificial intelligence, and the internet of things (IoT). These technologies enable the collection and analysis of large amounts of data from sensors and other sources, which can be used to optimize lighting systems and improve their performance over time.

Smart lighting is an essential component of a smart city, offering a range of benefits such as improved energy efficiency, enhanced safety and security, and a more comfortable and appealing urban environment. By leveraging advanced technologies such as cloud computing, artificial intelligence, and the internet of things, smart lighting systems can adapt to changing conditions and user needs, creating a more efficient, sustainable, and livable urban environment for all.

How does this initiative meet the City's needs?

Smart City lighting solutions play a crucial role in the transformation of Douglas into a sustainable and connected city environment by enhancing energy efficiency, public safety, connectivity, and service delivery.

By adopting energy-efficient LED luminaires, smart lighting reduces energy consumption and greenhouse gas emissions. Adaptive lighting adjusts brightness based on real-time conditions, optimizing illumination while minimizing energy waste. Through the LED technology and intelligent control mechanisms, smart lighting helps reduce operational costs associated with street lighting. Precise control and monitoring also enable effective maintenance planning, reducing expenses and improving resource allocation. Programmable and remotely controlled smart lighting systems enable dynamic lighting schemes based on factors like time of day, pedestrian traffic, or weather conditions. This flexibility optimizes energy usage and provides customized lighting experiences.

Well-lit streets, walkways, and public spaces enhance public safety, deter crime, and promote a sense of security. Real-time monitoring allows for timely detection of faults or outages, enabling prompt maintenance and uninterrupted lighting. One technology that can help to facilitate smart light is SmartPoles.

Enabling connectivity and multiple services, SmartPoles integrate various technologies, sensors, and communication infrastructure, enhancing connectivity, data collection, and service delivery in Douglas. The SmartPoles are equipped with wireless communication technologies like Wi-Fi, 4G/5G, and IoT connectivity and create a dense network of connectivity points throughout the City. This promotes digital inclusion, real-time data transmission, and supports Smart City applications.

SmartPoles house sensors for environmental monitoring, including air quality, noise levels, temperature, and humidity. This data enables informed decision-making for urban planning, resource management, and environmental sustainability initiatives. Additionally, SmartPoles host a range of services such as public address systems, surveillance cameras, electric vehicle charging stations, and interactive information displays. These integrated services enhance public safety, transportation efficiency, and citizen engagement.

Designed with a modular and adaptable structure, SmartPoles allow for easy integration of new technologies and services as the Smart City evolves. This scalability ensures the infrastructure remains flexible and capable of meeting future needs.

By implementing smart lighting systems and SmartPoles, Douglas can enhance energy efficiency, public safety, connectivity, and service delivery, ultimately driving the City's Smart City vision. The integration of technologies from vendors like Multiband Global, Philips Lighting, Cisco Systems, and Telensa will optimize lighting, improve resource management, and create a sustainable and connected community environment in the City of Douglas. These solutions play a pivotal role in advancing the City's Smart City Plan.

Types of sensors used for smart lighting and SmartPoles

Smart lighting and SmartPoles incorporate various sensors to enable efficient and responsive lighting systems. These sensors enhance energy savings, improve safety, and provide valuable data for Smart City management. Here are some common types of sensors used for smart lighting and SmartPoles:

1. **Motion Sensors:** Motion sensors, such as passive infrared (PIR) sensors, detect the presence of people or vehicles within a specific range. When motion is detected, they trigger the lighting system to turn on or increase the brightness. Motion sensors help optimize energy usage by ensuring that lights are only activated when needed. They are commonly used in outdoor lighting applications to provide illumination as people move through the area.
2. **Ambient Light Sensors:** Ambient light sensors, also known as photocells or light-dependent resistors (LDRs), measure the level of natural light in the surrounding environment. These sensors allow the smart lighting system to adjust the brightness or turn off lights when sufficient natural light is available. By adapting to natural light conditions, the system maximizes energy efficiency and reduces unnecessary lighting during daylight hours.
3. **Proximity Sensors:** Proximity sensors detect the presence or proximity of objects or individuals. They can be used in smart lighting applications to identify when someone is near a specific area or approaching a streetlight. This information triggers the lighting system to activate or adjust the illumination level accordingly. Proximity sensors contribute to enhanced safety and security in outdoor spaces.
4. **Environmental Sensors:** Environmental sensors monitor environmental parameters, such as temperature, humidity, and air quality. These sensors provide valuable data for optimizing lighting operations and maintaining comfortable and safe

environments. For example, temperature sensors can trigger adjustments to lighting intensity based on temperature fluctuations, ensuring optimal lighting conditions in different weather conditions.

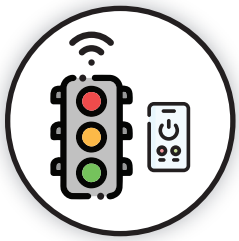
5. **Sound Sensors:** Sound sensors, also referred to as acoustic sensors, detect and analyze sound levels and patterns. They can be used in smart lighting systems to respond to specific sound events. For instance, in areas with high noise levels, sound sensors can trigger increased illumination to enhance visibility and security. Sound sensors are particularly useful in urban environments where lighting requirements may vary based on noise levels.
6. **Presence Sensors:** Presence sensors detect the presence of people within a designated area. They can be based on technologies like infrared or radar and are often used for occupancy detection. Presence sensors enable the lighting system to adjust lighting levels or turn off lights in unoccupied or low-traffic areas, reducing energy consumption and operational costs.
7. **Power Monitoring Sensors:** Power monitoring sensors measure and monitor energy consumption in lighting systems. These sensors provide real-time data on energy usage, helping to identify energy inefficiencies, optimize consumption, and support energy management strategies. Power monitoring sensors are integral to achieving energy savings and sustainability goals in smart lighting deployments.
8. **Communication Sensors:** Communication sensors facilitate connectivity and data exchange between smart poles and the central management system. These sensors may include technologies such as Wi-Fi, Bluetooth, or cellular communication modules. They enable remote monitoring, control, and management of lighting systems, allowing for real-time adjustments, scheduling, and fault detection.

By integrating these sensors into smart lighting and SmartPole systems, cities can optimize energy usage, enhance safety and security, and gather valuable data for future planning and management. The combination of sensor technologies enables dynamic and responsive lighting systems that adapt to the needs of the environment and users, contributing to more efficient and sustainable city environments.

Vendor Recommendations:

- **Multiband Global:** Multiband Global offers integrated smart lighting and SmartPoles systems, tailored to enhance energy efficiency, connectivity, and overall city management.
- **Philips Lighting (Signify):** Philips Lighting provides a wide range of smart lighting products and systems, including energy-efficient LED luminaires, connected lighting platforms, and lighting management software, designed specifically for Smart City applications.
- **Cisco Systems:** Cisco offers comprehensive Smart City solutions, including intelligent lighting systems, connectivity infrastructure, and IoT platforms. Their solutions focus on enabling connectivity, data management, and interoperability across Smart City deployments.
- **Ericsson:** Ericsson provides advanced solutions for Smart City connectivity and infrastructure, including 4G/5G networks, SmartPoles solutions, and IoT platforms that support various Smart City applications.
- **Telensa:** Telensa specializes in smart street lighting solutions and wireless control systems, enabling remote monitoring, adaptive lighting control, and data analytics to enhance energy efficiency and operational optimization.
- **GE Current, a Daintree company:** GE Current offers intelligent lighting solutions, including LED luminaires, wireless controls, and a cloud-based energy management platform for real-time monitoring and data-driven energy optimization.
- **Silver Spring Networks:** Silver Spring Networks provides Smart City platforms that integrate smart lighting, smart grids, and IoT devices. Their solutions enable efficient energy management, data analytics, and interoperability across various city services.
- **Cimcon Lighting:** Cimcon Lighting offers intelligent lighting controls and management systems for Smart City applications, including wireless control modules, data analytics software, and real-time monitoring capabilities.
- **Huawei Technologies:** Huawei provides comprehensive Smart City solutions, including smart lighting and SmartPoles systems, IoT platforms, communication infrastructure, and advanced technologies for intelligent city management.
- **Schréder:** Schréder offers a wide range of smart lighting solutions designed for urban environments, including connected LED luminaires, lighting management systems, and integrated SmartPoles solutions that enable energy-efficient lighting and connectivity services.

8.5 Smart Traffic Management



What is smart traffic management?

Smart traffic management refers to the use of technology and data analysis to improve the flow of traffic in cities. The goal of smart traffic management is to reduce congestion, improve safety, and increase efficiency on roads and highways. This is achieved through various technologies, such as sensors, cameras, and data analytics, to monitor traffic patterns and optimize traffic flow.

What are the benefits of smart traffic management?

One of the primary benefits of smart traffic management is reduced congestion. By using sensors and cameras to monitor traffic patterns, cities can identify areas where congestion is likely to occur and adjust traffic flow to prevent or alleviate it. This can help to reduce travel times and improve the overall driving experience for commuters and other road users.

Smart traffic management can also help to improve safety on roads and highways. Using sensors to monitor traffic patterns, cities can detect when accidents or other incidents occur and respond quickly to prevent further accidents. This can help to reduce the risk of injury or death on the roads, while also minimizing the disruption caused by accidents.

Another benefit of smart traffic management is increased efficiency. By using data analytics to optimize traffic flow, cities can ensure that vehicles are moving as efficiently as possible. This can help to reduce fuel consumption and emissions, while also improving the overall efficiency of transportation systems.

Smart traffic management can also help to improve the overall quality of life. Reducing congestion and improving traffic flow, cities can create a more livable environment for residents and visitors. This can help to attract new businesses and investment, while also improving the overall economic performance of the City.

How does this initiative meet the City's needs?

In the pursuit of creating efficient, sustainable, and connected community, Douglas, can leverage advanced technologies to transform its traffic management systems. Smart traffic management integrates intelligent sensors, data analytics, and real-time control mechanisms to optimize traffic flow, enhance safety, and improve overall mobility.

Smart traffic management systems in Douglas can leverage real-time data from various sources to analyze traffic patterns and optimize signal timings. This dynamic approach will improve traffic flow, reduces congestion, and minimizes travel times, enhancing overall transportation efficiency within the City. These systems utilize adaptive signal control systems that adjust signal timings based on real-time traffic conditions. By dynamically responding to traffic demands, these systems optimize signal cycles and improve traffic flow at intersections, reducing delays and improving overall travel efficiency.

Smart traffic management systems in Douglas can prioritize safety by integrating technologies that enhance visibility, detect traffic violations, and provide real-time alerts to drivers and pedestrians. These measures contribute to a safer and more efficient road-user experience. To improve intersection safety, Douglas can deploy technologies such as video analytics, vehicle-to-infrastructure (V2I) communication, and pedestrian detection. Automated detection of red-light violations and real-time adjustments of signal timings ensure smooth and safe traffic movements. Real-time traffic data, coupled with analytics capabilities, enables prompt detection and response to incidents, accidents, or hazardous conditions. In Douglas, these smart traffic management systems can facilitate efficient emergency response coordination and optimize traffic routing to minimize disruptions and enhance public safety.

Smart traffic management is a critical component of the Smart City vision in Douglas, revolutionizing mobility and transportation within the City. It also offers a comprehensive solution to the challenges posed by border traffic congestion; smart traffic management can utilize advanced technologies to inform drivers of wait-time and delays as well as synchronize traffic lights for optimum traffic flow. Incorporating recommended vendors like Miovision, Siemens Mobility, Cubic Transportation Systems, and SWARCO will accelerate the transformation of traffic management systems ensuring the city is at the forefront of intelligent mobility solutions.

Types of sensors used for smart traffic management

Smart traffic management systems rely on a variety of sensors to gather data and monitor traffic conditions in real-time. These sensors help optimize traffic flow, improve safety, and enable intelligent decision-making for efficient transportation management. Here are some common types of sensors used for smart traffic management:

1. **Inductive Loop Detectors:** Inductive loop detectors are installed beneath the road surface and use electromagnetic fields to detect the presence of vehicles. They can determine traffic volume, vehicle

speed, and occupancy within specific lanes. Inductive loop detectors are often used for traffic signal control, traffic counting, and vehicle classification.

2. **Video Cameras:** Video cameras, including CCTV cameras or surveillance cameras, are employed for traffic monitoring and surveillance. These cameras capture live video feeds of roadways, intersections, and critical points. Video analytics software can then be applied to extract information such as traffic flow, congestion, vehicle classification, and license plate recognition. Video cameras offer visual confirmation of traffic conditions and aid in incident management and enforcement.
3. **Infrared Sensors:** Infrared sensors, also known as infrared vehicle detectors (IVDs), use infrared beams to detect the presence of vehicles. These sensors are typically installed above the roadway and can monitor vehicle presence, speed, and occupancy. Infrared sensors are often used in combination with other sensors for traffic detection, signal control, and toll collection systems.
4. **Microwave Sensors:** Microwave sensors use radar technology to detect and measure vehicle presence, speed, and movement. They emit microwave signals and analyze the reflections from vehicles to gather traffic data. Microwave sensors can be mounted on roadside poles or installed in the pavement. They are commonly used for vehicle detection, speed measurement, and traffic management.
5. **Ultrasonic Sensors:** Ultrasonic sensors utilize sound waves to measure distance and detect objects, including vehicles. These sensors can be deployed in parking lots or at intersections to detect vehicle presence, count vehicles, and manage traffic signal timings. Ultrasonic sensors are useful for intelligent parking systems and intersection control.
6. **Bluetooth/WiFi Sensors:** Bluetooth and Wi-Fi sensors leverage the signals emitted by Bluetooth or WiFi-enabled devices, such as smartphones or in-car systems, to track the movement of vehicles. These sensors can capture anonymous data about travel times, origin-destination patterns, and traffic congestion. Bluetooth and Wi-Fi sensors provide valuable insights for traffic flow analysis and travel demand management.
7. **Acoustic Sensors:** Acoustic sensors, also known as sound sensors, detect and analyze sounds and vibrations produced by traffic. They can identify vehicle movements, measure traffic density, and detect abnormal events, such as accidents or emergencies. Acoustic sensors are used for real-time traffic monitoring, incident detection, and surveillance.
8. **Global Navigation Satellite System (GNSS):** GNSS receivers utilize signals from satellite navigation systems like GPS to track the position and movement of vehicles. GNSS sensors provide accurate data on vehicle speeds, travel routes, and travel times. They are commonly used for traffic flow analysis, route planning, and navigation applications.

These sensors, often deployed in combination, enable comprehensive data collection and analysis for smart traffic management. The data gathered from these sensors is processed, analyzed, and utilized by intelligent transportation systems (ITS) to optimize traffic signal timings, manage congestion, provide real-time traveler information, and improve overall transportation efficiency and safety.

Vendor Recommendations:

- **Miovision:** Miovision offers advanced traffic data collection and management solutions. Their technologies include video-based traffic sensors, data analytics software, and cloud-based platforms. Miovision's solutions enable real-time traffic monitoring, data-driven decision-making, and performance evaluation for effective traffic management.
- **Siemens Mobility:** Siemens Mobility provides a comprehensive portfolio of smart traffic management solutions. Their offerings include adaptive signal control systems, traffic management software, and intelligent transportation systems. Siemens Mobility's solutions enhance traffic flow, reduce congestion, and improve safety through data-driven insights and real-time control.
- **Cubic Transportation Systems:** Cubic Transportation Systems specializes in intelligent transportation solutions, including smart traffic management. Their advanced technologies encompass traffic signal control systems, transportation analytics, and integrated fare payment solutions. Cubic's solutions enhance traffic efficiency, enable multimodal connectivity, and improve the overall transportation experience.
- **SWARCO:** SWARCO offers a range of smart traffic management solutions, including adaptive traffic signal control systems, traffic management software, and parking management solutions. Their technologies leverage real-time data and advanced algorithms to optimize traffic flow, improve safety, and provide intelligent parking guidance.

8.6 Smart Parking

What is smart parking?

Smart parking is a concept that refers to the use of technology to manage and optimize parking spaces. The goal of smart parking is to improve the parking experience for drivers by reducing the time and frustration associated with finding a parking spot, while also reducing congestion and improving traffic flow in urban areas.

Smart parking systems typically use a combination of sensors, data analytics, and mobile applications to manage parking spaces. Sensors can be embedded in parking spots to detect when a vehicle is parked, while mobile applications can allow drivers to locate available parking spots and reserve them in advance. Data analytics can also be used to predict parking demand and optimize the allocation of parking spaces.

What are the benefits of smart parking?

One of the primary benefits of smart parking is increased efficiency. Using technology to manage parking spaces, cities can reduce the time and frustration associated with finding a parking spot, while also reducing traffic congestion and emissions. For example, a smart parking system may use real-time data to direct drivers to available parking spots, reducing the need for drivers to circle around in search of a space. This can help to reduce traffic congestion and improve air quality.

Smart parking can also help to improve the parking experience for drivers. By using mobile applications to locate and reserve parking spots, drivers can save time and avoid the frustration of searching for a parking spot. This can lead to greater satisfaction and loyalty among drivers and can help to attract more visitors.

Another benefit of smart parking is increased revenue. Using technology to manage parking spaces, cities can optimize the allocation of parking spots, ensuring that they are used as efficiently as possible. This can help to increase the revenue generated by parking fees, while also reducing the cost of managing parking spaces.

Smart parking systems can also help to improve safety and security. By using sensors to monitor parking spaces, cities can detect when a vehicle has been parked illegally or for an extended period of time. This can help to reduce the risk of theft and vandalism, while also ensuring that parking spaces are used fairly and efficiently.

How does this initiative meet the City's needs?

As the City faces parking congestion and inefficient space utilization, implementing smart parking solutions can significantly improve parking management and enhance the overall parking experience.

Smart parking systems utilize advanced technologies to efficiently manage parking spaces, reduce congestion, and optimize parking infrastructure. By deploying sensors, cameras, and data analytics, smart parking solutions provide real-time information on available parking spaces. Drivers will be able to access this information through mobile applications or digital signage, enabling them to quickly locate vacant parking spots and minimizing unnecessary driving time. These systems can also include intelligent guidance systems that offer real-time navigation to available parking spaces. Dynamic signage, mobile apps, and connected vehicle technologies can guide drivers to the nearest parking options, optimizing traffic flow and reducing congestion.

Smart parking solutions can integrate mobile payment systems, allowing drivers to conveniently pay for parking through mobile applications. Reservation capabilities can also be provided, enabling drivers to secure parking spaces in advance and reducing uncertainty about parking availability.

By minimizing the time spent searching for parking, smart parking systems contribute to reduced vehicle emissions and traffic congestion. Drivers will experience improved air quality and a more sustainable environment as the optimized parking process reduces the number of vehicles circling the streets in search of parking.

Smart Parking offers a comprehensive solution to address parking-related challenges in congested areas such as G Avenue and other commercial areas. By leveraging real-time data and advanced technologies, Douglas can optimize parking utilization and provide real-time parking information. eliminating frustration and helping drive a better overall experience for shoppers and tourists alike.

Types of sensors used for smart parking

Smart parking systems rely on various types of sensors to detect the availability of parking spaces and provide real-time information to drivers. These sensors play a critical role in optimizing parking operations, reducing congestion, and enhancing the overall parking experience. Here are some common types of sensors used for smart parking systems:

1. **Ultrasonic Sensors:** Ultrasonic sensors use sound waves to detect the presence or absence of vehicles in parking spaces. They are typically mounted on the ceiling or walls of parking structures or attached to parking meters. Ultrasonic sensors measure the time it takes for sound waves to bounce back from a vehicle, determining if the space is occupied or vacant. These sensors are widely used due to their accuracy and reliability.
2. **Magnetic Sensors:** Magnetic sensors, also known as magnetic loop detectors, utilize magnetic fields

to detect the presence of vehicles. They consist of loops of wire embedded in the ground and are installed beneath each parking space. When a vehicle is present, the magnetic field is disrupted, indicating occupancy. Magnetic sensors are commonly used in on-street parking and outdoor parking lots.

3. **Infrared Sensors:** Infrared sensors detect the presence of vehicles by emitting and detecting infrared radiation. They can be installed above each parking space or integrated into parking meters. Infrared sensors monitor changes in infrared light patterns caused by the presence or movement of vehicles. These sensors are particularly useful for outdoor parking lots and garages.
4. **Image-Based Sensors:** Image-based sensors, such as cameras or optical sensors, capture images of parking spaces to determine occupancy. These sensors use image processing algorithms to analyze the images and identify whether a space is occupied or vacant. Image-based sensors are often mounted on poles or ceilings and provide a visual confirmation of parking availability. They can also be used for license plate recognition.
5. **Wireless Sensors:** Wireless sensors utilize various technologies, including radio frequency identification (RFID) or Bluetooth, to detect vehicle presence and transmit data wirelessly. These sensors are typically installed on parking spaces or integrated into parking meters. Wireless sensors communicate with a central system, providing real-time information on parking space availability. They are commonly used in outdoor parking lots and on-street parking.
6. **Surface-mounted Sensors:** Surface-mounted sensors are installed directly on the pavement or ground surface of each parking space. These sensors can employ different technologies, such as pressure or weight sensors, to detect the presence of vehicles. When a vehicle occupies a parking space, the pressure or weight exerted on the sensor triggers occupancy detection. Surface-mounted sensors are often used in outdoor parking areas.
7. **Thermal Sensors:** Thermal sensors detect the presence of vehicles by measuring the heat signature or temperature differences. These sensors can differentiate between stationary vehicles and other objects, ensuring accurate occupancy detection. Thermal sensors are particularly useful in outdoor parking lots or garages where other sensor types may be affected by environmental conditions.

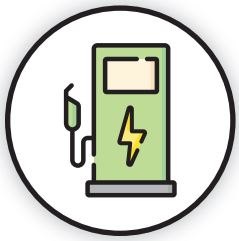
By deploying these sensors, smart parking systems can efficiently monitor and manage parking spaces, providing real-time information to drivers about available parking options. This helps reduce traffic congestion, minimize the time spent searching for parking, and enhance overall parking convenience and accessibility.

Vendor Recommendations:

- **ParkMobile:** ParkMobile offers a comprehensive suite of smart parking solutions, including mobile payment, reservation, and parking guidance systems. Integrating with various parking providers and cities, ParkMobile provides a seamless user experience and contributes to efficient parking management.
- **ParkWhiz:** ParkWhiz is a leading provider of smart parking solutions, offering mobile app-based parking reservation, navigation, and payment systems. Their platform connects drivers with parking options and provides real-time information on availability, facilitating convenient and hassle-free parking.
- **SpotHero:** SpotHero specializes in smart parking solutions that enable drivers to reserve and pay for parking in advance through their mobile app. With a vast network of parking partners, SpotHero offers a convenient and efficient parking experience in numerous cities today.
- **EasyPark:** EasyPark provides a range of smart parking solutions, including mobile payment, real-time guidance, and parking enforcement systems. Their platform offers a seamless parking experience, contributing to reduced traffic congestion and improved parking utilization.

By implementing smart parking solutions, the city of Douglas, can revolutionize its parking management systems and enhance the overall parking experience for residents and visitors. Integrating technologies from vendors like ParkMobile, ParkWhiz, SpotHero, and EasyPark will optimize space utilization, reduce congestion, and promote sustainable development. Smart parking solutions play a crucial role in the transformation of Douglas into a smarter and more livable city, improving mobility and contributing to a greener future.

8.7 | Electric Vehicle (EV) Charging Stations



What is EV charging stations?

Electric Vehicle (EV) charging stations are crucial infrastructure for the widespread adoption of electric mobility. These specialized facilities serve as power supply points for recharging the batteries of electric vehicles. EV charging stations come in various types, offering different charging speeds, power capacities, and connector types. They play a pivotal role in supporting the growth of the EV market and promoting a sustainable transportation future.

The first type of EV charging station is Level 1 charging. It involves plugging an EV into a standard electrical outlet, typically found in residential settings. Level 1 charging is the slowest method, suitable for overnight charging. While it may take several hours to fully charge an EV using Level 1, it offers convenience and accessibility to EV owners in their own homes.

Level 2 charging represents the next level of EV charging infrastructure. This type of charging requires a dedicated charging unit installed in parking areas, homes, or public locations. Level 2 charging stations offer faster charging speeds compared to Level 1, making them suitable for longer stops, such as at workplaces or shopping centers. Level 2 chargers often use a higher voltage and provide increased power output, reducing charging times significantly.

For rapid charging needs, DC Fast Charging (Level 3 charging) is the most efficient option. DC fast charging stations provide high-powered charging through direct current (DC). These stations are typically found along highways or in commercial areas, enabling EV owners to recharge their vehicles in a matter of minutes rather than hours. DC fast charging stations use high-capacity power sources and connectors specifically designed for fast charging.

What are the benefits of EV charging stations?

EV charging stations hold immense importance in supporting the growth of electric mobility. They help mitigate "range anxiety," a common concern among EV owners regarding the distance an EV can travel before requiring a recharge. The availability of a robust network of charging stations alleviates this anxiety by providing convenient charging solutions in various locations, including public areas, commercial establishments, and workplaces.

Moreover, EV charging stations play a crucial role in promoting EV adoption. As the number of charging stations increases, it encourages more individuals to switch to electric vehicles. The presence of charging infrastructure serves as a visual reminder of the practicality and viability of electric mobility, making EVs a desirable and accessible transportation choice.

In addition to their impact on EV adoption, charging stations also create economic opportunities. The establishment of EV charging infrastructure generates jobs in manufacturing, installation, maintenance, and support services. Furthermore, the growth of charging infrastructure drives investments in renewable energy sources, such as solar and wind, to power these stations sustainably, leading to a greener and more sustainable energy ecosystem.

EV charging stations are essential infrastructure for the successful transition to electric mobility. They come in different types, catering to different charging needs and scenarios. These stations address range anxiety, provide convenient recharging options, promote EV adoption, and contribute to job creation and sustainable energy development. As the world embraces electric vehicles, the expansion and accessibility of EV charging stations will play a pivotal role in realizing a cleaner, greener, and more sustainable transportation future.

How does this initiative meet the city's needs?

As the city embraces sustainable transportation solutions, the deployment of EV (electric vehicle) smart charging stations plays a vital role in promoting electric mobility and reducing carbon emissions. These intelligent charging stations leverage advanced technologies and smart features to enhance convenience, optimize charging infrastructure, and support the transition to electric vehicles.

Smart EV charging stations provide a convenient and accessible charging infrastructure for electric vehicles, encouraging EV adoption and supporting sustainable transportation options. These stations can be strategically located at key points such as parking lots, public areas, and transportation hubs to ensure easy access for EV owners. Smart charging stations offer advanced features that optimize charging efficiency, improve user experience, and integrate with Smart City infrastructure. These features include intelligent charging management, payment systems and user authentication, real-time monitoring and remote management, and integration with smart pole-mounted chargers.

Smart charging stations can manage charging schedules based on energy demand, grid conditions, and user preferences. This ensures efficient use of electricity resources, reduces peak demand, and minimizes strain on the local power grid. These stations can integrate with payment systems, enabling users to pay for charging services seamlessly. User authentication methods, such

as RFID cards or mobile apps, ensure secure access and enable personalized charging profiles.

EV charging stations can be equipped with real-time monitoring capabilities, allowing operators to remotely monitor station status, track energy consumption, and perform maintenance tasks. This ensures reliable operation, efficient maintenance, and timely troubleshooting.

Smart pole-mounted chargers combine street lighting and EV charging capabilities, leveraging existing infrastructure for efficient use of space and resources. Integrating EV charging into smart poles allows for widespread deployment of charging infrastructure throughout the city, particularly in public areas, downtown districts, and other high-traffic locations.

EV charging stations are an integral component of the City of Douglas's Telecommunications Roadmap. They contribute to an environmentally sustainable transportation deployment. By facilitating the widespread adoption of electric vehicles, cities can reduce emissions, improve air quality, support renewable energy integration, and create a greener, healthier, and more sustainable rural environment. Embracing EV charging infrastructure is a crucial step towards building a smarter and more sustainable future for the City of Douglas.

Types of sensors used for smart parking

Smart electric vehicle (EV) charging stations incorporate various types of sensors to monitor and manage charging processes effectively. These sensors play a crucial role in optimizing charging efficiency, ensuring user safety, and providing valuable data for smart charging infrastructure. Here are some common types of sensors used for smart EV charging stations:

1. **Current Sensors:** Current sensors measure the electrical current flowing through charging cables or connectors. They provide real-time data on the charging current, allowing for accurate monitoring of charging sessions. Current sensors help ensure that the charging process remains within safe limits and enable the detection of any abnormalities or faults during charging.
2. **Voltage Sensors:** Voltage sensors measure the electrical voltage levels at different points within the charging infrastructure. They help monitor the charging voltage and ensure it remains stable and within the desired range. Voltage sensors play a crucial role in maintaining the proper charging voltage for the connected EVs, preventing overvoltage or undervoltage situations.
3. **Temperature Sensors:** Temperature sensors monitor the temperature of various components within the charging infrastructure, including charging cables, connectors, and charging stations. They help prevent overheating and ensure safe charging operations. Temperature sensors enable the detection of abnormal temperature increases, allowing for timely intervention and prevention of potential hazards.
4. **Proximity Sensors:** Proximity sensors detect the presence of an EV or the positioning of the charging connector. They ensure proper alignment and connection between the charging station and the EV, preventing charging initiation if the connection is not secure. Proximity sensors contribute to safe and reliable charging experiences.
5. **RFID/NFC Sensors:** Radio Frequency Identification (RFID) or Near Field Communication (NFC) sensors enable secure authentication and identification of users accessing the charging station. These sensors are often integrated into charging stations or charging cables and allow users to authenticate themselves using RFID cards or mobile devices. RFID/NFC sensors ensure controlled access to the charging infrastructure and provide user-specific charging data.
6. **Power Quality Sensors:** Power quality sensors monitor the quality of the electrical power supply, including parameters like voltage stability, frequency, and harmonic distortion. They help maintain a stable and reliable power supply for charging EVs, ensuring optimal charging performance and efficiency. Power quality sensors enable the detection of any deviations or disturbances in the power supply that could impact charging operations.
7. **Environmental Sensors:** Environmental sensors monitor various environmental conditions around the charging station, such as temperature, humidity, and air quality. These sensors provide valuable data for assessing the charging station's surroundings and detecting any potential hazards or adverse conditions. Environmental sensors help ensure optimal charging conditions and the safety of the charging infrastructure.
8. **Communication Sensors:** Communication sensors facilitate connectivity and data exchange between the charging station, EVs, and the central management system. These sensors may include technologies such as Ethernet, Wi-Fi, or cellular communication modules. Communication sensors enable real-time monitoring, control, and data exchange, supporting features like remote monitoring, smart grid integration, and demand response capabilities.

By integrating these sensors into smart EV charging stations, cities and charging infrastructure providers can optimize charging processes, ensure user safety, and gather valuable data for future planning and management. These sensors enable efficient charging operations, reliable performance, and enhanced user experiences in the rapidly growing electric vehicle ecosystem.

Vendor Recommendations:

- **ChargePoint:** ChargePoint is a leading provider of EV charging solutions. Their portfolio includes a wide range of smart charging stations and management software. ChargePoint's expertise in networked charging infrastructure and user-friendly charging solutions makes them a reliable partner for EV charging deployments.
- **EVBox:** EVBox offers a comprehensive range of EV charging solutions, including smart charging stations for both cars and bikes. Their solutions feature advanced management software, user authentication options, and integration capabilities with other Smart City systems. EVBox's commitment to sustainability aligns with the city's vision for sustainable transportation.
- **ABB:** ABB provides innovative EV charging solutions designed for various applications. Their portfolio includes AC and DC charging stations, intelligent management systems, and interoperable network solutions. ABB's expertise in charging infrastructure and energy management can support the development of an integrated EV charging network in Douglas.
- **Enel X:** Enel X offers advanced smart charging solutions tailored for public and private EV charging infrastructure. Their solutions include networked charging stations, cloud-based management software, and billing/payment platforms. Enel X's expertise in e-mobility solutions can contribute to the implementation of an efficient and user-friendly EV charging network.

EV smart charging stations are essential components of a sustainable transportation ecosystem. By embracing smart charging features, integrating with smart pole-mounted chargers, and partnering with reputable vendors like ChargePoint, EVBox, ABB, and Enel X, Douglas can establish a robust and future-ready EV charging network. This network will support the growing demand for electric vehicles, reduce carbon emissions, and contribute to the City's vision of a greener and more sustainable transportation system.

8.8 | Smart Public Transportation

What is smart public transportation?

Smart public transportation refers to the use of advanced technologies and data analysis to improve the efficiency, safety, and overall quality of public transportation systems. This includes the integration of smart sensors, communication networks, and data analytics to optimize routes, schedules, and passenger experiences.

One example of smart public transportation is the use of real-time data analysis to optimize routes and schedules. By gathering data from sensors and GPS devices on buses and trains, transportation authorities can track the movement of vehicles in real-time, adjust routes and schedules on the fly, and provide passengers with accurate arrival times. Another example of Smart public transportation is the use of smart payment systems. By using contactless payment systems or mobile apps, passengers can pay for their fares quickly and easily. Smart transportation can also utilize video surveillance systems and other advanced security technologies. Smart buses can integrate technology such as wheelchair lifts, low-floor buses, and audio announcements to provide a more inclusive and accessible experience for all passengers.

What are the benefits of smart public transportation?

Smart public transportation offers a range of benefits to both passengers and transportation authorities. These benefits include improved efficiency, reduced congestion, enhanced safety and security, increased accessibility, and more sustainable transportation options.

One of the primary benefits of smart public transportation is improved efficiency. By using real-time data analysis and smart routing, transportation authorities can optimize routes and schedules to reduce wait times, minimize delays, and improve the overall efficiency of public transportation systems. This can help attract more riders to public transportation, reducing congestion on roads and highways.

Another benefit of smart public transportation is enhanced safety and security. By using advanced technologies such as video surveillance and passenger behavior analysis, transportation authorities can monitor and respond quickly to potential safety hazards, reducing the incidence of crime, vandalism, and accidents on public transportation systems. This can help improve the overall safety and security of cities, making them more livable for residents.

Smart public transportation can also increase accessibility for people with disabilities or limited mobility. By integrating technologies such as wheelchair lifts, low-floor buses, and audio announcements, public transportation systems can provide a more inclusive and accessible experience for all passengers.

Moreover, smart public transportation can promote sustainability by reducing the number of cars on the road and decreasing greenhouse gas emissions. By providing efficient, convenient, and affordable transportation options, public transportation can encourage people to use sustainable transportation modes, reducing traffic congestion and improving air quality. This can help create more sustainable and livable urban environments.

Smart public transportation can also benefit transportation authorities by reducing costs and increasing efficiency. By optimizing routes and schedules, transportation authorities can reduce operating costs and maximize the use of resources. Smart payment systems and real-time data analysis can also help streamline the fare collection process and reduce administrative costs.

Smart public transportation offers a range of benefits that contribute to more efficient, sustainable, and livable urban environments. By improving efficiency, enhancing safety and security, increasing accessibility, promoting sustainability, and reducing costs, Smart public transportation can help create more equitable, inclusive, and sustainable cities.

How does this initiative meet the City's needs?

In the pursuit of sustainable and efficient transportation the city can include smart transportation systems (ITS) for its city buses. These systems leverage advanced technologies, data analytics, and real-time information to optimize bus operations, improve passenger experience, and enhance overall public transit efficiency.

ITS enables real-time tracking and monitoring of bus fleets through GPS and telematics. This data can provide transportation authorities with comprehensive visibility into bus locations, schedules, and performance, allowing them to optimize routing, manage fleet maintenance, and respond promptly to disruptions or delays. Additionally, these systems can utilize data analytics and predictive modeling to optimize bus dispatching and routing, considering factors such as traffic conditions, passenger demand, and historical data to dynamically adjust routes and schedules. This can minimize wait times, reduce overcrowding, and improve operational efficiency.

The systems can employ digital signage, mobile apps, and communication systems to provide city passengers with real-time information on bus arrival times, service updates, and route changes. This information empowers passengers to make informed travel decisions, reducing uncertainty and improving their overall transit experience. ITS can also improve the accessibility of the city bussing system. They can incorporate accessibility features such as audio announcements, visual displays, and priority seating for individuals with disabilities. These features ensure inclusivity and make public transit more accessible to all residents of City of Douglas, promoting equitable transportation options.

By adopting smart transportation for city bussing, the City can optimize operations and improve passenger experiences. By adding public WiFi to buses on extended routes such as to and from the University of Arizona Douglas campus, students can use commute time more efficiently. By leveraging data-driven insights and integrating with other smart city initiatives, smart transportation modified schedules and real-time updates with bus location can be accommodated.

Types of sensors used for Smart transportation systems

Smart transportation Systems (ITS) relies on a variety of sensors to collect real-time data and enable smart transportation management. These sensors play a critical role in monitoring traffic conditions, detecting incidents, and providing valuable information for efficient and safe transportation operations. Here are some common types of sensors used for Smart transportation systems:

1. **Inductive Loop Detectors:** Inductive loop detectors are installed beneath the road surface and use electromagnetic fields to detect the presence of vehicles. They are widely used for traffic detection, vehicle counting, and occupancy monitoring. Inductive loop detectors provide real-time data on traffic volume, vehicle speed, and occupancy, enabling efficient traffic management and signal control.
2. **Video Cameras:** Video cameras, including CCTV cameras and surveillance cameras, are essential for traffic monitoring and surveillance. They capture live video feeds of roadways, intersections, and critical points. Video analytics software can be applied to analyze the video data and extract information such as traffic flow, congestion, and incident detection. Video cameras aid in real-time traffic management, incident response, and enforcement.
3. **Radar Sensors:** Radar sensors use radio waves to detect and measure the presence, speed, and movement of vehicles. They can be installed on poles or mounted on vehicles and provide accurate data on traffic flow, speed, and occupancy. Radar sensors are particularly useful in adverse weather conditions or low visibility environments, where other sensor types may be limited.
4. **Lidar Sensors: Lidar (Light Detection and Ranging) sensors** utilize laser beams to measure distances and create detailed 3D maps of the surrounding environment. They can be used to detect and track vehicles, pedestrians, and other objects on the road. Lidar sensors provide highly accurate data on

object detection, speed, and position, contributing to advanced applications such as autonomous vehicles and adaptive cruise control systems.

5. **Bluetooth/Wi-Fi Sensors:** Bluetooth and Wi-Fi sensors utilize signals emitted by Bluetooth or Wi-Fi-enabled devices, such as smartphones or in-car systems, to track the movement of vehicles. These sensors capture anonymous data on travel times, origin-destination patterns, and traffic congestion. Bluetooth and Wi-Fi sensors provide valuable insights for traffic flow analysis, travel demand management, and real-time traveler information systems.
6. **Global Navigation Satellite System (GNSS):** GNSS receivers, such as GPS (Global Positioning System), utilize signals from satellite navigation systems to track the position and movement of vehicles. GNSS sensors provide accurate data on vehicle speeds, travel routes, and travel times. They are commonly used for navigation systems, route planning, and real-time traffic information.
7. **Environmental Sensors:** Environmental sensors monitor various environmental parameters, including temperature, humidity, air quality, and weather conditions. These sensors provide data on road conditions, visibility, and the impact of weather on transportation operations. Environmental sensors support decision-making for route optimization, maintenance activities, and incident management.
8. **Weight-In-Motion Sensors:** Weight-in-motion sensors measure the weight and axle load of vehicles as they pass over the sensors. They are typically installed in roadways or bridges and provide data on vehicle weight, classification, and compliance with weight restrictions. Weight-in-motion sensors aid in monitoring truck traffic, ensuring road safety, and enforcing weight regulations.

By deploying these sensors, smart transportation systems can gather real-time data, monitor traffic conditions, and support effective transportation management. The combination of sensor technologies enables smart traffic control, incident detection, congestion management, and the provision of real-time traveler information, contributing to safer and more efficient transportation networks.

Vendor Recommendations:

- **Trapeze Group:** Trapeze Group offers comprehensive smart transportation solutions for public transit agencies, including city bus systems. Their offerings encompass real-time vehicle tracking, scheduling, passenger information systems, and demand-responsive services. Trapeze Group's solutions optimize bus operations, enhance passenger experience, and enable data-driven decision-making.
- **INIT:** INIT provides smart transportation systems specifically designed for public transit, including city bus fleets. Their solutions integrate real-time passenger information, fleet management, and fare collection systems, enabling efficient operations, improved service quality, and enhanced passenger satisfaction.
- **Clever Devices:** Clever Devices specializes in smart transportation systems for public transit agencies. Their solutions include real-time vehicle tracking, automated passenger counting, and on-board information systems. Clever Devices' technologies optimize bus operations, enhance passenger experience, and support data-driven decision-making.
- **TransLoc:** TransLoc offers smart transportation systems tailored for public transit, providing real-time bus tracking, passenger information, and demand-response services. Their solutions leverage advanced technologies and data analytics to enhance service reliability, improve passenger experience, and facilitate efficient fleet management.

Smart transportation systems for city buses can play a vital role in the transformation of the City's public transit network. By optimizing bus operations, improving service reliability, and enhancing passenger experience, these systems contribute to a more sustainable, efficient, and user-friendly public transportation ecosystem. Vendors such as Trapeze Group, INIT, Clever Devices, and TransLoc have established themselves as leaders in the Smart transportation industry, offering robust solutions that empower Douglas to revolutionize its public transit system. Integrating these systems into the fabric of the Smart City initiatives will create a more connected, accessible, and environmentally friendly transportation network.

8.9 Smart Environmental Monitoring

What is smart environmental monitoring?

Environmental monitoring in a Smart City refers to the use of advanced technologies and data analytics to collect and analyze data about the environment, including air and water quality, noise levels, and weather patterns. The goal of environmental monitoring is to better understand the impact of human activities on the environment and to develop strategies to mitigate negative effects.

In a Smart City, environmental monitoring systems utilize a range of sensors, including air quality sensors, water quality sensors, and noise sensors, to collect data in real-time. This data is then analyzed using machine learning algorithms and other advanced techniques to identify patterns and trends and to develop predictive models that can help City planners make informed decisions about development and environmental policies.

One example of environmental monitoring in a Smart City is air quality monitoring. Air quality sensors can be deployed throughout the City to measure levels of pollutants such as particulate matter, nitrogen oxides, and ozone. This data can be used to identify sources of pollution, such as traffic congestion or industrial emissions, and to develop strategies to reduce emissions and improve air quality.

Another component of environmental monitoring is water quality monitoring. Water quality sensors can be deployed in rivers, lakes, and other bodies of water to measure levels of pollutants such as nutrients, bacteria, and chemicals. This data can be used to identify sources of pollution, such as agricultural runoff or sewage discharges, and to develop strategies to reduce pollution and protect water resources.

Noise monitoring is another example of environmental monitoring in a Smart City. Noise sensors can be deployed throughout the city to measure levels of noise pollution, such as traffic noise or construction noise. This data can be used to identify areas where noise levels exceed recommended guidelines and to develop strategies to reduce noise pollution and improve quality of life for residents.

Weather monitoring is also an important component of environmental monitoring in a Smart City. Weather sensors can be deployed throughout the city to collect data on temperature, humidity, wind speed, and precipitation. This data can be used to develop models that can predict weather patterns and extreme weather events, such as heat waves or storms, and to develop strategies to mitigate their impacts.

What are the benefits of environmental monitoring?

Environmental monitoring in a Smart City provides a wide range of benefits that contribute to sustainable development and a better quality of life for residents. These benefits include improved public health, enhanced environmental sustainability, more effective emergency response, improved quality of life, more efficient use of resources, and enhanced transparency and accountability.

One of the primary benefits of smart environmental monitoring is improved public health. Air and water quality monitoring systems can provide real-time information on levels of pollutants, helping city officials identify and address sources of pollution that may negatively impact public health. By mitigating sources of pollution, environmental monitoring can help reduce the incidence of respiratory illnesses, asthma, and other health problems, leading to a healthier population.

Another benefit of environmental monitoring is enhanced environmental sustainability. By providing data on the impacts of human activities on the environment, environmental monitoring can help city officials make informed decisions about development and environmental policies. This can lead to reduced pollution, conservation of natural resources, and minimized waste, ultimately improving the sustainability of cities and reducing their environmental footprints.

Environmental monitoring also contributes to more effective emergency response. Real-time information on extreme weather events, natural disasters, and other emergencies can help city officials respond quickly and effectively, reducing the impact of emergencies on public safety and property damage. By providing critical information in real-time, environmental monitoring can help emergency responders make informed decisions and protect citizens during times of crisis.

Improved quality of life is another benefit of environmental monitoring in a smart city. By reducing pollution and other environmental hazards, environmental monitoring can help improve the quality of life for residents. Improved air and water quality, reduced noise pollution, and more livable environments can all contribute to a higher quality of life for residents, making smart cities more attractive places to live and work.

Environmental monitoring can also help cities use resources more efficiently, contributing to cost savings over the long term. By identifying areas of waste and inefficiency in systems, such as water and energy use, environmental monitoring can help cities optimize their resource use, reducing costs and increasing efficiency.

Enhanced transparency and accountability are critical components of environmental monitoring. By providing

a wealth of data on environmental conditions in smart cities, environmental monitoring can inform public policy decisions, engage citizens in environmental issues, and hold city officials accountable for their environmental stewardship. This can help build trust between citizens and government, ultimately leading to more effective and sustainable development.

Environmental monitoring is a critical component of Smart City development, providing a wide range of benefits that contribute to sustainable development and a better quality of life for residents. By improving public health, enhancing environmental sustainability, enabling more effective emergency response, improving quality of life, promoting efficient resource use, and enhancing transparency and accountability, environmental monitoring is a key tool for building smarter, more sustainable cities.

How does this initiative meet the City's needs?

Environmental monitoring plays a pivotal role in the development of the City of Douglas, as a smart city, promoting sustainable practices, mitigating environmental risks, and ensuring the well-being of its residents. Monitoring involves the collection, analysis, and interpretation of data from various sensors and monitoring systems deployed throughout the city. This data-driven approach provides valuable insights for informed decision-making and effective environmental management.

The City can employ sensors to continuously monitor air quality parameters such as particulate matter, pollutant levels, and air composition. Real-time data collection allows for early detection of pollution sources, supports policy interventions, and helps improve air quality through targeted measures. Environmental monitoring systems can include sensors and IoT devices to monitor water bodies, water treatment plants, and distribution networks. Real-time data on water quality parameters such as pH, dissolved oxygen, and contaminants enable proactive management of water resources, ensuring a safe and sustainable supply.

Environmental Monitoring as part of the City's strategy is a fundamentam component for small communities seeking to achieve sustainability, resilience, and improved quality of life. By harnessing real-time data and advanced technologies, small communities can make informed decisions, reduce environmental impacts, and actively engage residents in creating a greener and more sustainable future.

Types of sensors used for environmental monitoring

Environmental monitoring involves the use of various sensors to measure and monitor different aspects of the environment. These sensors help gather data on parameters such as air quality, water quality, noise levels, radiation, and weather conditions. Here are some common types of sensors used for environmental monitoring:

1. **Air Quality Sensors:** Air quality sensors measure the concentration of pollutants and gases present in the air, such as carbon dioxide (CO2), nitrogen dioxide (NO2), ozone (O3), particulate matter (PM), and volatile organic compounds (VOCs). These sensors enable the monitoring of air pollution levels and contribute to assessing the overall air quality index.
2. **Water Quality Sensors:** Water quality sensors are used to measure various parameters in water bodies, including temperature, pH, dissolved oxygen, conductivity, turbidity, and levels of nutrients and contaminants. These sensors help assess the health and quality of water sources, such as rivers, lakes, and oceans, and identify potential pollution or contamination.
3. **Noise Sensors:** Noise sensors, also known as sound level meters, measure the intensity or volume of sounds in the environment. These sensors help monitor noise pollution levels and can be used to assess compliance with noise regulations, identify noise hotspots, and study the impact of noise on human health and well-being.
4. **Radiation Sensors:** Radiation sensors, such as Geiger-Muller counters or dosimeters, detect and measure the presence of ionizing radiation in the environment. They are used to monitor radiation levels in areas near nuclear power plants, radioactive waste storage sites, or industrial facilities handling radioactive materials. Radiation sensors help ensure safety and compliance with radiation regulations.
5. **Weather Sensors:** Weather sensors measure various meteorological parameters, including temperature, humidity, atmospheric pressure, wind speed and direction, rainfall, and solar radiation. These sensors are used to monitor weather conditions, predict weather patterns, and provide real-time weather information for forecasting and climate studies.
6. **Soil Moisture Sensors:** Soil moisture sensors measure the moisture content in the soil, helping monitor soil conditions and irrigation needs. These sensors provide data on soil moisture levels, enabling efficient water management in agriculture, landscaping, and environmental conservation.
7. **Light Sensors:** Light sensors, such as photodiodes or lux meters, measure the intensity of light in the environment. They can be used to monitor natural lighting conditions, evaluate the impact of artificial lighting, and assess the quality of lighting in indoor and outdoor spaces.
8. **Gas Sensors:** Gas sensors detect the presence and concentration of specific gases in the environment, including toxic or hazardous gases. These sensors are used in industrial settings, laboratories, and areas prone to gas leaks or chemical emissions. Gas sensors play a crucial role in ensuring worker safety and environmental protection.

By utilizing these sensors, environmental monitoring systems can gather accurate and timely data on various environmental parameters. The collected data enables informed decision-making, early detection of environmental risks, and the development of strategies for sustainable resource management and pollution control.

Vendor Recommendations:

- **Aclima:** Aclima provides comprehensive environmental monitoring solutions tailored for smart cities. Their systems leverage sensor networks, data analytics, and machine learning algorithms to monitor air quality, greenhouse gas emissions, and other environmental parameters. Aclima's technologies enable cities to make data-driven decisions for improved environmental management.
- **Libelium:** Libelium offers a wide range of IoT sensors and monitoring platforms for environmental applications. Their solutions enable real-time monitoring of air quality, water quality, noise levels, and other environmental factors. Libelium's modular approach allows cities to customize their monitoring systems according to specific needs and integrate data into existing Smart City platforms.
- **OSIsoft:** OSIsoft provides data infrastructure solutions for environmental monitoring in smart cities. Their software platforms facilitate the collection, storage, and analysis of large-scale environmental data, enabling cities to gain actionable insights for better decision-making. OSIsoft's technologies support real-time monitoring, data visualization, and predictive analytics for effective environmental management.
- **METER Group:** METER Group specializes in environmental monitoring solutions, including soil moisture, weather, and climate monitoring systems. Their technologies provide cities with accurate and reliable data on soil conditions, precipitation, and microclimates. METER Group's solutions contribute to efficient water resource management, sustainable agriculture practices, and climate change adaptation.

Environmental monitoring can be a vital component of Smart City development, fostering sustainable practices and ensuring the well-being of its residents. By integrating technologies offered by vendors such as Aclima, Libelium, OSIsoft, and METER Group. The City can leverage data-driven approaches to monitor air and water quality, climate conditions, and other environmental factors. This enables informed decision-making, targeted interventions, and drives sustainable development initiatives and funding. Environmental monitoring serves as a crucial pillar in building a resilient, eco-friendly smart city that prioritizes the protection of natural resources and the improvement of the quality of life for its residents.

8.10 | Smart Waste Management

What is smart waste management?

Smart waste management is a system of waste collection and disposal that uses technology to improve efficiency, reduce costs, and minimize environmental impact. The goal of smart waste management is to optimize waste collection and disposal by using data analysis, sensors, GPS and other technologies to make the process more efficient and sustainable.

Smart waste management systems typically involve the use of sensors to monitor the waste management fleet and waste containers. These sensors can be connected to a central system that collects data on the location and status of waste fleet and containers, as well as the amount of waste they contain. This data can then be used to optimize waste collection schedules, route planning, and disposal processes. By using data analysis and real-time tracking, the system can identify areas where waste is accumulating and adjust collection schedules and routes accordingly.

What are the benefits of smart waste and waste fleet management?

One of the main benefits of smart waste fleet management is increased efficiency. By optimizing collection routes and schedules, cities can reduce the amount of time and resources required for waste collection and disposal. This can lead to cost savings for municipalities, as well as a reduction in the environmental impact of waste management.

Smart waste fleet management can also help to improve the overall cleanliness and hygiene of the community. By using sensors and GPS tracking to monitor waste collection vehicles, cities can quickly respond to areas where waste is accumulating and clean up the area. This can help to reduce the risk of pests and disease.

Another benefit of smart waste fleet management is improved safety for waste collection workers. By using GPS tracking and other technologies, cities can identify areas where waste collection workers may be at risk of injury and take steps to reduce the risk. This can help to

improve working conditions for waste collection workers and reduce the likelihood of accidents and injuries.

Smart waste fleet management can also help to promote recycling and resource recovery. By using data analysis to identify areas where certain types of waste are more prevalent, cities can develop targeted recycling programs that encourage residents and businesses to recycle more effectively. This can help to reduce the amount of waste sent to landfills, while also promoting a more sustainable approach to waste management.

Smart waste fleet management is an important concept for improving the efficiency, sustainability, and environmental impact of waste collection and disposal. By using technology and data analysis to optimize waste collection and disposal processes, cities can reduce costs, improve hygiene and cleanliness, promote recycling and resource recovery, and reduce their carbon footprint.

How does this initiative meet the City's needs?

The City operates its own waste management system. Smart City initiatives aim to enhance waste management practices and promote environmental sustainability, and the implementation of smart waste management solutions offers significant benefits. Smart waste management leverages technology and data-driven approaches to optimize waste collection, reduce operational costs, and improve overall efficiency.

Smart waste management systems streamline waste collection processes, ensuring efficient and timely waste removal. Intelligent bin monitoring, routine optimization, data-driven decision-making, and citizen engagement and education are the main features that contribute to the benefits of smart wase management systems.

Smart waste bins equipped with fill-level sensors and IoT connectivity provide real-time data on waste levels. This enables optimized collection routes, preventing overflowing bins and reducing unnecessary collection trips.

Route Optimization: Advanced algorithms and geospatial data analysis optimize waste collection routes, minimizing travel distance and time. This results in reduced fuel consumption, lower carbon emissions, and improved operational efficiency.

Data-driven Decision-making: Smart waste management solutions utilize data analytics and reporting tools to enable data-driven decision-making. This ensures effective resource allocation, performance monitoring, and waste management optimization.

Key aspects include:

- Data Analytics and Insights: Analyzing waste generation patterns, collection data, and disposal metrics provides valuable insights for optimizing waste management operations, identifying trends, and implementing targeted initiatives to reduce waste.
- Performance Monitoring: Real-time monitoring of key performance indicators, such as collection efficiency, bin utilization rates, and recycling rates, allows for ongoing evaluation and continuous improvement of waste management processes.

Citizen Engagement and Education: Smart waste management encourages citizen participation and awareness, fostering a sense of responsibility and promoting sustainable waste disposal practices.

Key elements include:

- Mobile Applications: Mobile apps provide citizens with information on waste collection schedules, nearby recycling centers, and educational resources. Citizens can report issues, schedule bulky item pickups, and receive updates on waste management initiatives.
- Public Awareness Campaigns: Engaging the community through educational campaigns, workshops, and events raises awareness about waste reduction, recycling, and proper disposal practices. Collaborating with local schools, community organizations, and businesses can amplify the impact of these initiatives.

Smart waste management is one of the first applications proposed in the City of Douglas Telecommunications Roadmap. By optimizing waste collection routes and schedules via IoT technologies, it reduces operational costs and provides real-time location data for tracking vehicle locations along route. This can lead to decreased costs being passed to constituents and easier management of issues related to waste pick up.

Types of sensors used for smart waste and waste fleet management

Smart waste and waste fleet management systems utilize different types of sensors to optimize waste collection, monitoring, and management processes. These sensors play a crucial role in providing real-time data, improving operational efficiency, and enabling informed decision-making. Here are some common types of sensors used for smart waste and waste fleet management:

1. **Fill-Level Sensors:** Fill-level sensors are used to measure the fill level of waste containers such as bins, dumpsters, or compactors. These sensors can employ various technologies, including ultrasonic, infrared, or weight sensors, to determine the amount of waste present in the containers. Fill-level sensors help optimize waste collection routes by providing real-time data on container fill levels, ensuring timely pickups and avoiding unnecessary trips.
2. **GPS Trackers:** GPS (Global Positioning System) trackers are used to track and monitor the location of waste collection vehicles and containers. These trackers provide real-time location data, allowing for efficient fleet management, route optimization, and tracking of waste collection activities. GPS trackers

enable better coordination, improved response times, and effective utilization of waste collection resources.

3. **Temperature Sensors:** Temperature sensors are used to monitor the temperature inside waste containers or compactors. They help detect temperature variations that could indicate issues such as fires or potential hazards. Temperature sensors contribute to early detection and prevention of safety risks, allowing for prompt actions and minimizing potential damage.
4. **Weight Sensors:** Weight sensors are used to measure the weight of waste containers or collection vehicles. They provide data on the weight of waste being collected, helping estimate waste generation rates, monitor collection efficiency, and optimize waste disposal processes. Weight sensors are often integrated into the lifting mechanisms of waste collection vehicles or installed on the floor of waste containers.
5. **Odor Sensors:** Odor sensors detect and measure the presence of unpleasant odors emanating from waste containers or waste processing facilities. These sensors help monitor and manage odor levels, enabling prompt response and implementation of odor control measures. Odor sensors contribute to improving the quality of the surrounding environment and addressing community concerns.
6. **RFID/NFC Sensors:** RFID (Radio Frequency Identification) or NFC (Near Field Communication) sensors are used for waste container identification and tracking. RFID or NFC tags are attached to waste containers, allowing for easy identification and data retrieval. These sensors facilitate efficient waste container inventory management, tracking of container movements, and integration with waste management systems.
7. **Moisture Sensors:** Moisture sensors are used to measure the moisture content in organic waste or composting processes. These sensors help monitor and optimize composting operations by providing data on moisture levels, ensuring proper composting conditions, and preventing issues such as excessive drying or over-saturation.

By deploying these sensors, smart waste and waste fleet management systems can enhance waste collection efficiency, reduce costs, improve environmental sustainability, and promote effective waste management practices. The real-time data provided by these sensors enables better decision-making, resource optimization, and proactive maintenance, leading to more sustainable and efficient waste management processes.

Vendor Recommendations:

- **Bigbelly:** Bigbelly offers smart waste management solutions, including solar-powered waste compactors and fill-level monitoring. Their platform provides real-time data, optimization tools, and analytics for efficient waste collection and management. Bigbelly's expertise in smart waste solutions can enhance waste management practices.
- **Compology:** Compology specializes in waste bin monitoring using image-based sensors and AI technology. Their smart waste management system provides real-time data on fill levels, contamination rates, and bin locations. Compology's solution can help optimize waste collection routes and improve operational efficiency.
- **Enevo:** Enevo offers smart waste monitoring solutions that utilize ultrasonic sensors and predictive analytics. Their platform provides insights into waste generation patterns, collection optimization, and cost reduction opportunities. Enevo's technology can assist in implementing data-driven waste management strategies.

8.11 | Smart Governance & Citizen Services

What are smart governance and citizen services?

Smart governance and citizen services refer to the use of technology to improve the delivery of public services and the governance of cities and communities. It is an approach that leverages digital technologies to create more efficient, effective, and responsive government services and engage citizens in the decision-making process.

Smart governance involves the use of technology to improve decision-making and service delivery in areas such as transportation, public safety, energy, and waste management. For example, a smart transportation system may use real-time data to optimize traffic flow and reduce congestion, while a smart energy system may use data analytics to optimize energy consumption and reduce costs.

Citizen services, on the other hand, involve the use of technology to improve the delivery of public services to citizens. This can include the use of digital platforms to access government services, such as online portals for paying taxes or registering for permits. It can also involve the use of mobile apps to access information about public services, report issues, and receive updates on service delivery.

Smart governance and citizen services are closely linked, as the use of technology in governance can lead to more effective and efficient delivery of citizen services. For example, a Smart city may use data analytics to identify areas where public services are most needed and allocate resources accordingly. This can lead to more targeted and effective service delivery, resulting in improved quality of life for citizens.

What are the benefits of smart governance and citizen services?

Smart governance and citizen services have numerous benefits for citizens and government officials alike, including increased efficiency, improved service delivery, and greater citizen engagement.

One of the primary benefits of smart governance and citizen services is increased efficiency. By leveraging data analytics, automation, and other digital technologies, governments can streamline their operations and improve decision-making. This can lead to faster response times, reduced costs, and improved service delivery. For example, a smart city may use real-time traffic data to optimize traffic flow, reducing congestion and travel time for citizens.

Another benefit of smart governance and citizen services is improved service delivery. By using digital platforms to access government services, citizens can enjoy more convenient and personalized services. For example, a citizen may be able to pay their taxes online, reducing the need to wait in line at a government office. Smart governance can also help to identify areas where public services are most needed, ensuring that resources are allocated efficiently and effectively.

Smart governance and citizen services can also foster greater citizen engagement and participation in the decision-making process. By providing access to information and opportunities for feedback, technology can enable citizens to play a more active role in shaping their communities. For example, a Smart city may use online platforms to solicit citizen feedback on proposed policies or projects, allowing citizens to have a direct impact on the decisions that affect their lives.

Another benefit of smart governance and citizen services is improved transparency and accountability. By making government operations more transparent, citizens can gain greater insight into how decisions are made and how public resources are allocated. This can lead to greater trust and confidence in government institutions and can help to reduce corruption and other forms of malfeasance.

Finally, smart governance and citizen services can lead to greater innovation and economic growth. By fostering a culture of innovation and entrepreneurship, smart cities can attract businesses and talent, driving economic growth and creating new jobs. For example, a Smart city may offer incentives for startups to develop innovative solutions to public problems, leading to new products and services that benefit citizens and government alike.

By leveraging digital technologies to increase efficiency, improve service delivery, foster citizen engagement, and drive innovation, smart cities can become more responsive, transparent, and effective.

How does this initiative meet the City's needs?

As the city develops its own Smart city concept, smart governance and citizen services play a pivotal role in creating a connected and citizen-centric environment. Smart governance leverages technology and data-driven approaches to enhance public administration, improve service delivery, and foster citizen engagement.

Digitizing government services enhances accessibility, efficiency, and transparency for citizens. There are many components of smart governance and individual features that contribute to its overall success. Providing a centralized online platform where citizens can access government services, submit applications, pay bills, and access relevant information. This eliminates the need for physical visits, reduces paperwork, and improves convenience.

Developing mobile applications that allow citizens to interact with government agencies, receive real-time updates, report issues, and participate in public consultations facilitates two-way communication between citizens and government administration. This enables the City to gather feedback and deliver personalized services.

Open data initiatives promote transparency, accountability, and collaboration between the government and citizens. Establishing an open data portal that provides access to non-sensitive government data encourages data-driven decision-making, empowers citizens, and fosters innovation by enabling developers, researchers, and entrepreneurs to utilize data for creating useful applications and services. Ensuring appropriate data governance measures to protect citizen privacy and comply with relevant data protection regulations builds trust between the City and the community. Implementing robust cybersecurity protocols, data anonymization techniques, and secure data storage systems can help to safeguard citizen data.

Smart governance emphasizes citizen engagement and participation in decision-making processes. Key components include digital participatory platforms and citizen feedback mechanisms.

Digital participatory platforms play a significant role in the transformation to a smart city. These online platforms will serve as a medium for the citizens to engage in discussions, express their opinions, and take part in surveys or polls. They democratize decision-making, enabling an inclusive process that incorporates diverse perspectives. These platforms won't just collect and analyze data; they will create a dialogue, helping citizens understand the city's plans and initiatives, and allowing their voices to be heard when shaping policies.

Incorporating tools like artificial intelligence (AI), machine learning (ML) and blockchain can also streamline and secure the data analysis process. By identifying trends and patterns, AI and ML can help in developing actionable insights from citizens' feedback and participation. This technology-driven approach can assist in forecasting public sentiment and adjusting government strategies and services accordingly. The inclusion of blockchain technology holds immense promise for the future of secure data access and handling, potentially revolutionizing the way the City handles internal and private citizen data.

Smart governance and citizen services play a pivotal role in the City of Douglas Smart city Plan, specifically by enhancing community engagement, improving transparency, and delivering city services more efficiently. Through digital platforms and technologies, such as AI and blockchain, the City allows for real-time citizen feedback and participation, fostering a more inclusive and responsive decision-making process. Consequently, smart governance and citizen services form a crucial cornerstone in the realization of a truly smart, inclusive, and efficient city.

Types of sensors used to support smart governance and citizen services

Smart governance and citizen services rely on various types of sensors to enhance public services, improve efficiency, and provide better experiences for citizens. These sensors help collect data, monitor infrastructure, and enable smart decision-making. Here are some types of sensors commonly used for smart governance and citizen services:

1. Public Safety Sensors: Public safety sensors include video surveillance cameras, gunshot detection sensors, or emergency call buttons. These sensors help enhance public safety by monitoring public spaces, detecting potential threats or incidents, and enabling quick response and emergency services. Public safety sensors contribute to crime prevention, crowd management, and emergency preparedness.
2. Smart Meters: Smart meters, such as electricity or water meters, provide real-time data on consumption patterns and usage. These sensors enable more accurate billing, help citizens monitor their resource usage, and facilitate energy or water conservation efforts. Smart meters support sustainable resource management and empower citizens to make informed decisions about their consumption habits.

By utilizing these sensors, as well as the data from sensors in various other City sectors, smart governance and citizen services initiatives can gather real-time data, optimize resource allocation, improve public services, and enhance overall quality of life in cities. The data collected from these sensors enables evidence-based decision-making, targeted interventions, and citizen-centric services.

Vendor Recommendations:

- **OpenGov:** OpenGov offers cloud-based solutions for smart governance, providing transparency, budgeting, and performance management tools. Their platform enables government agencies to streamline financial reporting, engage citizens, and make data-driven decisions.
- **Granicus:** Granicus specializes in digital citizen engagement solutions, including online platforms for government agencies to communicate, collaborate, and gather public input. Their solutions enable live streaming of public meetings, online comment platforms, and survey tools for citizen engagement.
- **OpenCities:** OpenCities offers digital government solutions, including user-friendly website development, online service portals, and e-forms. Their platform helps governments streamline processes, improve citizen access to services, and enhance overall digital experience.

Smart governance and citizen services are vital to creating a connected and citizen-centric environment. By embracing digital government services, promoting transparency through open data initiatives, and fostering citizen engagement in decision-making processes, the City can improve service delivery, enhance transparency, and strengthen the relationship between the government and its citizens. Collaborating with vendors like OpenGov, Granicus, and OpenCities can assist in implementing tailored smart governance solutions, and empowering the City for a connected future that prioritizes citizen needs and aspirations.

9. Recommendations

9.1 Overview of Recommendations for Long-Term Smart City Plan Success

There are three distinct categories of recommendations to create the building blocks for a smart city: the different roles, or critical groups and individuals needed to communicate the vision and to provide accountability and support for the initiatives; the critical documents, used as a consistent reference point and means of analyzing and evaluating funding and initiatives to adhere to stated objectives and realize the project benefits; and the foundational infrastructure, which enables all the other pieces of the smart city puzzle. Following the building block recommendations are tactical items for monetization and partnerships, and, finally, recommendations for long-term sustainability and scalability.

9.2 Roles

CRITICAL GROUPS/INDIVIDUALS	ROLES, OBJECTIVES & INITIATIVES
City Governing Body	• Provides an overview of the purpose, high-level goals, and focus areas for the Smart City Plan- takes into account existing and budgeted future projects • Develops a Smart City Plan Committee • Hires a Smart City Director (could be a 3rd party contract position)- see budget and Smart City Manager job description attachments.
Smart City Plan Committee *This committee will create the final Smart City Plan and provide accountability and oversight as implementation progresses. The goal of this committee is to create buy-in and understanding of the Plan throughout all City departments and the community.*	• Chooses a diverse slate of stakeholders with an understanding of defined focus areas • Agrees on plan elements eligibility- how do you evaluate and prioritize potential plan elements or action items? • Needs Assessment Matrix or other tool • Creates and documents Plan priority areas and assesses by department for funding needs/ resources/engagement needs • Creates Resource Needs Matrix for Plan realization • Creates a Funding Evaluation Guide to support the evaluation of different funding sources • Identifies potential conflicts of interest between departments that will need to be managed by the Smart City Director • Determines types of funding opportunities for each phase of the Smart City Plan
Smart City Director	• Member of the Smart City Plan Committee • Facilitates Smart City Plan Committee • Identifies, evaluates, and pursues funding opportunities with the help and support of various stakeholders • Identifies, vets, and pilots opportunities for Smart City advancements • Fosters public/private partnerships • Communicates with stakeholders to bring Smart City Plan to fruition
Grant Writer	• Member of the Smart City Plan Committee • Incorporates different tools for assessment of grant funding and potential for success • Identifies specific grant opportunities that correlate with Plan priorities and key performance indicators/action items • Builds and coordinates grant application • Monitors grant application and responds accordingly • Reports application progress to Smart City Director • Reports to Plan Committee and additional stakeholders within City Management on success

9.3 Foundational Documents

Smart City Plan

Utilizes Telecommunications Roadmap, knowledge of existing projects, and budgeted future projects to guide Plan creation.

Plan should include:

- Overview of the high-level purpose, goals, and focus areas for the Plan
- Desired outcomes/impacts of the Plan
- Strategic priorities
- Short-term and long-term key performance indicators (KPIs)/action items

Needs Assessment Matrix (or similar tool)

Guide for evaluating and prioritizing potential plan elements or action items

Resource Needs Matrix

Documentation of the assessment and evaluation of the funding/resource/engagement needs for each priority or action item by department

Funding Evaluation Guide

Guide for evaluating different funding sources. Could be used by committee, grant writer, or City management

9.4 Phasing

The construction, adoption and transition to a Smart City network is a complex and costly investment; the most efficient way of approaching the process is in phases. In the case of the City of Douglas, it is recommended that both core network and applications are completed in phases, with three regions of focus: the downtown corridor, remainder of the incorporated city limits, and the annexation targets and other regional points. There is some overlap in regions for phases based upon the criticality of the required infrastructure. An example of this would be the automation of the water and wastewater systems which, in some cases, extend beyond phasing delineations.

The network nodes and transmission sites are not necessarily located within the geographic confines of the phase, however, are required to provide the applications to the targeted region. For example, the water towers are not located in the downtown area but are a component of Phase 1, to provide the initial infrastructure to the target zone, such as Private LTE and fixed wireless coverage to enable high-speed internet, cameras, and parking sensors.

1 Phase 1: **Downtown Corridor & SCADA**

This includes G Avenue and the main business corridor. This is the most visible portion of the City from a local business perspective and will most quickly have the greatest impact. SCADA affects an area beyond the downtown corridor, however it is included because it is the most critical component to start up the smart city.

2 Phase 2: **City-Wide**

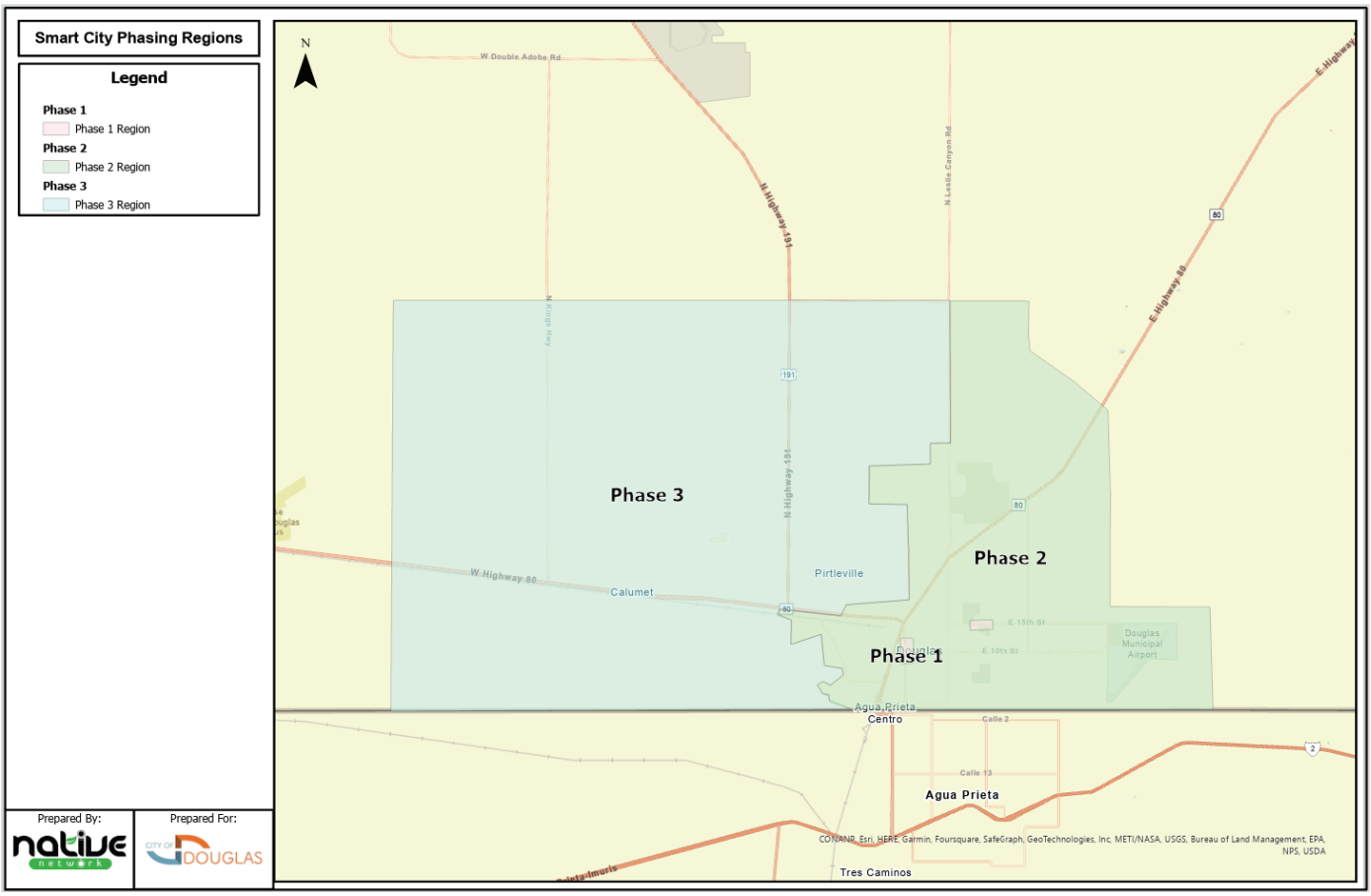
The city-wide phase includes the remainder of the city limits, including the airport. It incorporates fiber networking, wireless services, and the majority of Smart City applications.

3 Phase 3: **Annex-Regional**

This phase includes the proposed and potential annex areas as identified by the City's management team. This also covers regional interests that are not necessarily potential annexation targets but important to the area. Examples are the transportation corridor and connectivity between the City and Cochise College.

Phasing timeframes are fluid due to funding availability; however, it is estimated that each phase will take 2-3 years to complete, from securing funding to full implementation. There is some degree of overlapping of phases to be expected. Core infrastructure is the key driver for the timeline, with applications following an as-needed approach.

It is important to note that ongoing reviews of the Smart City Plan should be conducted to revise phasing and application rollout to accommodate the needs of the City. An annual report is recommended, drafted by the Smart City Director, for stakeholder committee review. See the map below for the phases by region.



Map of Phase Regions Diagram

Phase 1 - Core Infrastructure, Applications & System Integration

Use the Phase 1 infrastructure and applications maps in the section as a guide to network elements and services boundaries. For detailed wireless coverage maps by phase see section 7.3 and 7.4 of this document.

Phase 1 - Infrastructure

The inaugural phase of the project involves establishing core infrastructure, including fiber-optic connections, to service the downtown corridor and interconnection to the water towers on 15th Street. These water towers will be enabled with core wireless technologies to provide needed coverage to the targeted areas.

Water towers are existing City-owned structures that can be quickly retrofitted to support the core wireless technologies. The water towers are enhanced with magnetic mounting brackets to facilitate the installation of the LTE antennas, fixed wireless systems, and microwave backhaul between the towers. A telecommunications cabinet is installed to house the required electronics.

The water towers are the first step in the wireless strategy and will provide the needed wireless connections to support the new SCADA system for the water system management as well as the initial launch of fixed wireless for high-speed broadband to all City-owned buildings. The initial Private LTE systems in phase 1 provide IoT connectivity to the Smart City applications as well as mobile voice and data throughout the initial coverage footprint.

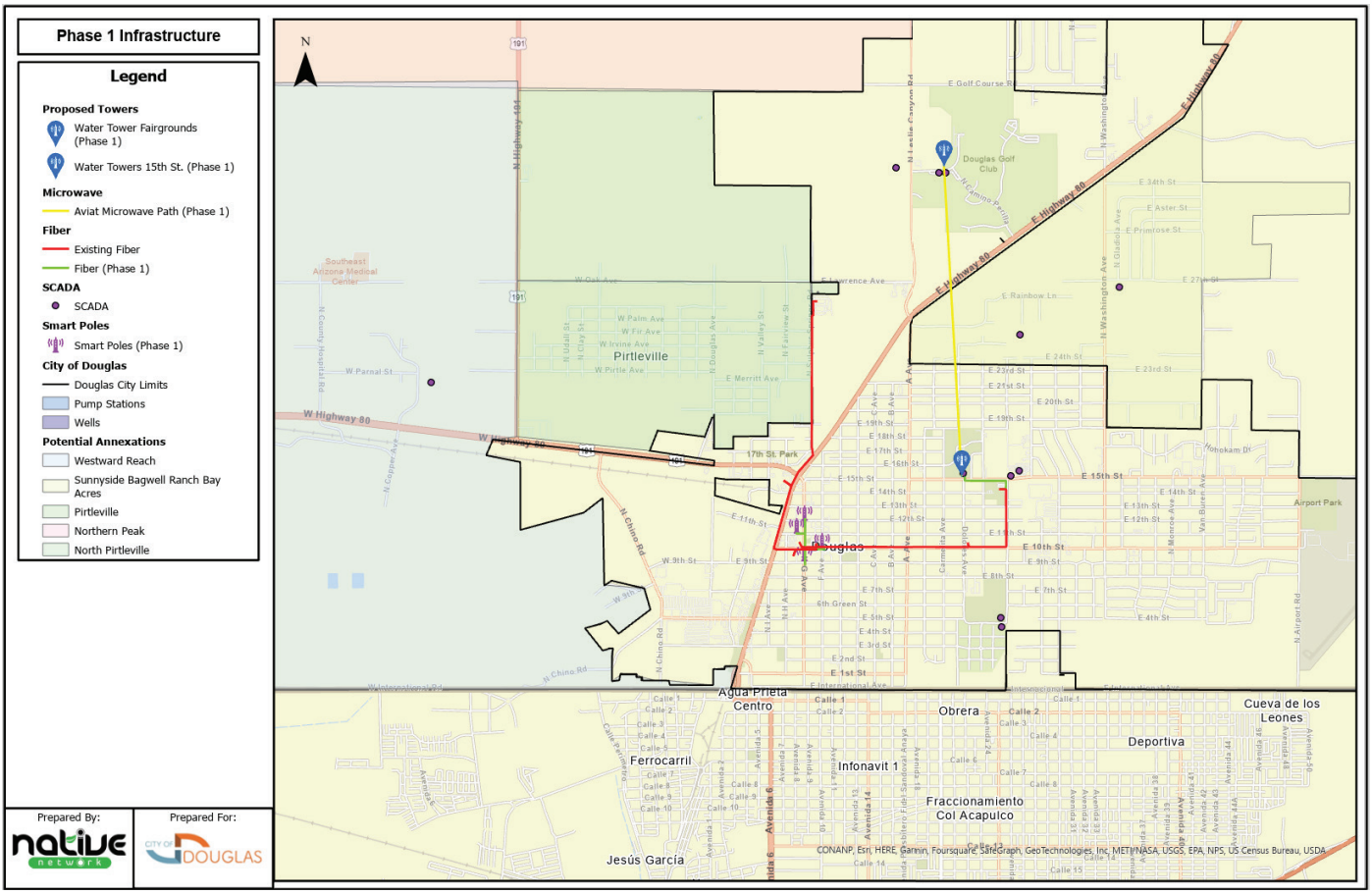
Private LTE – The Private LTE system is turned up on the water tower facilities and provides voice and data coverage to the downtown corridor and approximately 60% of the rest of the City. SCADA/IoT-capable coverage is usable to 95% of the incorporated city, approximately 8.7 sq. miles. SCADA and IoT require much lower signal strength and utilize very small packets of information, so the usable network has a much larger footprint for these devices than voice and broadband data.

Fixed Wireless Access (FWA) – The fixed wireless network provides 100% coverage to the downtown corridor and approximately 90% of the area within city limits. The fixed wireless system allows for any building or City-owned facility to have access to up to 1Gbps broadband coverage.

SmartPoles – Four SmartPoles are installed in the downtown region. These poles are connected to the electric grid and fiber optic network. They will come pre-fitted with outdoor access points and will also be fitted with smart lumineers (streetlights). The SmartPoles are pre-configured to accept outdoor WiFi equipment and support various Smart City applications. The SmartPoles can also accommodate 3rd party cellular micro-cells to enhance 4G and 5G coverage to the downtown region. It is important to place the conduit for fiber and power infrastructure to the SmartPoles prior to any street resurfacing projects.

Outdoor WiFi- This is considered a core infrastructure, and in Phase 1 these outdoor access points (AP) are installed on the four SmartPoles at the time of their installation. The outdoor WiFi covers the G Avenue area with strong signal strength to allow for use of multiple applications. Support for multiple bands including 2.4 Ghz, 5 Ghz and the new longer-range 6 Ghz band. The WiFi Signal is segmented for applications to support public WiFi and City-specific WiFi networks.

Ethernet Network - Core router and Ethernet Transport are installed in this phase to accommodate the various transport systems and subscriber services. Internet service is made available for the public WiFi and private networks for the SCADA, IoT and IIoT-based applications.



Map of Phase 1 - Downtown Corridor & SCADA - Infrastructure Design

Phase 1 - Applications

Alongside the infrastructure build out, the Phase 1 applications are rolled out. The core applications in the SCADA system for water management are the first and most critical applications. The other applications include traffic management systems, street lighting, waste management, transportation and security systems.

SCADA – The Supervisory Control and Data Acquisition (SCADA) network is the most critical application in this initial phase. The core system serves the City's water system, and the software required to operate SCADA also serves as the base software system from which to build the Smart City Network.

Smart Traffic Management – The system is implemented in this phase, and downtown traffic lights are upgraded and networked together. The upgraded traffic signals are fitted with smart technologies which include advanced traffic sensors, real-time data analytics, and adaptive signal control. The traffic management system will allow the traffic lights to be meshed together to optimize traffic flow. The system is monitored and managed more efficiently, enhancing safety, reducing congestion, and increasing the overall transportation efficiency within the city.

Smart Lighting – In addition to the smart lighting in the four new SmartPoles, 81 smart lumineers replace current lighting along G Avenue in the first stage of smart lighting implementation. These LED lights are networked together to form the initial lighting system to take advantage of smart technology to control power usage and reduce maintenance requirements.

Public WiFi – The public WiFi system is installed on the 4 SmartPoles on G Avenue. This forms a public access internet system, providing free or low-cost access that supports tourism, shopping and other similar applications tailored for the needs of the city.

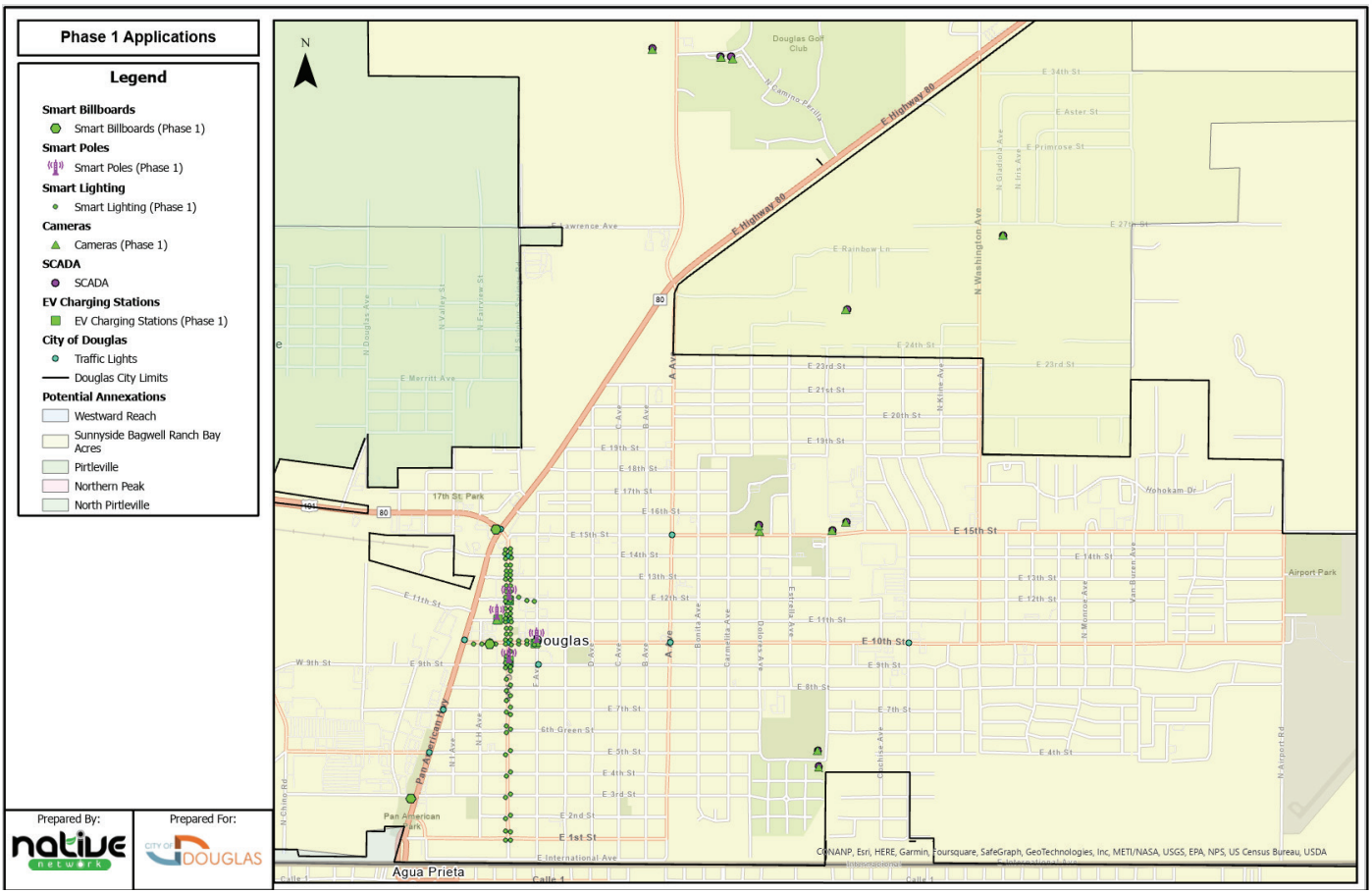
EV Charging Station – Electric vehicle charging stations are installed at each SmartPole location, providing two vehicle charging ports per station.

Smart Surveillance – In this phase, a total of 16 high-end Axis security cameras are deployed. Each water tower and SmartPole houses a high-resolution camera, providing real-time monitoring of these critical locations. Ten additional 360-degree cameras are placed strategically around the G Avenue area to further bolster security coverage. Cameras are strategically located to provide near ubiquitous coverage of the corridor. The cameras are connected by the fixed wireless or Private LTE network.

Smart Waste Management - This system is also implemented during this phase. Due to the initial coverage of the Private LTE network, sensors for trash bins in the city are equipped with fill-level sensors, and the waste collection trucks are integrated with route-optimizing software and GPS. This integration not only optimizes the waste collection routes but also reduces operational costs and improves overall waste management efficiency. There may be some locations or routes that are not covered initially, particularly at the edges of city limits. This service does not cover annexation areas in this phase.

Smart Transportation - The City's bus transportation system sees a significant upgrade in this phase. A total of 25 buses and 125 stops are integrated into a smart bus transportation system. Real-time information displays and a dedicated bus app are part of this new setup, offering passengers real-time updates, journey planning, and disruption notifications. The system incorporates advanced route optimization algorithms to reduce overcrowding and enhance operational efficiency.

Smart Billboards - A large mart billboard is located on Pan American Avenue near 5th Street and two mid-size smart billboards are located at the Visitor Center and City Hall to support smart governance, community communications and awareness, as well as visitor information.



Map of Phase 1 - Smart Applications

Phase 1 - Software & System Integration

Software System - The integration needs for Phase 1 are focused on the SCADA core system. The recommendation employs the Schneider EcoStruxture platform and AVEVA Software Unified Operation Center in conjunction to create the base system capable of supporting the Phase 1 applications. This software overlays the core infrastructure and end-user devices to create the network intelligence components.

Smart lighting, transportation, EV charging, WiFi management and surveillance software are stand-alone systems, but they each have their own virtual servers to reduce computing space. These systems are integrated into the Smart City application in Phase 2.

Hardware Systems - The integration in Phase 1 includes interconnecting the Phase 1 core infrastructure assets to the software residing on a new computer system (VM Stack) located at a common network convergence point, either City Hall or at the Public Works facility on N. Sulphur Springs Street. The end-user hardware is connected to the software over the newly-connected infrastructure.

Phase one is an intensive technical phase, establishing initial programming for SCADA/IIoT systems as well as core infrastructure installation that other future software and applications will rely on. Extensive testing of network and application integration as well as services delivery are included in this phase.

One stand-alone application, SolarWinds Orion network monitoring software, is installed on a separate VM Server in the VM Stack. SolarWinds is a solid network monitoring software package that ensures the network is up and operational while alerting the technical staff when something is wrong. It will manage the Ethernet network as well as computing power, monitoring CPU, disk and storage levels on the computer-based systems.

Phase 2 - Expansion City-wide & Application Enhancement

Use the Phase 2 infrastructure and applications maps in the section as a guide to network elements and services boundaries. For detailed wireless coverage maps by phase see section 7.3 and 7.4 of this document.

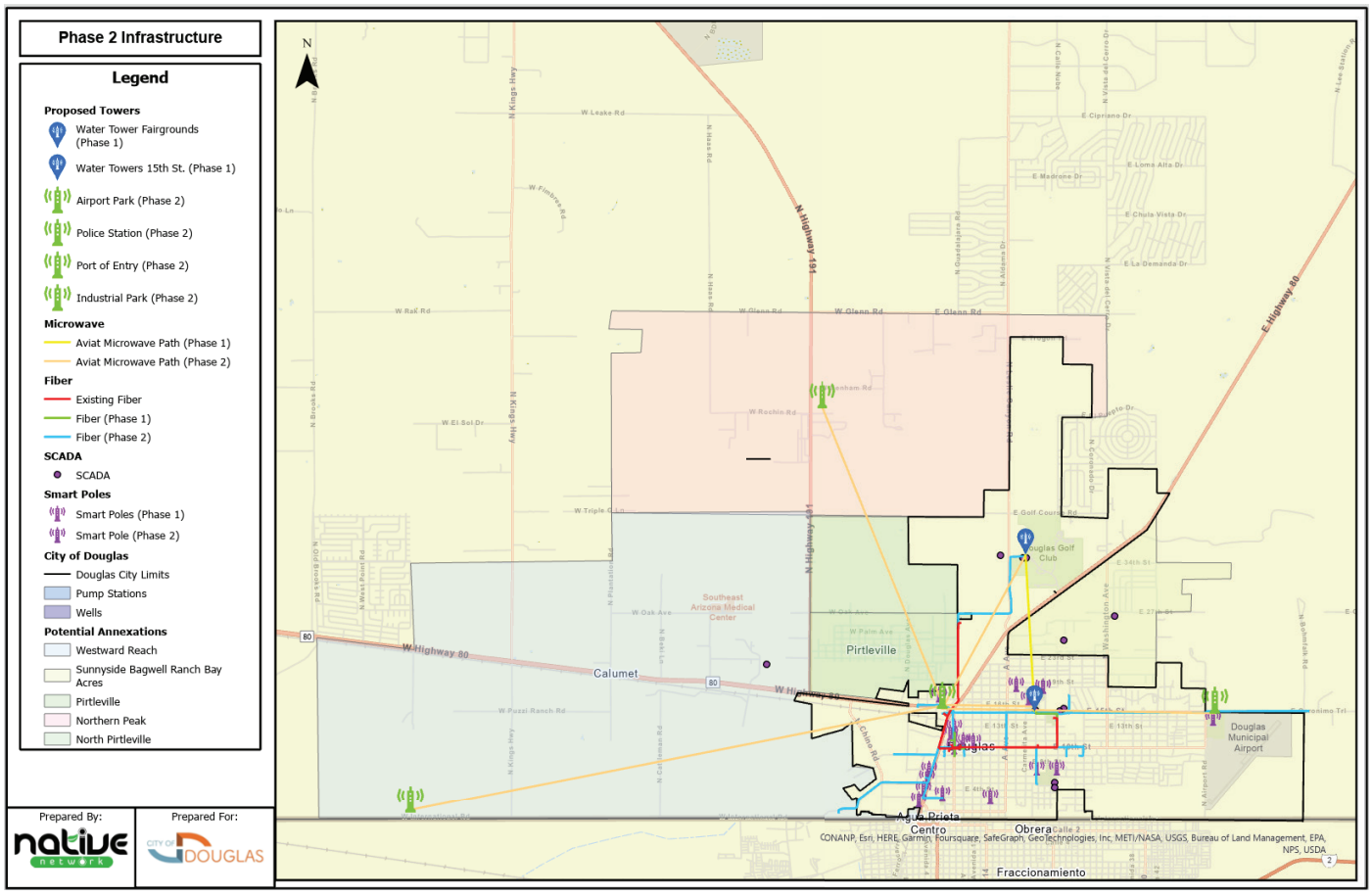
Phase 2 - Infrastructure

The second phase of the Telecommunications Roadmap builds upon the established core infrastructure by expanding it to cover the remainder of the city. This includes four new towers and additional radio equipment for the Private LTE and fixed wireless networks. This expanded network coverage allows for an increased footprint by 12 additional sq. miles for initial applications as well as the introduction of additional applications. As an example, the fiber network is extended by 57,974 feet, which will connect 23 City-owned buildings and key city assets within the city limits. This fiber will also pass by 750 commercial buildings, enhancing the value of dark fiber and conduit revenue opportunities to 3rd parties likely to lease the excess capacities. This additional City-wide network expands the fixed wireless network by 32 sq miles and the Private LTE network by 13 sq miles .

Additional state-of-the-art Ciena 5164 switches are installed, ensuring efficient network management and seamless connectivity across the wider City area.

An additional 16 SmartPoles are placed around the City in key locations including public parks, each equipped with outdoor access points for WiFi and surveillance systems and incorporating a 360-degree, high-resolution security camera.

The City's existing SCADA system is also upgraded to accommodate additional IIoT and IoT sensors and applications. Additional processing power may be required to accommodate the addition of container-based hosting of IIoT applications and new sensors. The upgraded hardware will accommodate the City's requirements well into the future, managing multiple Smart City systems.



Map of Phase 2 - City-Wide - Infrastructure Design

The City-owned water towers retrofitted in Phase 1 were the first step in the wireless strategy, due to their key locations and ability to quickly accommodate City-owned antennas. Phase 2 infrastructure constructs additional vertical assets, building four new monopole towers to expand the smart city coverage areas and add revenue-generating tower space and ground lease opportunities for 3rd party carriers.

The first tower is placed near the airport park and is designed as 140' monopole style tower; it can accommodate 3 additional tower lease customers. The tower is lower than others in the design due to the proximity to the airport, which has height restrictions governed by the FAA.

Phase 2 - Tower Locations

The second tower to be constructed is planned for the vacant city lot, Parcel 40825305, just west of the police station. This is planned as a 180' monopole style tower that can accommodate 3 additional revenue-generating carriers. This tower provides deep coverage to the commercial district on the west side of the city as well as extending west out toward the New Port of Entry and a significant portion of State Route 80 where new growth is happening.

In Phase Two, two additional towers are constructed outside of city limits at the New Port of Entry and the Industrial Park on Highway 191, providing for the known future expansion. This provides a quick way to get connectivity via microwave systems and extends the City's Private LTE and fixed wireless system to accommodate construction activity and near-term growth prior to fiber optic networks being built out in Phase 3 of the plan.

The New Port of Entry tower is located on City property and provides coverage and meets the wireless needs of the new Port traffic. It is designed as a 180' monopole style tower and can accommodate 3 additional carriers.

The Industrial Park tower is constructed on a vacant lot near the Industrial Park, as close to the SR191 as possible to provide the best coverage on the highway. This is planned as a 180' monopole style tower that can accommodate 3 additional carriers.

Map of Phase 2 - Tower Locations

Phase 2 - Applications

The majority of the application work in Phase 2 is extending the coverage for the existing Phase 1-delivered applications. The infrastructure growth pushes the need to expand the applications to accommodate that growth.

Traffic Management System – 10 additional traffic signals are installed and networked and integrated to work together with the 4 already placed in Phase 1.

The upgraded traffic signals are fitted with smart technologies which include advanced traffic sensors, real-time data analytics, and adaptive signal control. The traffic management system will allow the traffic lights to be meshed together to optimize traffic flow. The system is monitored and managed more efficiently, enhancing safety, reducing congestion, and increasing the overall transportation efficiency within the City.

SmartPole Applications –The 16 new SmartPoles being installed will come pre-fitted with outdoor access points and will also be fitted with smart lumineers (streetlights). IoT hubs are equipped with two of the three primary connection types: fiber, fixed wireless, or Private LTE points. Security cameras and other smart sensors becoming integral parts of the City's public WiFi network and security surveillance system.

Smart Lighting - 132 additional smart lumineers are installed, replacing existing G Avenue lighting on poles located in city parks. The new smart LED streetlamps are interconnected and controlled by a single interface in the Aveva software system to enable power management and reduce maintenance costs.

Surveillance – An additional 16 high-end Axis security cameras are deployed on SmartPoles. Each water tower and SmartPole houses a high-resolution camera, providing real-time monitoring of these critical locations. This effectively doubles the Phase 1 camera count.

Smart Waste Management - In this phase, the range of the waste management system is significantly expanded by the increased LTE coverage, allowing all garbage bins to be monitored and all drive routes within the city to be integrated. Due to the initial coverage of the Private LTE network, sensors for trash bins in the City are equipped with fill-level sensors, and the waste collection trucks are equipped with route-optimizing software and GPS. This integration not only optimizes the waste collection routes but also reduces operational costs and improves overall waste management efficiency. There may be some locations that are not covered initially, including potential annex areas.

Phase 2 - Software, Hardware & System Integration

Software System - In Phase 2, integration consists primarily of an upgrade to the existing Aveva Unified Operations Center (UOC), adding the Smart City application overlay. This is a software package that adds the full Smart City suite to the core SCADA system. The Smart City package provides specific applications for operations of Smart City and adds increased intelligence to the systems and more flexibility to integrate additional IIoT and IoT applications and prepares for the artificial intelligence sub-system in Phase 3.

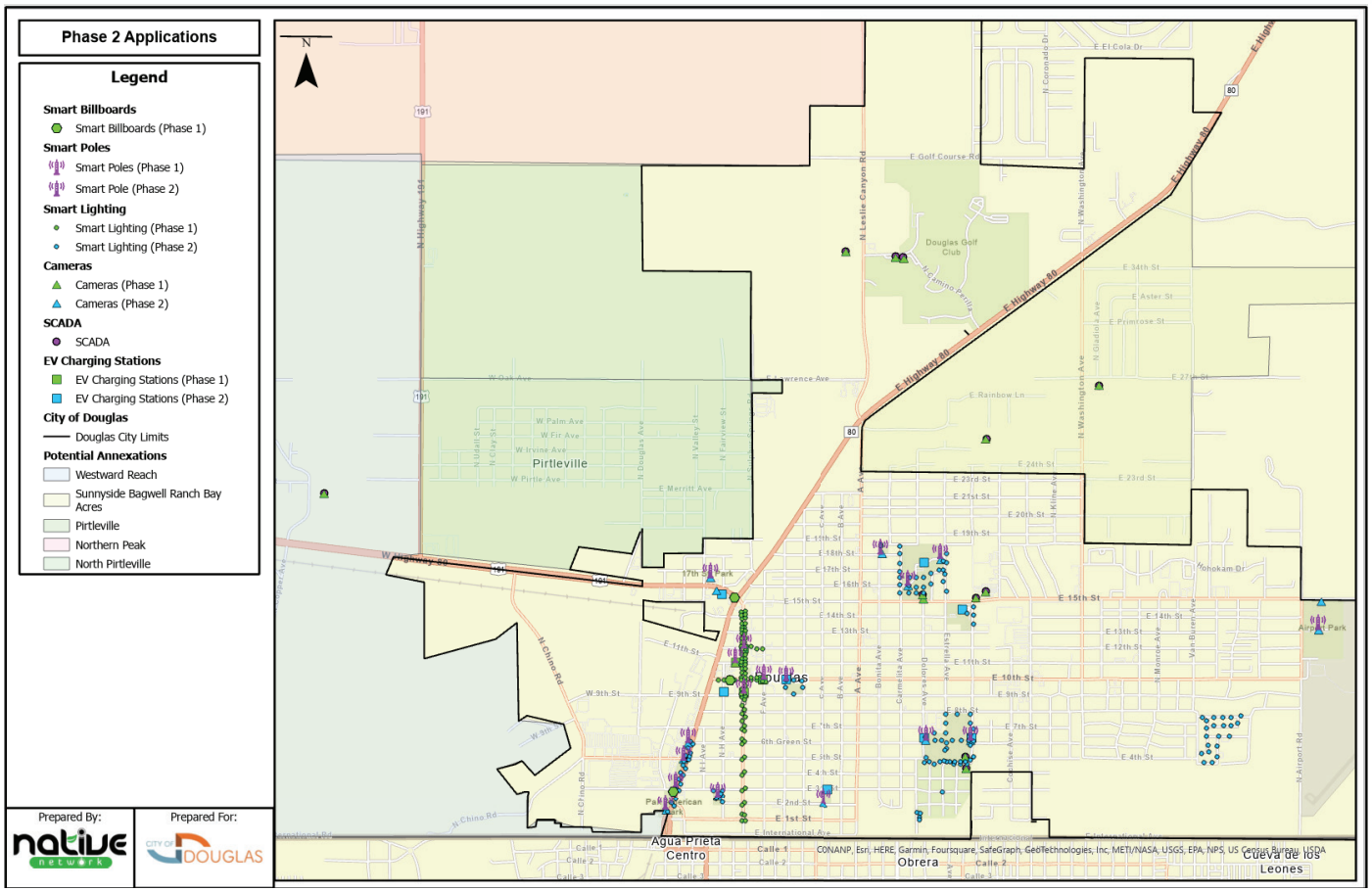
An additional stand-alone software package is put in place in Phase 2. SiteTracker will track and inventory all City-owned network facilities and assets. The product also manages the lease process for vertical assets and ground leases as well as the sale of excess fiber and conduit capacity.

SiteTracker leverages the manual lease process provided by Native Network, converting it to an automated lease process, tracking each step and providing a log file for each interaction. Once digitally signed, the contracts are stored in local or cloud servers.

Hardware Systems – Included in this phase is additional computing power to handle the additional compute and storage requirements of the Aveva Smart City Overlay and the significant increase in sensors. Additional servers are added to the existing VM Stack to accommodate the increased requirements.

System integration - In Phase 2, integration activity synchronizes Phase 1 systems with new Phase 2 software operating systems and installs them on upgraded computer hardware.

Interconnecting the core infrastructure assets to the new Smart City software residing on the upgraded computer system completes the SCADA upgrade.



Map of Phase 2 - Smart Applications

Phase 3 - Final Infrastructure & Comprehensive Integration (Artificial Intelligence)

Use the Phase 3 infrastructure and applications maps in this section as a guide to network elements and services boundaries.

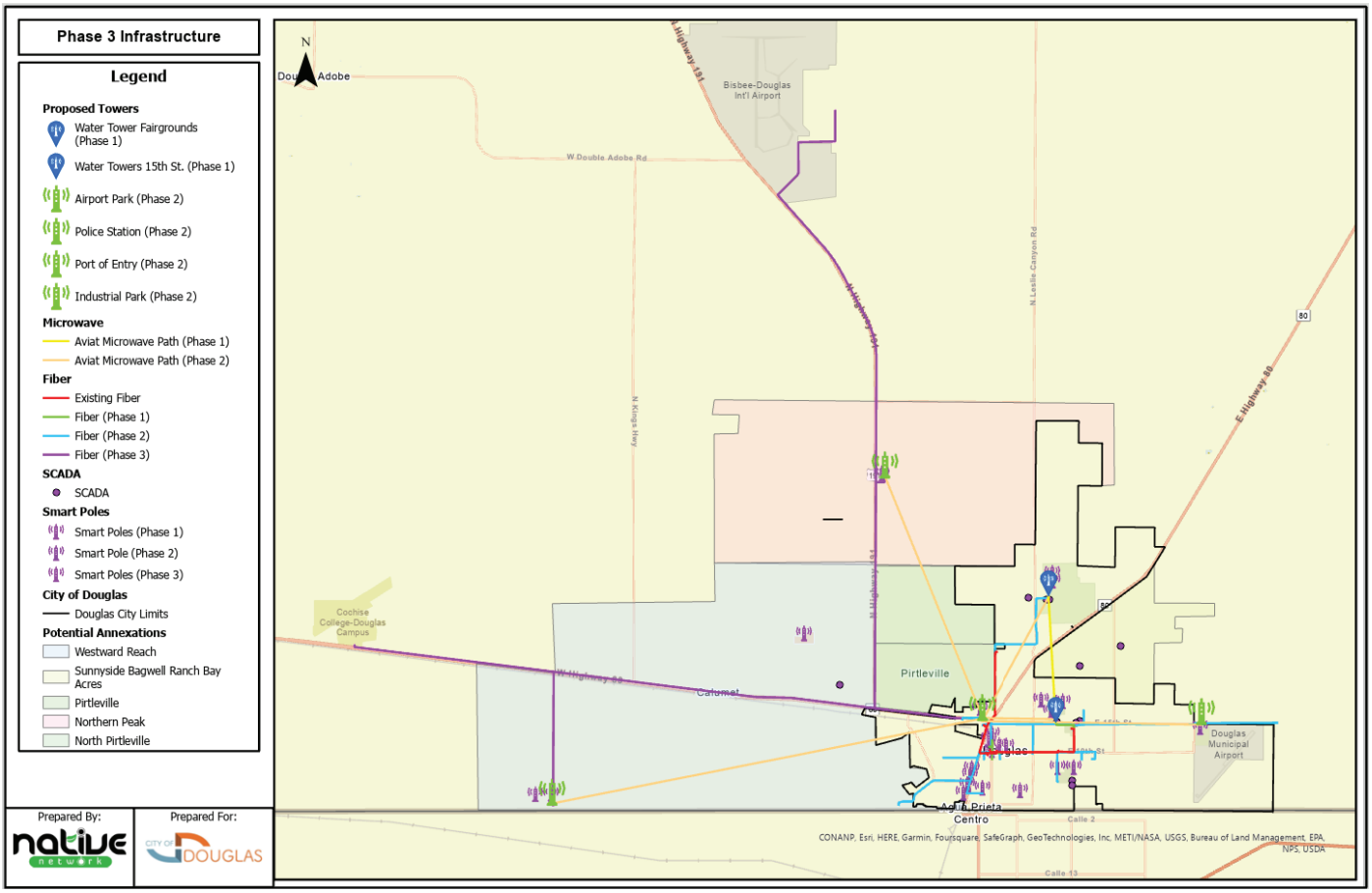
Phase 3 - Infrastructure

In the final phase of the Telecommunications Roadmap, the focus is on increasing the fiber network, which is expanded significantly to include the following routes:

1. US 80 from Douglas to James Highway and along King James Highway to the New Port of Entry.
2. Highway 191 North from US Route 80 to the Industrial Park at E. De Mur Drive.
3. From King James Highway along US 80 to the U of A Douglas Campus. From the new Police Tower west along US 80 to the University of Arizona Douglas Campus.

This increases the conduit and fiber network by 94,694 feet and includes 12 additional Ciena optical switches to support the new access points along the routes.

SmartPoles - Six additional SmartPoles are installed, with two dedicated to the New Port of Entry complex and two serving the municipal golf course and surrounding housing area. This completes the City's SmartPole network. Each of the new poles is equipped to handle the associated Smart City applications.



Map of Phase 3 - Annexed-Regional - Infrastructure Design

Phase 3 - Applications

The majority of the application work in Phase 3 is focused on extending the existing applications previously delivered in Phase 2. The infrastructure growth pushes the need to expand the applications to accommodate that growth.

SmartPole Applications –The 6 new SmartPoles being installed in this phase provide depth in the City's networks by adding additional capacity for public WiFi, surveillance, EV charging and increased lease capacity for cellular coverage expansion by 3rd party carriers.

Smart Lighting - 1092 additional smart lumineers are installed, replacing all remaining G Avenue lights on current light poles. The new smart streetlamps are interconnected and controlled by the Smart City application in the Aveva software system.

Surveillance – Six additional security cameras are deployed on new SmartPoles in this phase. High-resolution cameras providing 360-degree, real-time monitoring of these critical locations. This is an incremental addition to the existing camera network.

Smart Billboards - A single large smart billboard to support smart governance, community communications and awareness is installed at the New Port of Entry (POE) access road. An additional critical component of this billboard is to inform users of the POE about the public activities of the City of Douglas and guide traffic flow towards the City using directional indicators.

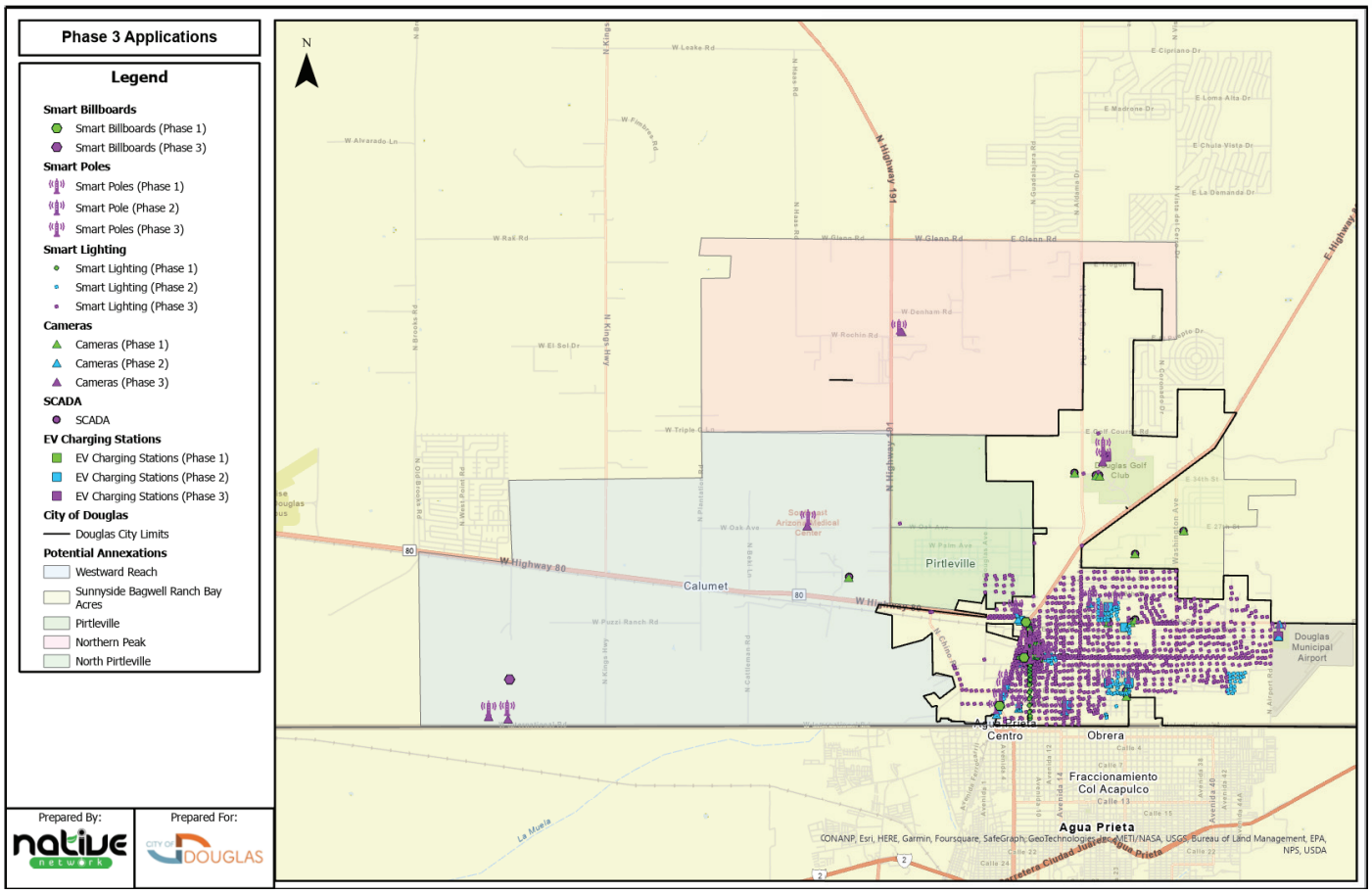
Phase 3 - Software, Hardware & System Integration

Software System – Phase 3 software upgrades adds artificial intelligence (AI) to the overall Smart City Package. The software will augment and integrate with the Aveva Smart City, Water and Wastewater packages already deployed in Phases 1 and 2. The AI engine is a separate application that takes advantage of all aspects of the system, with direct knowledge of sensor networks, video and security applications and edge analytics.

Hardware Systems – A new compute platform to host the AI software is included. A cloud backup of the AI server for redundancy and failover is highly recommended.

System Integration - In Phase 3 the heavy lift is the integration of the artificial intelligence (AI) capabilities with existing Smart City edge analytics established in Phase 2. The AI will perform the role of enhancing the efficiency and responsiveness of the smart city. AI algorithms will efficiently utilize data from City-wide sensors to streamline traffic, optimize energy consumption, and improve water and waste management, reducing operational costs.

The predictive capabilities of AI allow for the early detection of potential infrastructure issues, such as faults in water or wastewater systems, preventing major disruptions and saving on repair costs. It bolsters public safety by integrating with security cameras, potentially using facial recognition and predictive policing to preempt and react to criminal activities, if desired. The predictive analysis empowers decision-makers with valuable insights for effective policy implementation and city planning, considering aspects like traffic, pollution, and population density. AI fosters democratic engagement by creating platforms for citizens to voice concerns, share opinions, and interact with City officials.



Map of Phase 3 - Smart Applications

9.5 Phasing Matrices

Infrastructure Matrix

	PHASE 1		PHASE 2		PHASE 3	
APPLICATION	DESCRIPTION	COUNT	DESCRIPTION	COUNT	DESCRIPTION	COUNT
Fiber/Conduit	Downtown corridor along G Ave between 9th & 12th St & connection from 15th St water towers to aquatic center	3,696 Feet	Connect airport park tower, police station tower & fairgrounds water tower to fiber network. Connect all City of Douglas buildings to fiber network	57,974 Feet	Connect new point of entry tower, UofA Douglas campus, the prison & industrial park tower to fiber network.	94,694 Feet
City Buildings (Fiber)	Number of city buildings or buildable Property connected by fiber in this phase	1	Number of city buildings or buildable Property connected by fiber in this phase	23	Number of city buildings or buildable property connected by fiber in this phase	4
Commercial Buildings (Fiber)	Number of commerical building or lots passed by the newly constructed fiber network	20	Number of commerical building or lots passed by the newly constructed fiber network	750	Number of commerical building or lots passed by the newly constructed fiber network	6
Towers	Utilize 15th St water towers & Fairgrounds water tower for initial network development	0	Construct airport park, police station, new point of entry, & industrial park towers exp& network coverage to all annexation areas & allow for future expansion of network	4	Towers complete	0
Microwave Backhaul	Microwave link between 15th St water towers & Fairgrounds water tower	1	The police station becomes the hub with all other towers connecting via microwave	5	Microwave backhaul Complete	
Fixed Wireless	100 Mbps connection using Tarana equipment mounted on 15th St water towers & fairgrounds water tower covers the majority of City of Douglas limits	35.8 Sq. Miles	100 Mbps connection using Tarana equipment mounted on the airport park, police station towers, New Port pf Entry & Industrial Park towers will cover surrounding annexations including North Pirtleville, Pirtleville, Bagwell Ranch, Northern Peak & Westward Reach	67.58 Sq. Miles	Fixed Wireless Complete	0
City Buildings (FWA)	Number of city buildings or buildable property connected by fixed wireless in this phase	28	Number of city buildings or buildable Property connected by fixed wireless in this phase	0	Number of city buildings or buildable property connected by fixed wireless in this phase	0
Commercial Buildings (FWA)	Number of commerical building or lots covered by the newly constructed fixed wireless network	1,020	Number of commerical building or lots covered by the newly constructed fixed wireless network	50	Number of commerical building or lots covered by the newly constructed fixed wireless network	0
Private LTE	5 bars of coverage using Baicells equipment mounted on 15th St water towers & fairgrounds water tower covers the majority of City of Douglas limits	8.77 Sq. Miles	5 bars of coverage using Baicells equipment mounted on the airport park, police station towers, New Port Entry & Industrial Park towers will cover surrounding annexations including North Pirtleville, Pirtleville, Bagwell Ranch, Northern Peak & Westward Reach	21.87 Sq. Miles	Private LTE Complete	0
Smart Poles	Installed in Downtown corridor along G Ave between 9th & 12th St.	4	Installed at parks City-wide.	16	Installed at Annexed locations.	6
SCADA	Upgrade SCADA sensors, equipment & management system at all well, tanks, & booster sites	8	SCADA upgrade complete	0	SCADA upgrade complete	0

Applications Matrix

	PHASE 1		PHASE 2		PHASE 3	
APPLICATION	DESCRIPTION	COUNT	DESCRIPTION	COUNT	DESCRIPTION	COUNT
Public WiFi	Enabled on Smart Poles installed in Downtown corridor along G Ave between 9th and 12th St.	4	Enabled on Smart Poles installed at parks city wide.	16	Enabled on Smart Poles installed at Annexed locations.	6
Smart Lighting	Bulbs along G Ave replaced with Smart Luminares	81	Bulbs in all city parks replaced with Smart Luminares	132	All other city bulbs replaced with Smart Luminares	1,092
EV Charging	Located on G Ave smart poles	4	Located at most parks throughout City	8	Located at new port of entry and industrial park	2
Security Cameras	Located on G Ave Smart Poles, SCADA equipment sites, and water towers	16	Located on Phase 2 Smart Poles	15	Located on Phase 3 Smart Poles	6
Smart Billboards	Located outside of city hall and on Pan American hwy	3	No billboards in this phase	0	Located on the way to New Port of Entry	1
Waste Management	Sensors added to current waste management bins	7,500	Waste Management complete	0	Waste Management complete	0
Water Management	Utilize ExoStruxure to manage new SCADA sensors and equipment	1	Add AVEVA software to add management capabilities of IIoT and IoT sensors and equipment to current SCADA system	1	Number of commerical building or lots passed by the newly constructed fixed wireless network	
Smart Transportation	Install bus tracking hardware, bus stop sensors and develop app	25	Smart Transportation complete	0	Smart Transportation complete	0
Smart Parking	Install in G Ave downtown corridor	TBD	Install at parks city wide.	TBD	Smart Parking complete	TBD
Traffic Management	Install smart camera system on downtown corridor traffic lights	5	Install smart camera system on City-wide traffic lights	8	Traffic Management complete	0

9.6 Monetization

Once the key assets from the recommended Phase 1 deployment are in place, the City will have several opportunities to monetize these assets.

Tower Lease

Towers, also referred to as vertical assets, can be lucrative assets for Smart City applications and for generating revenue from mobility carriers, Internet Service Providers, and state/interstate public safety organizations. These leases are referred to as tower or collocation leases. To provide a standard industry offering to these types of carriers and other tenant prospects, the City must have the following capabilities:

- A base pricing model based on the tenants desired location on the tower
- An intake process with a designated department or person to field inquiries and gather the right information to determine the appropriate location and price for the tenant
- A tower lease agreement for the City and the tenant to execute
- Lease management process to collect and calculate rental costs
- Site access and security standards
- Ability to monitor and address any issues arising among the tenants
- Ability to track and inventory all tenant equipment and load on the tower asset
- A maintenance plan for the tower asset

On average, tower lease rates in the United States range between $1,500 and $3,500 per tenant, per month, which is equivalent to $18,000 and $42,000 per tenant, per year. Realistically, the tower sites selected for the City should be able to attract two tenants leasing space at $ 2,000 per month, which equates to $48,000 per year, per tower. These tenant leases will also include a contractual rent escalator, at a rate of 3% annually. Carrier tenants are expected to pay for all of the make-ready improvements to the leased area and all of the ongoing utilities and telecom connectivity costs.

Tower lease agreements incorporate key contractual obligations such as term, rent, rent escalator, tower space, ground space, utilities, property tax, termination, and right of first refusal (ROFR). The tower lease will have four additional, automatically renewing, 5-year extensions. In this scenario, including renewal terms, the tower lease would have a minimum total duration of 25 years. However, it is also possible for cell tower leases to reach total durations of up to 50 years.

A complete proposed tower lease package has been provided as part of this Telecommunications Roadmap. These documents can be used for water towers today and new cellular tower leases in the future. Additionally, a land lease template has been provided for cases where a cellular carrier or a tower company insists on building their own tower. Of course, the land location would need to be acceptable to the city and then satisfy all environmental requirements and ordinances to accomplish this. It is recommended that the City build, own and operate the tower assets whenever feasible, so multiple mobility carriers can use the same towers, limiting the number of towers in the City and surrounding area from an aesthetic standpoint while still improving the cellular coverage quality.

All legal documents will need to be modified specifically for any additional legal considerations for the City of Douglas.

Conduit Lease

It is common for municipalities to construct fiber pathways to connect key locations throughout their jurisdictions. When digging, and then laying, the new infrastructure, it is a nominal amount of money to build in the additional conduit capacity. One way to reduce future ground disturbance and additional costs is to install conduits, which are essentially narrow pipes with no actual fiber optic cable housed within. The City can also install these fiber optic conduits with minimal financial investment while upgrading or repairing water or sewer pipes or repairing or building roads and sidewalks. This business model removes the cost barrier for service providers to deliver Internet to the community and can often stimulate competition, which is typically better for consumers who will benefit from competitive pricing.

Similar to our recommendation for the City of Douglas, the State of Arizona designed a middle mile fiber strategic plan in early 2022, which has been funded for 4 major pieces of the plan to install conduit – ready for fiber investment. The initial project includes I-12, I-19, I-40 west and the Pima County portion of a 134-mile fiber optic ring that was recently funded by the NTIA Middle Mile Grant Program. The infrastructure will be made available to all viable Internet Service Providers (ISPs) and other government entities to lease, share or swap resources. This future-proof design has the capacity to accommodate expansive growth in the region. This middle mile infrastructure will reduce the cost for last mile providers to connect unserved and underserved communities by providing a neutral network that last mile providers can access in a non-discriminatory open access model.

https://broadbandusa.ntia.gov/funding-programs/enabling-middle-mile-broadband-infrastructure-program/funding-recipients

An example of a Conduit Lease Agreement has been included between the City of Boulder, CO and Zayo, a telecommunications company, which illustrates the Conduit Lease Agreement recommended to City of Douglas.

Pole Lease for Small Cell (5G)

Today, particularly in urban areas, mobility carriers lease streetlights, traffic lights and rooftops to install antennas known as small cells for their 5G deployments. Carriers are doing this to increase the density and capabilities of the cellular service in areas where they have coverage but perhaps not the capacity to handle all the functionality and applications required by their customers. This is becoming more prevalent as end-user customers increasingly require robust activities from their smartphones, tablets, smart watches and to accommodate all the Smart City applications in use or planned.

We have not modeled revenue for this, as we do not think rural areas are the key focus for mobility operators at this time, however, want to bring awareness for future revenue possibilities. It is recommended that the City of Douglas understand this capability and discuss with carriers.

9.7 | Initial Grant & Funding Recommendations

Typical grant cycles that relate to "opportunities for funding" start in early spring (Q1-Q2) and close by mid-summer (Q2-Q3) and are then awarded the early in the following year (Q2-Q3) as shown below:

Typical Calendar Patterns by Quarter for major grant programs

	Q1	Q2	Q3	Q4
Major award quarters from previous years' requests	58%	42%		
Major grant request quarters for upcoming budget year		25%	75%	

For example, many grants have opened in April-June of 2023 and close June-July of 2023. These applications will likely be awarded in Q1 (Jan-Mar) or Q2 (Apr-June) of 2024.

We suggest a three-to-five-year funding timeline for developing a successful Smart City Program, with an understanding that year one should be devoted to building the specific funding plan. The 2023-2024 fiscal year would be considered year one of that timeline. The second year would be devoted to sharing the plan with agencies and stakeholders (i.e. local, state and federal elected officials that help drive interest needed to agencies in charge of funding) and the second or third year would start the application process based on outcome of those responses, therefore mitigating many risks in a competitive grant assessment environment. **It is critical to have a cohesive plan in place to generate competitive grant funding proposals.**

The funding approach we suggest in the short-term is to focus on contacting programs for which the City has already received funding. Completing a focused review of these existing grants and asking for guidance from the respective agency on any discretionary funding that may still be available could yield additional funding opportunities.

Below are the grants we have identified:

1. ADOT awarded $1.5M grant to City of Douglas in 2023
2. DOE provided funding to keep a key employer in Douglas afloat
3. City of Douglas Façade Improvement Grant Program, which are competitive grants awarded annually
4. Arizona Broadband Grant Program- Cox Communications received $8.2M to bring a fiber network to Douglas
5. Douglas, Arizona residents may be eligible to apply for various housing grants and HUD initiatives available to them
6. Small businesses in Douglas, Arizona may be eligible to apply for various small business grants to expand their businesses

Specific Grant Opportunities

Additionally, we identified 2 grants as possible short-term opportunities for the City, potentially able to fund Smart City initiatives:

1. Strengthening Mobility & Revolutionizing Transportation (SMART) Grants- DOT- Estimated NOFO- Fall 2023 (see Build.gov attachment)- could potentially support smart transportation/city bussing initiative
2. Building Resilient Infrastructure and Communities Program- DHS/FEMA- Estimated NOFO- Fall 2023- could potentially support infrastructure build for Smart City

We have also attached the entire Building a Better America "Open and Upcoming Infrastructure Funding Opportunities" document for a more comprehensive picture of infrastructure grant opportunities and application timelines.

9.8 Smart Government

Recommended best practices for governance and citizen services

EXECUTIVE OPERATIONS

Office of City Manager: Oversees the overall development and implementation of Smart City initiatives. The top 10 best practices for city managers in Smart City implementation:

1. **Vision and Strategy:** Develop a clear vision and comprehensive strategy for Smart City initiatives, aligning them with the city's broader goals, such as sustainability, economic growth, and improved quality of life.
2. **Cross-Departmental Collaboration:** Foster collaboration among different city departments and agencies, ensuring seamless integration of Smart City initiatives and leveraging shared resources, expertise, and data.
3. **Stakeholder Engagement:** Engage with a wide range of stakeholders, including citizens, businesses, and community organizations, to gather input, build consensus, and ensure the success of Smart City projects.
4. **Public-Private Partnerships (PPPs):** Encourage public-private partnerships to leverage private sector resources, expertise, and innovation, sharing risks and rewards in the development of Smart City projects.
5. **Data Driven Decision Making:** Utilize data analytics and performance metrics to inform decision-making, measure the success of initiatives, and enable continuous improvement in service delivery.
6. **Open Data and Transparency:** Promote open data policies and transparency in government operations, allowing citizens and businesses to access and use public data, fostering innovation and trust in the community.
7. **Digital Infrastructure:** Invest in digital infrastructure, such as broadband connectivity and IoT networks, to support the deployment of Smart City technologies and enable data-driven services.
8. **Capacity Building and Training:** Provide ongoing training and capacity building opportunities for city staff, equipping them with the skills and knowledge necessary to effectively manage and implement Smart City initiatives.
9. **Pilot Projects and Scaling:** Launch pilot projects to test the feasibility and effectiveness of Smart City solutions, using the insights gained to refine strategies and scale successful initiatives across the city.
10. **Cybersecurity and Data Privacy:** Implement robust cybersecurity measures to protect sensitive information and maintain citizens' trust, ensuring compliance with data privacy regulations and safeguarding critical infrastructure from cyber threats.

City Attorney's Office: Plays a critical supporting role for the City Manager's Office in Smart City initiatives by providing legal guidance, ensuring compliance, and managing potential risks. The top 10 best practices for city attorney offices should be:

1. **Legal Framework and Compliance:** Develop a comprehensive legal framework that addresses the unique challenges posed by Smart City technologies, ensuring compliance with relevant laws and regulations at the local, state, and federal levels.
2. **Public-Private Partnerships (PPPs):** Provide legal guidance and support for the establishment of public-private partnerships, helping to negotiate and draft agreements that protect the city's interests while fostering collaboration with private sector partners.
3. **Data Privacy and Security:** Advise city departments on data privacy and security issues, ensuring compliance with data protection regulations and safeguarding sensitive information collected through Smart City initiatives.
4. **Intellectual Property Rights:** Protect the city's intellectual property rights in Smart City projects, including patents, trademarks, and copyrights, to ensure appropriate recognition and protection of the city's innovations and assets.
5. **Contract Management:** Oversee the procurement and contracting processes for Smart City projects, ensuring that contracts are legally sound, enforceable, and aligned with the city's strategic objectives.
6. **Risk Management and Liability:** Identify potential risks and liabilities associated with Smart City initiatives, providing legal guidance on risk mitigation strategies and ensuring appropriate insurance coverage.
7. **Public Engagement and Transparency:** Advise on legal matters related to public engagement and transparency in Smart City projects, ensuring that communication and decision-making processes adhere to legal requirements and promote public trust.
8. **Ethics and Governance:** Provide guidance on ethical considerations and governance structures for Smart City initiatives, ensuring that projects are implemented in a manner that promotes equity, fairness, and public accountability.
9. **Environmental and Land Use Laws:** Offer legal counsel on environmental and land use laws

applicable to Smart City projects, ensuring that development is sustainable and compliant with relevant regulations.

10. **Training and Education:** Provide ongoing training and education opportunities for city attorney office staff, ensuring they have the knowledge and expertise required to navigate the complex legal landscape of Smart City initiatives.

Finance Department: Plays a critical role in the research, monetization, and effective implementation and management of Smart City initiatives. The top 10 best practices for finance departments in Smart City implementation are:

1. **Financial Planning and Budgeting:** Develop comprehensive financial plans and budgets for Smart City initiatives, considering both short-term and long-term objectives, revenue streams, and funding requirements.
2. **Public-Private Partnerships (PPPs):** Foster collaboration with private sector partners to leverage additional funding, share risks and rewards, and drive innovation in Smart City projects.
3. **Performance-based Budgeting:** Implement performance-based budgeting to allocate resources based on the outcomes and performance metrics of Smart City initiatives, ensuring that investments yield maximum impact.
4. **Grants and Incentives:** Identify and pursue grant opportunities from federal, regional, and international sources to fund Smart City projects, and establish incentive programs to encourage private sector investment.
5. **Revenue Diversification:** Explore innovative revenue streams, such as data monetization, digital advertising, and user fees, to fund Smart City initiatives and reduce dependency on traditional tax revenues.
6. **Transparent Financial Reporting:** Ensure transparency in financial reporting and maintain open communication with stakeholders about the costs, benefits, and progress of Smart City initiatives.
7. **Cost-Benefit Analysis and ROI Tracking:** Conduct cost-benefit analyses and track return on investment (ROI) for Smart City projects to evaluate their effectiveness and inform future decision-making.
8. **Financial Management Systems:** Implement advanced financial management systems to streamline budgeting, procurement, and reporting processes, enhancing efficiency and reducing operational costs.
9. **Capacity Building and Training:** Provide ongoing training and capacity building for finance department staff to ensure they have the skills and knowledge necessary to effectively manage Smart City initiatives.
10. **Risk Management and Compliance:** Develop robust risk management strategies to identify, mitigate, and monitor potential financial risks associated with Smart City projects, and ensure compliance with relevant regulations and standards.

Data Analytics Office: The analysis of data is crucial for the success of Smart City initiatives, as it enables evidence-based decision-making, performance measurement, and continuous improvement. Here are the top 10 best practices for Smart City data analysis:

1. **Data Collection and Integration:** Establish processes for collecting and integrating data from various sources, including IoT devices, sensors, and existing databases, to create a comprehensive and unified view of the city's operations.
2. **Data Quality Management:** Implement data quality management practices to ensure the accuracy, completeness, and reliability of the data being used for analysis, identifying and resolving data quality issues as they arise.
3. **Data Privacy and Security:** Maintain robust data privacy and security measures to protect sensitive information and maintain public trust, ensuring compliance with data protection regulations and safeguarding critical infrastructure from cyber threats.
4. **Data Sharing and Collaboration:** Foster a culture of data sharing and collaboration among city departments, agencies, and external stakeholders, promoting the use of open data platforms and APIs to enable seamless access to data and insights.
5. **Advanced Analytics Tools and Techniques:** Utilize advanced analytics tools and techniques, such as machine learning, AI, and predictive modeling, to uncover hidden patterns, trends, and relationships in the data, enabling more informed decision-making.
6. **Visualization and Reporting:** Develop user-friendly data visualization and reporting tools that enable stakeholders to easily explore and understand the data, promoting transparency and data-driven decision-making.
7. **Capacity Building and Training:** Provide ongoing training and capacity building opportunities for city staff, equipping them with the skills and knowledge necessary to effectively analyze and interpret Smart City data.
8. **Performance Measurement and Benchmarking:** Use data analysis to develop performance metrics and benchmarks for Smart City initiatives, measuring the success of projects and identifying areas for improvement.
9. **Real-time Data Analysis:** Leverage real-time data analysis capabilities to monitor city operations and respond to emerging issues and opportunities, enabling more agile and responsive decision-making.

10. **Continuous Improvement and Innovation:** Utilize data analysis to drive continuous improvement and innovation in city operations and services, identifying opportunities to optimize processes, reduce costs, and enhance the quality of life for citizens.

By adopting these best practices, the executive management team can effectively manage the legal, operational, analytical and financial aspects of Smart City implementation, ensuring that investments are strategically allocated, risks are mitigated, and initiatives deliver maximum value for citizens.

PUBLIC SAFETY

First Responders to include Fire, Police, and Health Departments should adopt a top 10 list of shared best practices for Smart City strategy:

1. **Emergency Communication Systems:** Implement effective communication channels between fire and other emergency services, such as police and medical personnel, to facilitate rapid response and coordination during emergencies.
2. **Real-time Resource Management:** Utilize data analytics and IoT devices to optimize resource allocation, manage equipment and personnel in real-time, and enhance overall operational efficiency.
3. **Community Engagement and Education:** Leverage digital platforms and social media to engage with citizens, disseminate fire safety information, and build trust within the community.
4. **Incident Data Analysis:** Collect and analyze incident data to identify trends, assess response effectiveness, and inform future decision-making and resource allocation.
5. **Cybersecurity and Data Privacy:** Implement robust cybersecurity measures to protect sensitive information and maintain citizens' trust, ensuring compliance with data privacy regulations and safeguarding critical infrastructure from cyber threats.
6. **Smart Building Codes and Inspections:** Promote the adoption of smart building codes that integrate fire safety technologies and utilize digital tools for efficient building inspection and code enforcement.
7. **Enhanced Training and Skill Development:** Provide ongoing training and skill development opportunities for firefighters, focusing on the effective use of smart technologies, digital tools, and data-driven decision-making.
8. **Advanced Fire Detection Systems:** Deploy smart fire detection systems, such as IoT sensors, thermal imaging cameras, and intelligent smoke detectors, to rapidly identify and locate fires, enabling faster response and minimizing damage.
9. **Wildfire Monitoring and Prevention:** Deploy remote sensing technologies, such as drones and satellite imagery, for early detection and monitoring of wildfires, enabling proactive prevention strategies and rapid response.

PUBLIC WORKS

Water, Wastewater, Streets, Sanitation, and Parks all play a vital role in the development and maintenance of a city's infrastructure. Here are the top 10 best practices for public works in Smart City implementation:

1. **Asset Management Systems:** Implement an integrated asset management system to monitor, maintain, and optimize the performance of public infrastructure assets, such as roads, bridges, and utilities.
2. **Intelligent Transportation Systems (ITS):** Deploy ITS to improve traffic management, reduce congestion, and enhance road safety through real-time data analysis, dynamic traffic signal control, and smart parking solutions.
3. **Smart Waste Management:** Utilize IoT sensors and data analytics to optimize waste collection routes, monitor waste levels in real-time, and implement smart waste sorting and recycling initiatives.
4. **Energy-efficient Street Lighting:** Implement smart street lighting systems that use energy-efficient LED lights, adaptive controls, and IoT sensors to reduce energy consumption and maintenance costs.
5. **Smart Water Management:** Leverage IoT devices, data analytics, and remote monitoring technologies to optimize water distribution, reduce leakage, and improve water quality and conservation efforts.
6. **Green Infrastructure and Urban Forestry:** Promote the use of green infrastructure, such as permeable pavements, green roofs, and urban forestry, to manage stormwater, reduce urban heat island effects, and enhance air quality.
7. **Digital Twin Technology:** Utilize digital twin technology to create virtual models of the city's infrastructure, enabling more efficient planning, monitoring, and maintenance of public assets.
8. **Building Information Modeling (BIM):** Implement BIM for infrastructure projects to enhance collaboration, reduce construction costs, and improve the lifecycle management of public assets.
9. **Disaster Preparedness and Resilience:** Develop robust disaster preparedness plans and deploy Smart City technologies, such as early warning systems and real-time monitoring, to enhance resilience and response capabilities during natural disasters or emergencies.
10. **Citizen Engagement and Feedback:** Encourage citizen participation in public works initiatives through digital platforms, mobile apps, and social media channels, enabling better-informed decision-making and more effective service delivery.

By adopting these best practices, public works departments can utilize Smart City technologies to

improve the efficiency, sustainability, and resilience of infrastructure, ultimately enhancing the quality of life for citizens.

HUMAN RESOURCES

Human resources departments play an essential role in supporting Smart City initiatives by recruiting, training, and retaining the workforce required to implement and manage these projects. Here are the top 10 best practices for human resources departments in Smart City implementation:

1. **Workforce Planning:** Develop a comprehensive workforce plan that aligns with the city's Smart City vision and strategy, identifying current and future skills gaps and outlining recruitment and training initiatives to address them.
2. **Digital Recruitment and Onboarding:** Utilize digital platforms and tools for recruitment and onboarding processes, streamlining procedures and ensuring a more efficient and data-driven approach.
3. **Skills Development and Training:** Offer ongoing training and professional development opportunities for city employees to develop the skills and knowledge necessary to effectively manage and implement Smart City projects.
4. **Performance Management:** Implement data-driven performance management systems to track employee performance, set goals, and provide feedback, fostering a culture of continuous improvement and accountability.
5. **Employee Engagement and Well-being:** Promote employee engagement and well-being initiatives, such as flexible work arrangements, health and wellness programs, and opportunities for career development, to attract and retain a skilled workforce.
6. **Inclusive Hiring Practices:** Foster diversity and inclusion in the workplace by implementing equitable hiring practices, promoting a diverse workforce that reflects the community's demographics, and ensuring equal opportunities for all employees.
7. **Succession Planning:** Establish robust succession planning processes to identify and develop future leaders, ensuring the continuity of expertise and knowledge in managing Smart City initiatives.
8. **Collaboration and Cross-functional Teams:** Encourage collaboration and cross-functional teams across departments and agencies, promoting the sharing of expertise, resources, and data to enhance Smart City project outcomes.
9. **Data Privacy and Security:** Implement stringent data privacy and security measures to protect sensitive employee information, ensuring compliance with data protection regulations and maintaining trust in the organization.
10. Change Management: Develop and implement effective change management strategies to support the transition to Smart City initiatives, ensuring clear communication, stakeholder engagement, and the provision of necessary resources and support.

By focusing on these key areas, city leaders can ensure that the government, ownership, and management strategy for Smart City implementation is robust, effective, and aligned with the City's overall objectives, driving the successful execution of projects and the realization of Smart City benefits.

After analyzing the Smart City needs mentioned, the following priority list is proposed:

1. **Robust broadband infrastructure and improved cellular coverage:** Ensuring that all citizens, businesses, and city departments have access to reliable and high-speed internet is crucial for the success of Smart City initiatives. This includes expanding Wi-Fi and cellular coverage in public spaces, residential areas, and historic buildings.
2. **Inter-agency communication and collaboration:** Improved communication and coordination among city departments, law enforcement, emergency services, and neighboring jurisdictions are vital for efficient service delivery and emergency response. Implementing tools for streamlined and secure communication can enhance overall city management.
3. **Security and safety measures:** Prioritize implementing technologies that improve public safety, such as surveillance cameras, shooting detection systems, automated door locks, and real-time public information sharing.
4. **Data collection, analysis, and reporting:** Focus on technologies that enable the easy collection of data, the generation of reports for audits, and the efficient tracking of various city assets, such as water levels, electricity usage, and building inspections.
5. **Emergency response improvement:** Invest in solutions that provide quicker awareness and streamlined processes for emergency response, such as panic alarms, GPS tracking, remote monitoring, and coordinated notification systems.
6. **Sustainable solutions and energy management:** Prioritize solutions that promote sustainability, such as smart irrigation systems, solar power, energy usage monitoring, and electricity efficiencies.
7. **Digital literacy and community engagement:** Offer digital literacy programs to ensure that citizens can effectively use and benefit from Smart City technologies. Communicate project updates and timelines transparently to maintain community buy-in and support.

8. **Redundancy and resiliency:** Implement backup power systems, redundant network connections, and risk management plans to ensure the resiliency of critical systems and infrastructure.
9. **Efficient maintenance and asset management:** Utilize automated maintenance scheduling, monitoring, and control of city assets to improve overall efficiency and reduce costs.
10. **Economic development and tourism:** Leverage technology to market the city, attract customers, and promote tourism. This includes creating digitized tourism registers, smart parking solutions, and tools for tracking cross-border wait times.

By prioritizing these areas, City leaders can focus on implementing Smart City initiatives that address the most pressing needs, provide the greatest benefits to citizens, and ensure the long-term success and sustainability of the Smart City vision.

9.9 Collaboration & Partnerships

The City of Douglas has successfully secured or benefitted from funding and collaboration with several multi-agency efforts. The Arizona Department of Transportation (ADOT), General Services Administration (GSA), and City of Douglas have received federal funding for the Two Port Solution; Cochise County Schools is partnering with local districts and law enforcement to implement a School Safety Pilot Program. The City of Douglas can realize significant benefits when maximizing resources through collaborations such as these.

Our recommendation is that the City continues to pursue collaborative efforts that accomplish components of the City's Smart City goals. This Telecommunications Roadmap becomes critically important as funding is made available in pieces, to ensure each piece fits into the coherent whole as it is implemented. We recommend building a Smart City Plan Committee, whose members belong to various cross-agency stakeholders, to foster continued partnerships that build on common goals and maximizes resources.

9.10 Long-Term Sustainability & Scalability

In terms of the Telecommunications Roadmap project, long-term sustainability and scalability refer to the ability of the City of Douglas to grow and thrive into the foreseeable future. Resilience planning will support Douglas's investment into its community, and implementing resilient and scalable Smart City infrastructure and applications will provide opportunities to seamlessly incorporate future growth into the City.

A community resilience decision-making paradigm provides many benefits: decreased vulnerability, faster recovery, improved quality of life, and sustainable development. Resilient communities are better prepared to withstand and recover from shocks and stresses. By identifying and addressing vulnerabilities, communities can minimize the impacts of disasters or crises on human lives, infrastructure, and the environment. Community resilience enables quicker recovery and restoration of essential functions following a disruption. Resilient communities bounce back more efficiently, minimizing the social, economic, and environmental impacts and reducing the duration of recovery.

By investing in resilience planning, Douglas can enhance public safety, healthcare services, access to resources, and overall well-being of its residents. Resilient communities also foster a sense of security, stability, and confidence among their members. Climate and community resilience paradigms should be woven into the fabric of the Smart City Plan and governance, and then the City will be able to collect baseline data and create goals, initiatives and strategies that include these frameworks. Additionally, the federal government has highlighted these paradigms as critical priorities, and incorporating resilience frameworks will not only support Douglas's long-term sustainability but also position it to be more competitive for future funding opportunities.

A Smart City Plan is inherently scalable, as it includes methods for anticipating and managing change and maximizing efficiencies. As the City grows both through population and geographically, incremental additions and upgrades to the network are expected. The City must maintain its current capabilities, managing existing networks through rigorous maintenance and support policies; ensuring support agreements are in place will keep networks performing at peak state. Ongoing database management as well as software patches should follow standard IT policies. Alongside maintaining existing networks, new network elements can be integrated into the system as needed to support growth initiatives.

The Smart City network design supports scalability, both in incremental software upgrades to add new elements and functionality into the core network and sub-systems. Hardware refreshes typically occur every 5 years for network equipment, however, can be extended on a specific sub-system basis, depending upon current network requirements. Servers will reach end-of-life or computing power will increase, requiring the purchase of new replacement servers. From time-to-time, the City may want to upgrade features and functionality that require both hardware and software, so yearly budget

line items for hardware, server, and software upgrades should be included to take advantage of incremental improvements in technology.

This Telecommunications Roadmap is designed to increase Douglas's long-term sustainability and seamless capacity to scale for growth and functionality needs. The recommendations of planning for and collecting data around resilience measures not only increase the City of Douglas's ability to thrive for future generations but also provides expanded funding opportunities, due to the federal emphasis in these areas. Having resilient infrastructure, utilizing fiber and redundant connections in adding to operating with a resilience methodology in infrastructure planning also lends itself uncomplicated integration of new functionalities and growth management.

10. Business Model & Financial Analysis

10.1 Business Model

Today it is common for municipalities to own telecommunications infrastructure that can be leveraged by private sector organizations to provide commercial services. This wholesale model, sometimes referred to open access, works well for private sector service provider organizations, allowing them to serve more end users in a cost-effective way, reducing their capital requirement for entry especially in a rural market or community where a traditional return on investment requirement cannot be met. It is also positive for the community constituents that will benefit from more options to purchase services due to a more competitive environment.

It is recommended that the City sell tower (initially water tower) space and conduit to carriers that will improve the cellular coverage and the Internet services in Douglas. By offering only these services the City will essentially be selling space and will not need to be credentialed as a telecommunications carrier that must be registered and regulated by the Federal Communications Commission (FCC) or the Arizona Corporation Commission – Utilities Division. Additionally, the City won't be viewed as competing with Cox or other private sector providers.

The operating expenses and telecom expertise necessary for the wholesale model are much less than that of a telecommunications company, although additional staff and resources will be required.

Although there are revenue opportunities for this model, they will not yield a traditional return on the capital investment, as the assets recommended throughout have, in some cases, an expenditure reduction component and all certainly represent a technological advancement for the City.

To truly measure success, planners need to lay out achievable goals for each phase of development and then the City must develop key performance indicators (KPI's) that are in alignment with the entity's overall objectives. Then it is imperative that the data captured is put to good use. This takes discipline to dedicate the staff and process to interpret, validate and understand the data from the Smart City initiatives. As cost savings and quality of life improvements become clear, the return on the investment can be validated and the next phases implemented with more certainty.

10.2 Financial Data

Capital Expenditures

The capital costs to deploy Smart City infrastructure and applications have been recommended in a phased approach and are depicted here in the following summary. The full details have been provided as an excel spreadsheet as an Attachment labeled "COD Smart City - Master Financial Workbook".

The pricing has been derived from recent quotations from industry-leading manufacturers or the value-added resellers (VARs) that sell their products and from companies that build and provide software for this project scope. A full bill of materials (BoM) worksheets provide detail needed for RFP creation and grant applications going forward.

CAPITAL EXPENDITURES	PHASE 1	PHASE 2	PHASE 3	TOTAL BY TYPE
SCADA	$1,629,285.84	$225,000.00	$0.00	$1,854,285.84
Water Tower Improvements	$362,373.72	$0.00	$0.00	$362,373.72
New Towers	$0.00	$1,667,449.27	$0.00	$1,667,449.27
Fiber Network	$261,021.37	$3,445,815.80	$5,240,685.74	$8,947,522.91
Microwave Backhaul	$47,852.08	$239,260.40	$0.00	$287,112.48
Fixed Wireless	$195,551.66	$357,041.73	$0.00	$552,593.39
Private LTE	$315,337.62	$337,342.92	$215,377.24	$868,057.78
Smart Poles	$125,324.32	$501,297.28	$187,986.48	$814,608.08
Public WiFi	$22,666.84	$90,667.36	$34,000.26	$147,334.46
Security Cameras aka City Surveillance	$72,337.05	$56,654.55	$10,224.60	$139,216.20
Smart Lighting	$85,050.00	$138,600.00	$1,146,600.00	$1,370,250.00
Smart Traffic Management	$129,375.00	$207,000.00	$0.00	$336,375.00
EV Charging	$231,032.00	$924,128.00	$346,548.00	$1,501,708.00
Smart Transportation	$72,500.00	$0.00	$0.00	$72,500.00
Smart Waste Management	$1,140,000.00	$0.00	$0.00	$1,140,000.00
Smart Billboards	$239,650.00	$0.00	$109,250.00	$348,900.00
Implementaiton Support	$323,750.00	$0.00	$0.00	$323,750.00
Core Hardware/Software	$374,576.60	$36,915.00	$141,070.00	$552,561.60
Equipment Refresh	$0.00	$0.00	$885,465.88	$885,465.88
TOTALS:	**$5,627,684.10**	**$8,227,172.31**	**$8,317,208.20**	**$22,172,064.60**

Economic Benefits

REVENUE ASSUMPTIONS

There are several revenue opportunities throughout the Smart City transition based on phases presented in this document. Revenue projections for 10 years have been created as an example of the economic benefits associated with the recommendations in this Telecommunications Roadmap.

1. **Land lease - $2,500 per month** - Although we recommend owning the tower assets for Douglas's own use and to generate revenue, some carriers may insist on building their own tower. If the City is amenable and would like to pursue this revenue model for a specific situation, a lease example has been provided at Attachment "Land Lease Agreement," and the City can expect lessees to pay approximately $2,500 a month for a 20-year agreement.
2. **Existing water tower - $1,800 per month** - Based on the improvements to the water tower, carriers will pay between $1,800 per month for a minimum 5 year commitment, with 3 additional 5 year terms usually equating to 20 years.
3. **New tower - $2,000 per month** - Based on the tower location, carriers will pay between $1,900 and $2,500 per month for a minimum 5-year commitment with additional terms usually equating to 20 years.
4. **Visitor WiFi - $6.95 per day** - Visitors will have access to the city-wide WiFi network and will be prompted on a splash page to sign up for daily service and agree to the terms and conditions, also known as the acceptable use policy, much like a hotel or airplane service common today.
5. **Conduit revenue from carrier - $5.50 per ft** - Cities commonly lease spare conduit and duct capacity to telecommunications companies, as a way of improving local broadband facilities and to generate revenue. Sometimes those agreements result from a request for proposal process and sometimes from direct negotiations. Carriers should receive an initial 10-year term with 2 additional 5-year terms, usually equating to 20 years.

Conduit for Sale

- Example conduit routes for sale in Phase 3
- Conduit from City of Douglas to the New Point of Entry - 36,066.24 Ft.
- Conduit from City of Douglas to U of A Campus at Douglas - 40,707.59 Ft
- Conduit from City of Douglas to Industrial Park on SR191 - 21,585.10 Ft
- Conduit from City of Douglas to Prison - 50,238.99 Ft

EXPENDITURE REDUCTION ASSUMPTIONS

1. **Reduce energy costs** - By implementing LED smart streetlights, the City could save up to 50-70% of the lighting energy costs.
2. **Reduce water costs** - Using smart meters, cities can lower costs by detecting pipe leakages and reducing water loss. This results in more efficient regulation of water consumption. Many reports indicate that smart water initiatives help reduce water usage by 10-20%.
3. **Reduce telecom costs** - The City will be able to reduce and/or prevent future circuit costs by using its own network for its own building-to-building purposes.
4. **Reduce labor costs or create efficiencies that allow existing staff to take on other responsibilities** - The City will be able to reduce or eliminate manual processes or tasks that need an on-call person to manage, freeing up employees to work on more impactful activities.
5. **Improve communication** - The City will be able to create more timely communications with safety messaging and community notifications on electronic billboards visible throughout the region.
6. **Reduce crime** - The use of smart technologies creates deterrents to criminal behavior by promoting City surveillance capabilities and the ability to record any crimes.

Expenditures

There are a variety of expenditures associated with the capital expenditures and the operations of the Smart City. Most of the capital expenditures (assets) require annual fees such as, licensing renewal, warranty renewal and maintenance activities. Monthly or annual expenses to implement and then operate include consulting fees, grant writing and dedicated personnel.

Here the high-level depiction of the Capital Expenditures, Revenue and Expenses by the phases can be seen as described throughout the document. In addition to raising the capital budget to purchase the Smart City assets the annual operting budget will need to be increased to the Smart City costs that won't be covered by new revenue.

Please note that Phase 1 and Phase 2 are three-year periods, whereas Phase 3 is four years.

10 Year Financial Snapshot

HIGH LEVEL	PHASE 1	PHASE 2	PHASE 3	TOTAL BY TYPE
PHASE TIMELINE	2024-2026	2027-2029	2030-2033	
Capital Expenditure Totals	**$5,627,684.10**	**$8,227,172.31**	**$8,317,208.20**	**$22,172,064.60**
Revenue Totals	$371,800.00	$941,700.00	$2,429,600.00	$3,743,100.00
Operating Expense Totals	$460,800.00	$1,909,318.73	$3,183,005.52	$5,553,124.25
NET INCOME:	**($89,000.00)**	**($967,618.73)**	**($753,405.52)**	**($1,810,024.25)**

Below is the more detailed information by year to see that, in some cases, the City will have expenses for the new Smart City initiatives BEFORE there will be revenue capabilities. The Excel worksheet is dynamic and you are able to adjust the revenue assumptions as needed to conduct sensitivity testing.

10 Year Profit & Loss

	Phase 1			Phase 2			Phase 3				TOTALS
YEAR	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	10 Year
REVENUE											
Water Tower Space	$0	$86,400	$86,400	$86,400	$86,400	$86,400	$86,400	$86,400	$86,400	$86,400	$777,600
New Tower Space	$0	$0	$0	$0	$192,000	$192,000	$192,000	$192,000	$192,000	$192,000	$1,152,000
Conduit	$0	$0	$0	$0	$0	$0	$0	$814,000	$0	$0	$814,000
Smart Poles	$0	$0	$0	$0	$0	$0	$26,000	$26,000	$26,000	$26,000	$104,000
Public WiFi	$0	$69,500	$69,500	$69,500	$69,500	$69,500	$69,500	$69,500	$69,500	$69,500	$625,500
EV Charging	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Land Lease (not recommended)	$0	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$270,000
Total Gross Revenue	**$0**	**$185,900**	**$185,900**	**$185,900**	**$377,900**	**$377,900**	**$403,900**	**$1,217,900**	**$403,900**	**$403,900**	**$3,743,100**
Total 10-Year Revenue Potential	**$3,743,100**										
OPERATING EXPESNSE PROJECTIONS											
SCADA	$0	$0	$0	$3,649	$3,649	$3,649	$7,298	$7,298	$7,298	$7,298	$40,138
Water Tower Improvements	$0	$0	$0	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$21,000
New Towers	$0	$0	$0	$0	$0	$0	$14,000	$14,000	$14,000	$14,000	$56,000
Fiber Network	$0	$0	$0	$8,263	$8,263	$8,263	$35,805	$35,805	$35,805	$52,330	$184,533
Microwave Backhaul	$0	$0	$0	$500	$500	$500	$3,000	$3,000	$3,000	$3,000	$13,500
Fixed Wireless	$0	$0	$0	$1,635	$1,635	$1,635	$4,906	$4,906	$4,906	$4,906	$24,529
Private LTE	$0	$0	$0	$21,269	$21,269	$21,269	$59,126	$59,126	$59,126	$59,126	$300,311
Smart Poles	$0	$0	$0	$400	$400	$400	$2,000	$2,000	$2,000	$2,600	$9,800
Public WiFi	$0	$0	$0	$400	$400	$400	$2,000	$2,000	$2,000	$2,600	$9,800
Security Cameras aka City Surveillance	$0	$0	$0	$9,600	$9,600	$9,600	$18,600	$18,600	$18,600	$22,200	$106,800
Smart Lighting	$0	$0	$0	$810	$810	$810	$2,130	$2,130	$2,130	$13,050	$21,870
Traffic Management	$0	$0	$0	$500	$500	$500	$1,300	$1,300	$1,300	$1,300	$6,700
EV Charging	$0	$0	$0	$2,000	$2,000	$2,000	$10,000	$10,000	$10,000	$13,000	$49,000
Smart Bus Transportation System	$0	$0	$0	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$33,500	$234,500
Smart Waste Management	$0	$0	$0	$43,500	$43,500	$43,500	$43,500	$43,500	$43,500	$43,500	$304,500
Smart Billboards	$0	$0	$0	$42,735	$42,735	$42,735	$42,735	$42,735	$42,735	$56,980	$313,390
Implementaiton Support	$122,880	$122,880	$215,040	$422,400	$422,400	$422,400	$422,400	$422,400	$422,400	$422,400	$3,417,600
Core Hardware/Software	$0	$0	$0	$42,279	$42,279	$42,279	$66,919	$66,919	$66,919	$111,559	$439,153
Total Operating Expenses	**$122,880**	**$122,880**	**$215,040**	**$636,440**	**$636,440**	**$636,440**	**$772,219**	**$772,219**	**$772,219**	**$866,349**	**$5,553,124**
Net Income/Operating Budget Need	**($122,880)**	**$63,020**	**($29,140)**	**($450,540)**	**($258,540)**	**($258,540)**	**($368,319)**	**$445,681**	**($368,319)**	**($462,449)**	**($1,810,024)**

Community Satisfaction

The three pillars of Smart City success are social, economic, and environmental benefits. This three-dimensional return on investment (ROI) for Smart City applications is about delivering cost, energy, time, and other tangible savings that go straight to a community's bottom line, but also "softer" benefits that may mean more to citizens.

Smart City initiatives mean different things to different demographics, each having its own value system and beliefs and responding favorably to different parts of the Smart City strategy. For instance, a baby boomer may be most interested in security, time savings and communication but likes to visit with the parking attendant rather than use technology to park their car. A millennial may care most about the positive impact on the environment and the innovation around direct impact services like EV charging, smart parking, and other automated government services.

It will be key to develop and implement a communications plan that educates various demographics on the benefits of the Smart City long-term vison and investment so that the City receives buy in from diverse constituents.

11. Grant & Funding Recommendations

There are several federal grant programs available to support revitalization efforts in downtown corridors and other rural areas:

1. **Community Development Block Grant (CDBG):** The CDBG program provides funding to cities and counties for a variety of community development projects, including downtown revitalization, affordable housing, and economic development.
2. **Brownfields Assessment and Cleanup Grants:** These grants provide funding to assess and clean up contaminated properties, which can be a major obstacle to downtown revitalization efforts.
3. **Transportation Alternatives Program (TAP):** The TAP program provides funding for a variety of transportation-related projects, including pedestrian and bike infrastructure, which can help make downtown areas more accessible and vibrant.
4. **Main Street America Grants:** This program provides funding and technical assistance to small towns and cities for downtown revitalization and economic development projects.
5. **Sustainable Communities Regional Planning Grant Program:** This program provides funding to regional planning organizations for sustainable community planning and implementation, which can include downtown revitalization efforts.
6. **Community Economic Development (CED) Grants:** These grants provide funding to support economic development activities, including business incubators, workforce development, and entrepreneurial support, which can help stimulate economic activity in downtown areas.
7. **Economic Development Administration (EDA) Grants:** The EDA provides a variety of grants and technical assistance to support economic development efforts in distressed communities, including downtown revitalization and business development.

It's worth noting that grant programs are often subject to changes in funding and eligibility requirements, so interested parties should check the latest information on each program's website. Additionally, many state and local governments also offer grant programs to support downtown revitalization efforts. These revitalization efforts can include resiliency planning and strategies, which makes them more likely be funded and contribute to the long-term sustainability of the City.

Resilient downtown solutions can help communities prepare for and recover from natural disasters, economic shocks, and other crises. Here are some federal grant programs that can support resilient downtown solutions:

1. **National Disaster Resilience Competition (NDRC):** The NDRC provides funding to communities that have been affected by natural disasters. The grants can be used for a variety of activities, including infrastructure improvements, economic development, and community engagement.
2. **Community Development Block Grants - Disaster Recovery (CDBG-DR):** CDBG-DR funds can be used to support disaster recovery efforts in communities that have been affected by natural disasters. The grants can be used for a variety of activities, including housing, infrastructure, and economic development.
3. **Economic Development Administration (EDA) Disaster Recovery Programs:** The EDA offers a variety of grants to support economic recovery in communities that have been affected by natural disasters. The grants can be used for activities such as business development, workforce training, and infrastructure improvements.
4. **Main Street America Disaster Response and Resilience Program:** This program provides technical assistance and training to communities that have been affected by natural disasters. The program can help communities develop strategies for economic recovery and resilience.
5. **Smart and Connected Communities:** This National Science Foundation program provides funding for research and development of Smart City technologies that can improve resilience and preparedness in the face of natural disasters and other crises.
6. **Building Resilient Infrastructure and Communities (BRIC):** The Federal Emergency Management Agency (FEMA) BRIC program provides funding for a variety of projects that improve resilience and reduce the risk of natural disasters. The grants can be used for activities such as infrastructure improvements, hazard mitigation planning, and community outreach.

It's important to note that the Infrastructure Investment and Jobs Act (IIJA) authorized under the Biden Administration in 2021 dedicates $1.2 trillion for transportation and infrastructure spending with $550 billion of that figure going toward new investments and programs. Funding from the IIJA is expansive in its reach, addressing energy and power infrastructure, access to broadband Internet, water infrastructure, and more. Some of the new programs funded by the bill could provide the resources needed to address a variety of infrastructure needs at the local level for Smart City deployment.

In addition, phases (portions) of the City's plan can be funded by partners that may want to leverage the infrastructure once it is put in place. For example, the Private LTE network could be utilized by public safety agencies. In these cases, it makes sense for an inter-agency collaboration to seek grant funding that will enable enhanced public safety.

These are just a few examples of federal grant programs that can support Smart City solutions. It's important to note that the availability and eligibility requirements for these grants may vary depending on the specific program and location.

One way to get and stay engaged with the Smart City ecosystem is to attend "Smart City Connect" annually. This gathering's mission is to provide meaningful content and connect a thoughtful community of decision-makers to empower smart cities at all stages of growth. They strive to accelerate the adoption of smart technology solutions, aid in problem solving, and amplify city resources for the betterment of cities, communities, and residents. The next convention is November 28-30 in Washington DC and is free to city leaders. We recommend attending and staying connected to this community of peers and resources.

https://fall.smartcitiesconnect.org

12. Next Steps

Next Steps for City of Douglas

FUNDING TYPE	STATUS, DETAILS & COMMENTS
Within 30 days:	• Circulate the Telecom Roadmap to all key stakeholders for review
Within 60 days:	• Provide a formal opportunity for key stakeholders to ask questions about the Telecom Roadmap • Establish members of the Smart City Plan Committee • Prepare and publish SCADA Request For Bid (RFB)
Within 120 Days:	• Hire Smart City Director (or interim 3rd party) • Hold the first meeting of the Smart City Plan Committee • Create guidelines for Smart City Plan • Fully fund SCADA project (approx. $1.6M) with existing allocation and uncommitted remaining ARPA funds • Select SCADA award recipient
Within 180 days:	• Start new SCADA deployment • Hold a Smart City Plan workshop for Smart City Plan Committee members (can be facilitated by a 3rd party) • Map out all current and future City projects for a 10-year period to align with the Telecom Roadmap • Establish a consistent cadence of meetings for the Smart City Plan Committee • Use Telecom Roadmap details to apply for all relevant grants in the upcoming funding cycle (Spring 2024 for Phase 1) that will support the completion of one (or part of one) of the Smart City initiatives
Within 1 year:	• Approve official Smart City Plan • Create a Funding Evaluation Tool • Identify and determine how to measure KPIs (key performance indicators) for the Plan • Integrate Telecom Roadmap recommendations into city governance and into planning and design for existing projects • Continue to refresh funding list and apply for funding opportunities for each strategic priority in the Smart City Plan

Key Terms & Function

- **Telecom Roadmap** – This is a compilation of the network design, technology selection, financial data, benefits, and funding resources to serve as the foundation for the Smart City initiatives.
- **Smart City Director** – This person or entity has full responsibility for the funding, implementation/project management, measurement and reporting of the Smart City Plan.
- **Smart City Plan Committee** – This oversight group is formed of key stakeholder groups for decision making, prioritization and accountability to the success of various Smart City initiatives.
- **Smart City Plan** – This is the specific, detailed plan that is coordinated and balanced with all City priorities over a 10-year period. This is critical in eliminating silos that are not productive or efficient.
- **Key Performance Indicators (KPI's)** – There are a set of measurements for the success of each priority of the Smart City Plan. These should encompass the important data sets for various stakeholders and be reviewed quarterly.

Notes

native network

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