



KVA

THE FIRE DEPARTMENTS OF ELGIN COUNTY



FIRE PAGING AND TWO-WAY RADIO COMMUNICATIONS SYSTEMS STUDY FINAL REPORT

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Prepared For:

**The Fire Departments of Aylmer, Bayham, Central Elgin,
Dutton-Dunwich, Malahide, Southwold and West Elgin**

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Signed:

**Al Forest, P. Eng.,
President**

EXECUTIVE SUMMARY

KVA Communications Inc. has been hired by the municipal Fire Departments of Elgin County to review the existing radio paging and two-way voice communications systems shared among the Departments.

The primary focus of this effort is to confirm that the current situation is consistent with norms established for Public Safety agencies with regard to the quality, stability and redundancy for radio communications. Furthermore, the Fire Departments are looking for guidance regarding short and long term actions to ensure that effective mission critical communications are maintained and enhanced for years to come.

Prior to KVA Communications taking on this assignment in Elgin County, we had certain pre-conceived notions of what to expect for rural Fire Department paging and voice radio communications – these, based on our experience over many years. To say the least, we were pleasantly surprised by what we found here. There are many very good elements about the system, but, it is not perfect.

Shoreline Coverage

The biggest complaint regarding radio operations was the shadowing of OPS channel signals at the beach shorelines of Lake Erie, especially near the towns of Port Burwell, Port Bruce, Port Stanley and Port Glasgow. One possible solution might be strategically located and remotely controlled “fixed” VR units to relay radio calls automatically between a TAC channel and an OPS channel in those areas. Such devices would cost about \$15,000 each, assuming suitable locations; for example, utility poles could be secured at little or no extra cost.

Future Plans

The Departments may wish consider other providers of dispatching and maintenance/repair services; however, they are cautioned to make “apples-to-apples” comparisons, especially with regard to the specific service levels.

In our view, over the next five-to-ten years, there will not be any new technology emerging to supplant the radio system that exists today. Also, now is not the time for system replacement – certainly not a wholesale or “forklift” replacement. The system and equipment has been reliable and should continue to be so.

However, the Departments should keep aware of any developing and troubling trends with the system and take action as needed. There would be not be any specific “upgrades” necessary.

If not already doing so, each Department should be putting aside funds in anticipation for the recommended future “replacement-in-kind” solution, which would cost in the neighbourhood of \$1,000,000. Therefore, each Department should budget at least \$30,000 per year, over and above their current expenditures, for their System Replacement Fund in order to reach that goal in five years and then plan the system replacement process. Hopefully no extraordinary outlay of funds would eat into these reserves.

1.0 INTRODUCTION

KVA Communications Inc. has been hired by the municipal Fire Departments of Elgin County; that is, those of the Town of Aylmer, the Municipality of Bayham, the Municipality of Central Elgin, the Municipality of Dutton-Dunwich, the Township of Malahide, the Township of Southwold and the Municipality of West Elgin, to review the existing radio paging and two-way communications systems shared among the Departments. The scope of the study was outlined in our proposal dated January 20, 2022.

The primary focus of this effort is to confirm that the current situation is consistent with the norms established for Public Safety agencies with regard to the quality, stability and redundancy for radio communications. Furthermore, the Fire Departments are looking for recommendations to guide them regarding near and long term actions to ensure that effective mission critical communications are maintained and enhanced for years to come.

Background

KVA Communications was approached in early 2022 to consider undertaking this study. Given our background in the Land Mobile Radio Industry and a host of similar projects in the recent past including reviews for the Fire Departments of Perth County, Wellington County, York Region and Waterloo Region, not to mention Fire radio studies in the distant past for Middlesex County, Northumberland County, Victoria County and Lennox and Addington County, we gladly accepted the opportunity.

Objectives

The specific objectives of the study are:

- to review the existing Operations and Paging radio systems utilized by the municipal Fire Departments across the County,
- to ascertain the requirements for mission critical voice radio communications based on our experience and as expressed by operational personnel,
- to provide an assessment of the effectiveness of the current equipment and systems, including their strong and weak points,
- to identify any technical or other issues which require immediate remedial action,
- to provide a set of alternatives and recommendations as a road map to guide the member departments on upgrade and/or replacement strategies,
- to prepare a report which summarizes the findings of our study.

Sources of Information

The sources of information for this report include the following:

- a project “kick-off” meeting with the Fire Chief at their regular monthly meeting in Aylmer to discuss the scope of the study and other details,
- a meeting at the primary service provider, BearCom Canada (formerly Spectrum Communications), with their account and technical personnel, to determine the system operational and technical details,
- a meeting and site visit with each of the six Fire Chiefs,
- a site visit and discussions with the Tillsonburg Fire Chief and representatives from Five 9 Solutions, their service provider, regarding dispatch operations,
- site visits to three representative base radio sites – master and slaves – to view typical installations,
- review of relevant documentation, including the Industry, Science and Economic Development (ISED) Canada [formerly Industry Canada] Technical and Administrative (Radio) Frequency List (TAFL) website for radio licence technical information,
- radio equipment vendor specifications sheets, as obtained on-line,
- municipal and township websites for background information for each Fire Department.

2.0 REVIEW OF THE EXISTING SYSTEM

2.1 Overview

The fire protection services throughout Elgin County are handled by the seven municipal Fire Departments, one for each of the seven municipalities within the County (not St. Thomas) with a total of fourteen Fire Stations serving a total population of over 51,000. In 2021, there were a total of 1737 call for service among the departments and this represented 30% of the total calls handled by the Tillsonburg Fire Dispatch Centre, which provides primary dispatching services for all departments. Six Fire Chiefs lead the Fire Departments with one Chief covering Southwold and West Elgin.

There are various agreements in place for mutual aid support to Fire Departments and areas outside of the County, including in Norfolk County, Oxford County, Middlesex County and Chatham-Kent. Our study concentrates on the seven departments within Elgin County and on the radio infrastructure owned and operated by the Fire Departments.

2.2 Fire Department Operations and Equipment

Nine-One-One calls from areas serviced by the Fire Stations within Elgin County are initially answered by the Public Safety Answering Point (PSAP), Northern 9-1-1 in Sudbury and then routed, as necessary, to the Tillsonburg Fire Dispatch Centre, located at 80 Concession Street East, where the calls are answered by one of the Fire Dispatchers on duty.

ANI/ALI information pertaining to the calls is also provided to the Dispatcher and the Computer Aided Dispatch (CAD) system which provides the specific instructions, called the ***Run Sheet***, for that particular Department/Station. These Run Sheets have been developed, refined and updated by each user organization themselves, in conjunction with the Tillsonburg Fire Department. Among other elements displayed, there is an electronic map of the incident location provided for the Dispatcher. For ease of identification and accuracy, these maps are colour coded and scalable.

It should be noted that the seven Fire Departments have adopted common Standard Operating Guidelines in order to provide appropriate responses to emergency incidents and to ensure effective communications among Fire Fighters, between Departments and with Fire Dispatch.

Using the Run Sheet information provided, the Dispatcher would alert the volunteer Fire Fighters from the designated Fire Station by activating the appropriate console module. This action would cause a specific two-tone audio signal to be broadcast from the VHF simulcast paging system, whose transmitters are located at seven strategically located sites around the County (not including the Oneida Water Tower). The Dispatcher would then broadcast the details of the call by voice. This sequence is repeated approximately one minute after the initial page with tones and voice being broadcast a second time throughout the County.

All of the radio pagers worn by volunteer Fire Fighters that are within range of the broadcast would receive the signals, but only the pagers of the designated Fire Station personnel would respond and enable their unit's speaker to allow the Dispatcher's voice message to be heard.

There are typically about 20 volunteer Fire Fighters per Fire Station and each would be provided with a radio pager –the majority of units are understood to be Motorola Minitor V and VI, although other models including some Swissphone and Unication pagers are used. The primary requirement is for a rugged and reliable unit, operating at the paging frequency of 151.970 MHz.

In addition to the VHF paging channel, there is a mechanism in place to convey alerts to volunteers' "smartphones" via the Internet and cellular telephone using the "SINIRJI", "IamResponding", or "Who's Responding" applications. These also provide data to some of the Fire Halls where the information is displayed on large TV screens.

Anecdotal information indicates that sometimes these alerts are received prior to the actual VHF paging signal.

In virtually every case, the volunteers would respond to their Fire Station and typically, the first one to arrive would call back to the Fire Dispatcher in Tillsonburg to acknowledge details of the call for service. This return call would be made on the Elgin OPS 1 channel via the Fire Hall base radio unit. The local Fire Chief may also respond on his mobile or portable radio. Once the Dispatcher receives the call from the responding unit, they will repeat this message on the paging channel, so that volunteers still enroute would be aware of the unfolding events.

All radio communications for the enroute units and personnel would continue via Elgin OPS 1 until their arrival at the incident location and the Incident Command is established. Once that happens, the Dispatcher would assign one of the three Elgin TAC channels for fireground operations. All Fire Fighters arriving to the scene would be advised of the Elgin TAC channel which would be used for that incident.

The on-scene Fire crew would continue their operations on their assigned Elgin TAC channel with all voice radio traffic being recorded in Tillsonburg. A second Elgin TAC channel may be requested for the same incident to alleviate excess radio comms on the primary channel for activities such as water supply and equipment staging. In some cases, depending on the distances or terrain involved, these secondary communications may be conducted on the Elgin OPS 2 channel.

The Incident Commander may be instructed to, or they may initiate a request to, switch to the Elgin OPS 2 channel. The main purpose of this switch would be to make Elgin OPS 1 clear, should another incident arise during the original call. The Incident Commander would monitor both the Elgin OPS 1 (or 2) and the assigned Elgin TAC channel with his portable and truck radios (some of these are equipped with a Bluetooth or Wi-Fi wireless remote microphone) or with two portable radios.

Like the paging channel, Elgin OPS 1 and 2 are VHF simulcast from eight sites (now including the Oneida Water Tower); however, they utilize repeater channels, so they are two-way, with separate transmit and receive frequencies. The Elgin TAC 1, 2, 3 channels are direct or simplex; that is, they use the same VHF frequency for both transmit and receive modes of operation.

Unlike the OPS channels, which provide wide-area coverage, the TAC channels are local, primarily because of the use of portable radios; however, since there are base receivers located at all eight repeater sites, these local transmissions are by and large extended back to the Tillsonburg Comm Centre where they are recorded for future reference, as necessary.

Regarding interoperability with outside agencies, the Fire Departments have some alternatives. Within Elgin County, the first eight channels for all radios are programmed identically, so that communications may proceed easily. Outside of the County, depending on the location, the Departments may interoperate with units from Norfolk County, Oxford County, Tillsonburg, Middlesex County, St. Thomas, Chatham-Kent and the Oneida First Nation. All of these utilize VHF, so the channels may be programmed, assuming sufficient space is available in the specific radio units. The Ontario Fire Marshal (OFM) channel may also be used for direct interoperability among radios from different Fire Departments. As a last resort, a more practical solution may be to swap portable radios for the duration of the specific Mutual Aid activities.

All radios in Elgin County have a VHF Canadian Coast Guard frequency programmed for water rescue operations, as needed. For other outside agencies, for example, Police and Public Works, initial contact would be facilitated through Dispatch and on-scene communications would be done face-to-face.

Each Fire Department has a similar complement of radio equipment which include a Fire Hall base complete with a paging encoder, Fire Truck mobile radios, with the Incident Command vehicle sometimes having two radios, portable radios and pagers for the volunteer Fire Fighters. The majority of radio units are from Motorola, although it is understood that some Kenwood radios are in use. Pagers are manufactured by Motorola, Swissphone and Unication and some portable radios are equipped with a voice annunciator function, so that the user does not need to see the front panel in order to confirm which channel is being selected.

The user radio equipment repairs are done by BearCom Canada or Five 9 Solutions on an “as required” basis.

For privacy and to keep the County radio channels clear for mission critical communications, it is understood that administrative and other non-emergency calls would be conveyed by cell phones.

2.3 Radio Infrastructure

Refer to Appendix A, Block Diagrams, for a schematic representation of the paging and operations radio communications infrastructure. The radio infrastructure is located at ten (eleven, if you count the Tillsonburg Comm Centre) sites strategically situated around Elgin County and a bit beyond. These sites are as follows:

- the tower on John Wise Line at Imperial Road (master site)
- Straffordville: at the FS Partners Feed Mill, Jackson Line & Plank Road
- the Belmont Water Tower
- the Ford Water Tower
- the Oneida Water Tower
- the Port Stanley Water Tower (back up master site)
- the Wallacetown Water Tower
- the Rodney Water Tower
- the AGRIS Co-operative Feed Mill in Dutton
- the town reservoir site in Tillsonburg

Among other reasons, these sites have been selected due to the heights of their existing structures – ranging from 120’ to 220’ above ground level – allowing the primary VHF broadband antennas to be placed at the top for maximum coverage.

We first consider the John Wise Line site, which is designated the “Master” for the paging and OPS transmitter systems. The remaining infrastructure sites utilize similar equipment, with the Port Stanley site designated as the back up Master. Should any failure at the John Wise site cause its functioning to stop, the control system automatically switches over to Port Stanley until the failure(s) are rectified.

The **VHF ANTENNA MULTICOUPLER**, designed and built by Sinclair Technologies, is used to combine the various transmit and receive frequencies at the site onto a single wideband Sinclair **SD214** (four bay dipole) **ANTENNA**. The multicoupler consists of a number of tuned cavities (aluminum “cans”) which are specifically and precisely set up to pass certain frequencies and to block others. It allows for the simultaneous transmission and reception of VHF radio signals (full duplex) at the site.

At some sites, there are **SD212** (two bay dipole) antennas and there are other, non-Fire Department base radios connected to the same antenna. It is assumed the any actual or potential interference conditions were rectified during the original installation in 2014.

The frequencies used are:

| CHANNEL | BASE TRANSMIT | BASE RECEIVE |
|---------------------|---------------|--------------|
| PAGING | 151.970 MHz | --- |
| OPS 1/2 Transmitter | 164.910 MHz | --- |
| OPS 1/2 Receiver | --- | 168.555 MHz |
| TAC 1 | --- | 171.420 MHz |
| TAC 2 | --- | 165.555 MHz |
| TAC 3 | --- | 163.830 MHz |

The entire radio system operates as an IP (Internet Protocol) data network, with virtually all active elements having an IP address. Although the Paging channel and the three TAC channels end up being in analog mode, these are converted to digital streams, so that along with the two OPS channel signals, all voice information is being processed as data.

The OPS channels operate in digital mode per the DMR Tier 2 Standard in what is known as two slot TDMA (Time Division Multiple Access). The radio channel which is 12½ KHz wide is divided into time slots, with slots 1, 3, 5, 7, ... assigned to OPS 1 and slots 2, 4, 6, 8, ... assigned to OPS 2. The analog voice audio from the Dispatcher's microphone is converted into a stream of data packets by means of a device called a Vocoder and transmitted over the air. The receiver reconstitutes these packets back into analog mode as heard in the radio speaker. To ensure correct receipt, the data stream contains redundant bits to help overcome the inevitable fades in signal that occur at VHF. At the limits of coverage, there are too many data errors to be corrected and the audio falls apart.

All of the VHF base radio equipment is manufactured by Radio Activity SRL from Milan, Italy.

The **ROUTER**, made by MicroTik of Markham, is used to distribute the various data packets to/from the respective radios over the **4.9 GHz ANTENNAS / MICROWAVE** system, manufactured by Ubiquiti Networks of New York, for pick up from, and delivery to, the Tillsonburg consoles. Unlike in the past, microwave antennas and RF units are now supplied as integrated pairs, with power and data being the only connections to the equipment in the shelter below.

To facilitate wide area coverage, the OPS channels take the audio received at one or more sites and distributes it to all sites for re-broadcast. The mechanism for this includes the use of receiver voting – now primarily achieved the use of software rather than a physical piece of equipment. This voting process analyzes the quality of signals conveyed from each remote site and selects the best quality for re-transmission. The TAC signals received at each site are also analyzed so that the best is chosen to be recorded at Tillsonburg. The direct connection from the consoles ensures that Dispatcher priority is normally in effect; that is, the Dispatcher may pre-empt a call in progress between field radios, should the need arise.

Being simulcast systems, the paging and OPS transmissions must be carefully controlled to make sure that mutual interference between sites does not occur. (You may be aware of what happens when two radios are keyed up on the same channel at the same time – generally speaking, both transmissions are garbled, due to heterodyning.) To ensure successful simulcasting, the transmit frequencies, modulation levels and “launch” times at each site must be precisely established and controlled.

Now-a-days, the most practical way to control base transmit and receive frequencies sufficiently precisely is by means of **GPS RECEIVERS**. A “normal” base FM transmitter, such as ones used

for non-simulcast VHF systems, must maintain an accuracy and frequency stability to within about one part per million (± 1 ppm). A simulcast transmitter requires stability to about one part per billion (± 1 ppb). This is orders of magnitude more stringent and requires the use of an external frequency source. The GPS system of global satellites generates extremely precise time signals which provides the needed accuracy.

To make sure the connections to/from each site are controlled, stable and interference free, microwave links in the 4.9 GHz band reserved for Public Safety have been established. High gain, directional dish antennas, aimed at the remote sites, focus the radio waves to ensure reliable connections, not prone to fading due to weather or other environmental factors. Since the distance between the Rodney Water Tower and the Oneida Water Tower is too great to allow a dependable link, an intermediary “hop” site was established in Dutton.

As shown in Figure 5, the microwave system is configured as a RING (actually two rings). This arrangement increases significantly the overall reliability of signal distribution. Should a single link be lost due to equipment failure or an atmospheric fade, the flow of data would automatically reverse and the system would return to complete functionality. Within this set up, there is only one single point of failure and that is the link between the Tillsonburg reservoir site and the Comm Centre; however, it is understood that there are currently plans to expand this connection into a ring between the reservoir, Comm Centre and the backup Comm Centre facility.

All of the radio and control equipment at each site operates from a **UPS** (Uninterruptable Power Supply) unit, made by Alpha Technologies of Burnaby, BC, which is powered by eight (8) batteries, each with a capacity of 100 Amp Hours. While it is unclear exactly how long this power system could maintain operations should the primary AC power fail, it would certainly be well in excess of 8 hours, the norm for most Public Safety radio systems.

All site equipment and cabinets are connected to ground and each antenna cable has a grounded Polyphaser protection device to minimize damage from lightning strikes to the tower.

BearCom has set up its monitoring system for remote access to status and “health” data for each site and all of the radio units (but not the paging power amplifiers used at some sites). This provides alarm information to their service personnel should performance parameters fall below prescribed thresholds, allowing quick deployment for repairs. The remote monitoring system includes alarms for loss of primary AC power and in some cases, high and low temperature alarms should the controls at the site fail to regulate the ambient environment.

2.4 Communications Centre Equipment

The primary access points to the paging and radio systems in Elgin County are two Avtec IP Consoles located at the Tillsonburg Comm Centre. (It is understood that there is an expansion program in place with a plan to have four active consoles. To date, this expansion may have already been completed.) The path for the radio signals is via the Tillsonburg Reservoir site and through a number of router, gateway, and server units for the OPS and Tac channels. The Paging gateway unit is located at the Reservoir. The gateways are manufactured by Avtec and Radio Activity.

During active calls, the dispatcher monitors both Elgin OPS channels which are recorded using the centre’s Komutel logging recorder. The TAC channel audio is received and recorded for future reference; however, it is not readily available to the dispatchers in real time and therefore not typically monitored. The OPS channels are the primary means for the Incident Commander to call for additional support.

When the Dispatcher activates the paging function, to ensure that the correct tone code was actually broadcast on the system, there is an annunciator panel available which by a series of lights provides a positive visual confirmation. (This panel is critical when Tillsonburg is alerting a remote Department such as Fort Erie.)

As a backup mechanism, should the primary links fail, the Dispatcher has a base radio at their disposal on the Elgin OPS channels to access the system directly.

Furthermore, if the Comm Centre itself were to be evacuated, the Dispatchers would move to the Tillsonburg Customer Service Centre (CSC) which is in a geographically separate location. At the CSC, there is an identical Avtec Console which is connected by means of a fibre optic cable and it can be configured to have the same “look and feel” of the primary consoles. Also, if there is need for additional dispatching resources during a surge in activity, this console may be utilized. The CSC location is also equipped with a base radio unit and access to the paging gateway at the Reservoir.

3.0 ASSESSMENT

3.1 Effective Radio Communications

Effective two-way voice radio communications are a necessary part of the “mission critical” operational requirements for municipal Fire Fighters when dealing with the routine and emergent situations which they can face on any given day. In order to be effective, all six of the following basic requirements must be satisfied.

The two-way voice radio communications system must:

- i) have adequate coverage,**
- ii) have sufficient capacity,**
- iii) provide the required functionality,**
- iv) deliver reliable operation,**
- vi) be compliant with Industry (ISED) Canada regulations, and,**
- v) be cost effective.**

Coverage is the unique requirement for radio systems; without coverage, there is no radio system. To be effective, radio coverage must encompass, in a reliable manner, the areas and modes of operation which municipal personnel utilize on a daily basis.

Excellent radio coverage throughout the required areas would be useless, if the radio communications were to be disrupted and Fire Fighters could not gain access to their co-workers, supervisors or dispatchers within a reasonable length of time, especially during critical life and death situations that can occur during fire suppression activities.

The radio system must satisfy the functional and operational requirements of the end users, including the need for interoperability among user groups, as and when needed.

Operational reliability is a critical aspect to overall radio system effectiveness. Down time must be minimized and a robust system configuration is required with adequate redundancy of equipment and components throughout the radio infrastructure. Back up power is needed at all radio and control sites to ensure continued operation without the main AC power feed.

Any failures causing a *complete* system shut down would be unacceptable. Work around equipment, plans and procedures must be set up to ensure that radio communications continue at all times with perhaps reduced performance levels. Users should be fully trained and comfortable with back up procedures and to understand the limitations of all failure-mode operations.

An effective maintenance and repair program should be in place to ensure that the inevitable equipment failures are rectified quickly. The remote monitoring of equipment status, in order to

ensure timely equipment repair, is an important aspect of system reliability. There should be plans in place to periodically update and/or replace obsolete equipment and sub-systems.

The radio systems must comply with all ISED Canada technical regulations including the Redeployment Plan for Land Mobile Radio equipment operating within the frequency range of 100 - 500 MHz. Furthermore, if there were to be a need for additional radio channels, user agencies should be aware of the justification process utilized by Industry Canada.

The radio systems and ancillaries should be cost effective for the respective agencies to own and operate.

3.2 Analysis of the Current Systems

How well does the radio system currently in place satisfy the operational needs of the municipal Fire Departments in Elgin County ?

Coverage

Refer to Appendix B for a set of coverage maps generated using the available technical information for the eight base paging/repeater sites. There is a plot for each site individually and three with (i) all sites together, (ii) all sites except Oneida representing paging coverage, and (iii) all sites except the Ford Water Tower, representing coverage for the TAC 1 channel.

Paging is, of course, one-way from the base transmitter to the pagers and the TAC channel is also one-way from the user equipment back to the base receivers. The OPS channels are two-way, the so-called “talkout” and “talkback” paths. In our analysis, based on the various technical parameters understood to be in place – things such as transmitter RF power output, cable and multicoupler losses, antenna heights, etc. – the coverage is approximately the same for talkout to portable radios and pagers and for talkback. Hence, only one coverage plot is shown.

These coverage predictions are based on the expected coverage for portable radios at chest level as used by Fire Fighters outdoors at an incident. The parameters include an expectation of Circuit Merit (CM) or Delivered Audio Quality (DAQ) for digital calls of at least 3.4 (on a scale of 1 to 5) and the zones in red show the extent of an Area Reliability figure of 95%. This means that in those areas, of 100 points taken at random, at least 95 would be expected to have good coverage.

Acceptable coverage for portable radios may extend beyond the red zones; however, the reliability level would fall below 95%. **Note:** There are no specific “standards” established for Public Safety agencies in Canada with to regard to radio coverage. One hundred percent area reliability is not achievable in practical terms.

However, within the Land Mobile Radio Industry, there is a document, TSB-88, published by Telecommunications Industry Association (TIA), which sets out the methods to predict and test for radio coverage over wide areas. This may be considered by some to be the “de facto” standard. In our view, this document presents many useful ideas; however, it is largely a product of the major suppliers in the sector and thus masks their vested interests. It is interesting to note, that TSB-88 originally recommended an area reliability figure of 95% for Public Safety agencies. Subsequent revisions increased this to 97%, but the latest version reduced the level back to 95%.

From Figure 14, there appears to be a coverage hole in the middle of Southwold. This is likely not the case, due to a phenomenon that is termed “Voter Advantage” for base receivers (and its equivalent for simulcast transmitters) in areas of overlap from two or more sites. The rationale goes like this: In an area with 77% coverage reliability from two sites, of 100 points chosen at

random, 77 would be covered by site a and 23 would not be covered. Of those 23 points, 18 would be covered by site b and there would be only 5 points without coverage. Hence, a 95% area coverage is achieved. With three or four sites providing some amount of the coverage, the required reliability from each is far less. Fifty percent coverage from each of four sites should provide more than 97% area reliability.

After the recent failures of base receiver units due water damage which necessitated a re-jigging of the TAC receivers, it was decided to eliminate the TAC 1 unit from the Ford Water Tower. While it would have been far better to install a spare unit, the choice made is probably having the least impact on day-to-day operations, as that tower has four sites surrounding it. With voter advantage coming into play in that blank area, reliable coverage is likely quite good. Refer to Figure 16.

However, this voter/simulcast advantage does not improve reliability in areas where only one site provides coverage.

It can be seen from the coverage maps, that highly reliable coverage to and from portable radios and to pagers is not achieved throughout the County. As indicated by the Fire Chiefs, the main areas where portable coverage is deficient is along the shoreline of Lake Erie in beach areas, in the north-west area of West Elgin and northern parts of Malahide and Bayham – near Avon, Springfield and along Highway 3 going to Tillsonburg. This is consistent with the predicted coverage shown in Figure 14.

Since a paging transmitter is not installed at the Oneida Water Tower, the expected reliable coverage is shown in Figure 15. It is not certain why there were no complaints of poor paging coverage in the upper end of Southwold; however, it may be that the three surrounding sites, Wallacetown, Port Stanley and Ford, compensate for the deficiency. It is understood that there is a high power RF amplifier used at the Ford site, which may partially explain the extra coverage.

Also perhaps, in this area is where volunteers have the Internet app on their smartphones and they may be getting their alerts before their pagers go off.

Capacity

With the current complement of two operational channels and three tactical channels, there seems to be more than ample capacity in the radio system to handle day-to-day operations, which on average, would be less than a few calls per week for the typical Fire Station. No Fire Chief complained of a lack of system capacity.

The primary issue is how does the system handle a surge of calls, during for example, wide-area storm situations ? Calls may be divided among the two OPS and three TAC channels and if the incident locations are sufficiently separated geographically, one TAC channel may be able to be shared without mutual interference. The Dispatchers would control channel access and inform Incident Commanders of such sharing arrangements.

Functionality

The paging and radio communications infrastructure provides for the alerting/dispatching of volunteer Fire Fighters throughout the County and mission critical voice communications for tactical on-scene operations. As indicated by the Fire Chiefs, no other functionality is required, although there may be a need to program additional channels in a few cases to allow for improved interoperability outside of the County.

Furthermore the radio infrastructure, with the three TAC receivers distributed around the County, provides the means to record at the Tillsonburg Comm Centre virtually all of the incident radio comms conveyed on these simplex frequencies.

In addition to all of the console and ancillary support equipment at Tillsonburg, the Dispatchers have a paging annunciator panel which provides a positive acknowledgement that an alert has actually been broadcast correctly. This provides assurance that some catastrophic equipment failure hasn't occurred to prevent the signals from being transmitted.

Reliability

The paging and voice radio communications systems are well designed with inherent reliability. The multiple site configuration ensures that, generally speaking, single point equipment failures would not cause a complete shutdown. For example, if a single radio unit fails, the ones at the other sites would still be available as normal.

If an entire site is lost, then the other seven (or six for paging) sites would still provide communications, albeit with somewhat reduced coverage for portables – depending on which site failed. Mobile coverage should still be more than adequate.

If the Master site (at the John Wise Line tower) were to fail, the Port Stanley Water Tower site would automatically be designated the new Master, and operations would continue.

Because of the microwave linking ring configuration, a single link failure should not disrupt communications.

All radio units at each site are powered from a UPS complete with eight 100 Amp-Hour battery units and primary site AC power is monitored remotely. The John Wise Line site shelter seems to have an exterior connection for a transportable generator for extended periods of no primary power. It is assumed that the other sites could be powered in a similar manner, if necessary.

Other specific equipment failures would have varying degrees of impact on the systems. Hence it is important that the remote monitoring system in place at BearCom is available to alert and dispatch their technicians immediately upon a failure, so they may expedite repairs and bring the system back to full functionality. It is understood that at some sites, the paging power amplifier units are not monitored, so it is critical for users to report on any paging anomalies they experience. On the other hand, due to the simulcast configuration, a failure of one of these power amplifiers may not be immediately obvious to the volunteers.

Another key element affecting the overall availability of a Public Safety radio network are its backup units. There must be several levels of backup. For example, if a console fails, there are at least two (and soon more) identical consoles which can take over. If **all** consoles were to fail, there are access base radios available to the Dispatcher to maintain communications. If there were to be major outages affecting several base radio sites, each Fire Hall is equipped with a base radio complete with a paging encoder to allow continued contact with deployed Fire Fighters and the Comm Centre.

While we did not visit all of the base radio infrastructure locations, we did view three representative sites – the Belmont Water Tower, the Ford Water Tower and the John Wise Line Tower. It is understood that the Ford Tower may be slated for removal and so a substitute site would need to be developed, in that eventuality. The John Wise Line site seems to be rather old (a former cable TV site ?) with a dated, but functional equipment shelter.

Industry (ISED) Canada Compliance

The equipment conforms to all technical requirements mandated by Industry Canada, except that the analog channels operate in 12½ KHz mode, which makes them technically “non-standard” as of January 1, 2010, to Phase 2 of the Redeployment Plan (RDP 100-500 MHz). Unless and until the federal government formally requires a move to narrow-band (6¼ KHz) operation (with a minimum of two years’ notice) the Fire Department need not make changes. In light of the current spectrum situation in the VHF band, this is highly unlikely.

Cost Effectiveness

It is understood that the system and equipment is cost-effective for the municipal Fire Departments to operate, although there were concerns raised about the relative high cost of dispatching services and the increasing costs of radio equipment repair.

3.2 Conclusions

Prior to KVA Communications taking on this assignment in Elgin County, we had certain pre-conceived notions of what to expect for rural Fire Department paging and voice radio communications – these, based on our experience over many years. To say the least, we were pleasantly surprised by what we found here.

Like many things, a well-designed and functional radio system should be transparent to the end users. They can “take it for granted” and thus Fire Fighters can focus on the critical tasks at hand and not have to worry about the technical details of the radio system.

There are many very good elements about the system, but, it is not perfect – no system ever is.

The fact that all of the Fire Departments have developed and agreed upon a common set of radio operating procedures is a good thing and it certainly helps to utilize the radio system efficiently.

Having Tillsonburg Comm Centre provide professional Dispatcher support throughout the entire call and then providing an Incident Report in a timely manner, with time stamped markers for all significant elements, also helps on-scene personnel to focus on their required tasks. Various systems, such as the Paging Annunciator panel, assist Dispatchers in their efforts to expedite the call processes. Furthermore, with additional resources and backup systems readily available, the Comm Centre can handle surges in call volumes and potential equipment failures.

Many other rural Fire Departments struggle to solve the problem of how to record on-scene radio communications when operating via direct, simplex channels; that is, off the network. Some try less effective methods such as mobile recording units in a Fire truck or in their local Fire Hall. However, the idea of providing TAC receivers at every base site is an elegant solution and often not implemented due to cost factors. Yet you have it here.

It is understood that the radio system has been very reliable over the past eight or so years, with recent outages caused externally by water damage, rather than by internal equipment or component failures. Having 24/7 monitoring of equipment and site “health” means that the inevitable failures can be dealt with quickly. The on-going Preventative Maintenance program is key to keeping the system fully functional.

If anyone needed further evidence that relying on an Internet provided application for mission-critical / emergency communications is not a good thing, then the nation-wide outage of Rogers on Friday July 8, 2022 is ample proof. Having a completely independent paging and voice radio

communications system is essential. The “smartphone” applications which can enhance the alerting process have their place, but they are not, repeat not, a substitute.

There may be an interesting dilemma shaping up in the telecommunications Industry in Canada as Public Safety users look to adopt broadband network operations, as is being done in the US. There the “FirstNet” system is being implemented by AT&T on its commercial LTE network with priority and pre-emption features for First Responders who operate on the network. In Canada, it would likely be one of the large, nation-wide carriers who would be the only entity capable of implementing such a network. There would have to be “iron-clad” guarantees that wide-area outages simply never occur. Thankfully, for rural Fire Departments use of such broadband networks for anything but secondary communications, is likely only in the distant future.

4.0 ALTERNATIVES

This section of the report provides some details as to what the municipal Fire Departments could do to improve areas of deficiency in the radio system. It should be noted that there were no issues found which necessitate immediate remedial action.

Coverage

Shorelines

The biggest complaint regarding radio coverage was the shadowing of OPS channel signals at the beach shorelines of Lake Erie, especially near the towns of Port Burwell, Port Bruce, Port Stanley and Port Glasgow.

One possible solution would be to implement a true vehicular repeater in at least one vehicle per station in areas where these deficiencies are experienced. Unlike the current microphone extenders, these VR units would receive the TAC channel and re-broadcast it on one of the OPS channels (and vice versa). The problem is that users have indicated that this VR unit would need to be parked at the top of the bluffs in order to have coverage to the OPS channel. This would be a similar situation as to what is done currently in order to maintain communications with Dispatch: a vehicle and operator are left on top to relay messages. It seems a VR unit would not be practically different as the vehicle would still require a Fire Fighter to remain with it.

Alternatively, if a “fixed” VR unit were to be strategically located on the top of the bluff and have the capability to be remotely activated and disabled (say, by using DTMF tones generated by a portable radio), then once a team finds itself without OPS coverage, that unit would be enabled to automatically relay messages. It would not be necessary to implement a tall tower for the antenna, since vehicular mounted antennas are sufficient given the right location. It is estimated that such a device would cost between \$10,000 to \$15,000, assuming suitable locations (one for each beach area) could be secured at little or no expense – for example, on a local utility pole.

Other Areas

There are several other areas in the County where spotty coverage was reported. If these are areas where coverage for mobile radios is also poor, then there would be little recourse than to add new base repeater sites – one in the east and one in the west. At some \$100,000 per site, this approach would not seem to be cost effective.

On the other hand, if these are areas where wide area portable coverage is required, then a wireless microphone or full vehicular repeater option should suffice to allow the Incident Commander to monitor both OPS and TAC when away from their vehicle.

Capacity

The system capacity is fine and no action is needed.

Functionality

Operational functionality is fine and no action is needed.

Reliability

While the systems have been quite reliable over the years since implementation, there is the potential for increasing failures, especially for two elements. As put forward recently by BearCom, they have proposed to replace all of the TAC 1 base receivers with the latest, KAIROS product line from Radio Activity SRL, at some \$75,000 plus.

Also, due to past “intermittent” disruptions with operations, BearCom is proposing that the entire microwave linking system be replaced. Here, there are two alternatives presented – units from Ubiquiti Networks at about \$90,000 and units from Cambium for just over \$150,000.

ISED Canada Compliance

There are currently no issues with regard to ISED Canada compliance and no action is needed, unless and until there is a mandatory requirement to comply completely with the Redeployment Plan, a highly unlikely prospect.

Cost Effectiveness

It is understood that the current infrastructure and user equipment represents cost effective solutions for the Fire Departments. However, the Departments may wish consider other providers of dispatching and maintenance/repair services. They are cautioned to ensure that they are making “apples-to-apples” comparisons, especially with regard to service levels during surge or major failure scenarios.

5.0 RECOMMENDATIONS

With regard to the paging and voice radio communications systems used by the municipal Fire departments of Elgin County, the following suggestions and recommendations are made by KVA Communications Inc.

Grounding

During our visit to the John Wise Line tower site, it was noticed that perhaps the shelter grounding was not entirely adequate. Good equipment grounding is essential as a protection mechanism, should the tower be struck by lightning. It is recommended that the site grounding be explicitly measured at the next PM inspection to ensure compliance with Industry norms such as the Motorola R56 or Harris AE/LZT 123 4618/1 specs. The grounding at other sites may also need to be verified.

Planned Obsolescence

Regarding the introduction by radio vendors of new products – portable radios in particular – which have redesigned accessories, such as batteries, chargers and microphones, there is no easy answer. It can create major logistics challenges for a Fire Department and can even impact operational efficiency. When a wholesale changeout of radios is out of the question, the only solution may be to try and source compatible after-market accessories, and eventually used radios.

It is frustrating when, in the name of progress, major suppliers put profits ahead of serving their long standing customer groups.

Spare Parts

While it is certainly not the ideal situation for any Public Safety agency to be short of spare parts, it may not be the dire condition suggested, not having spare components for the RA units. The radios have generally been reliable and external factors were to blame for the recent failures. Another failure at this point, should not be catastrophic, as the system could be re-jigged as had been done to TAC1 to minimize the overall impact. The multiple site configuration of the system allows for a high degree of flexibility and reliability.

Radio Activity themselves have stated that *“as far as our old RA-160 base station[s], we still guarantee repairs”* and that they would explore other possibilities to provide their best support. Also, it is understood, that by law, suppliers of infrastructure electronics equipment must provide spare parts at reasonable cost for up to seven years after a product is discontinued from manufacture (2020 for the case of the RA-xx product line).

Towers

There was a question raised as to whether the Fire Departments should consider erecting their own radio towers in order to (i) reduce the site rental being paid to the existing tower owners, and (ii) generate revenue from other agencies, such as cellular providers. While it is true than in recent years, there has generally been an increase in tower access fees – primarily due to the CRTC’s mandate that cell providers allow access by competitors to their towers – it is unlikely this is an avenue for the departments to consider. [Gone are the days, when the cellular carriers would provide access to their towers and equipment shelters to local Fire Departments at no charge, in order to be seen as “good corporate citizens”.] In addition to the costs of the actual tower, foundations and installation, there are issues related to finding the right location, land acquisition, building and zoning approvals, dealing with local protesters and maintenance.

Currently five of the ten sites used for the system are water towers owned by member municipalities. If the rental for these sites are considered excessive, then the Departments themselves need to convince their councils to make reductions.

Dispatching Services

The dispatching services from Tillsonburg Fire was universally praised as being “top notch” by the Fire Chiefs. From our perspective, what we saw there was untypical and very impressive when compared with what most rural Fire Departments have to put up with. Tillsonburg is well equipped to handle day-to-day operations with a professional, well trained staff. They are forward thinking and proactive in their planning and execution of expanded facilities and are well able to deal with the inevitable “storm surges”. They comply with the latest NFPA 1061 requirements and are planning for Next Gen 9-1-1 upgrades.

It is unlikely that the Fire Departments of Elgin County would be able to find a better level of service from any other facility; however, it would be up to each Department to decide whether it is too costly. It is assumed that a less expensive service would not be up to the same level as Tillsonburg. How much less would still be acceptable ?

Maintenance and Repair

There are indications that over time, Spectrum/BearCom has become more expensive and less responsive to the needs of the Fire Departments. While BearCom has the knowledge and experience of servicing the radio infrastructure since its installation, there are other service providers available who could also get the job done. It would be up to each Department to determine the best fit for themselves.

The Future

In our view, over the next five-to-ten years, there will not be any new technology emerging to supplant the radio system that exists today. There is no need for a P25 solution and broadband may have potential as an adjunct, but never as the primary means for mission-critical communications in Elgin County.

Also, now is not the time for system replacement – certainly not a wholesale or “forklift” replacement. The system and equipment has been reliable and should continue to be so. But, of course, the Departments should keep aware of any developing and troubling trends with the system and take action as needed. Also, no specific “upgrades” are necessary for the system.

If not already doing so, each Department should be putting aside funds in anticipation for the recommended future “replacement-in-kind” solution. No vendor should be given any specific advantage. If, for example, the TAC1 channel equipment were to be replaced at this time with the proposed KAIROS units, there might be less flexibility to choose freely a vendor or equipment when the time comes for replacement.

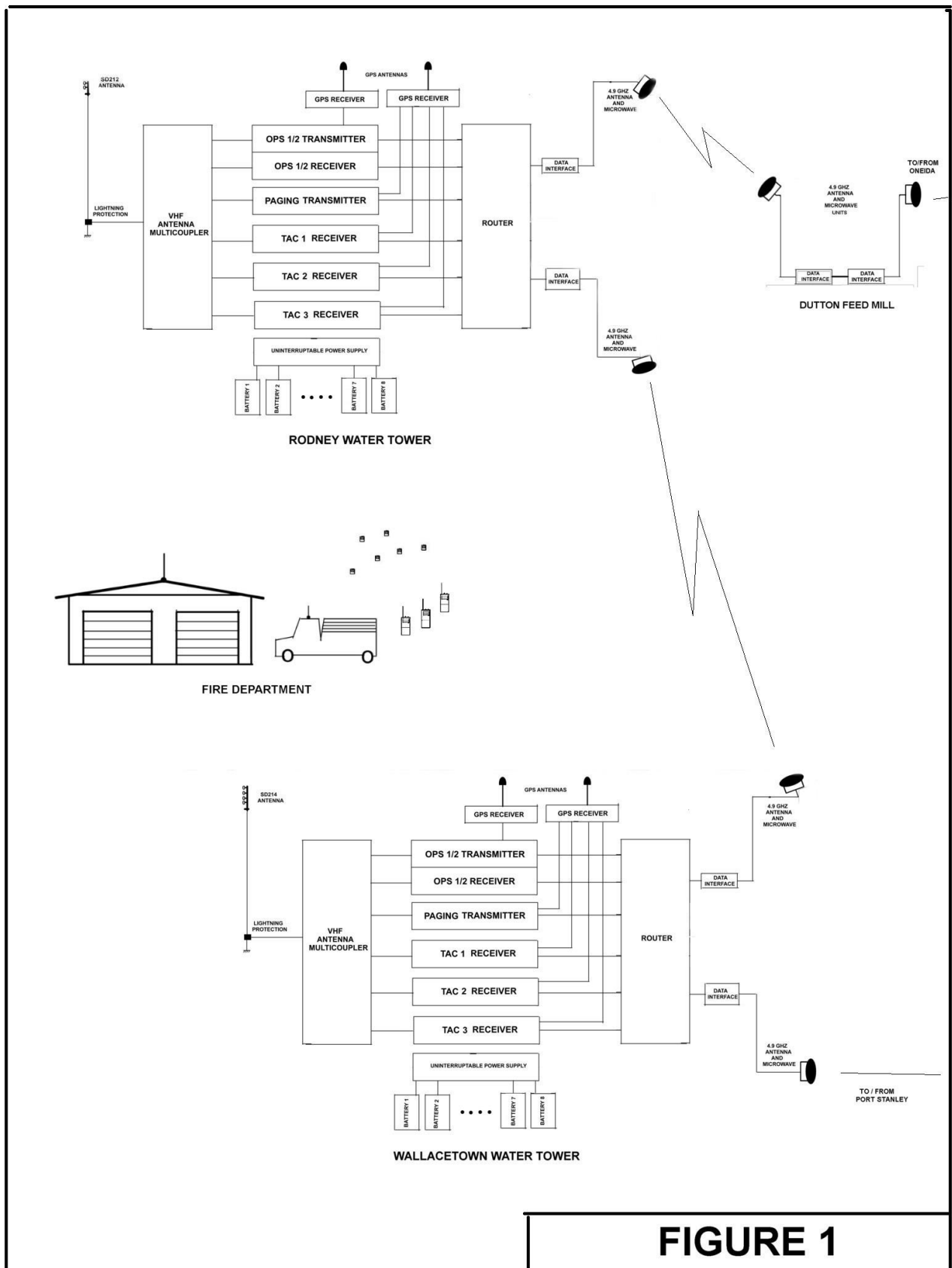
A similar argument can be made for BearCom’s proposed replacement of the microwave linking system equipment. The intermittent problems cited may be due to any number of factors including atmospheric conditions. The ring configuration is designed to mitigate those factors, so a replacement at this time is not warranted, in our view, unless there were to be major and consistent equipment failures.

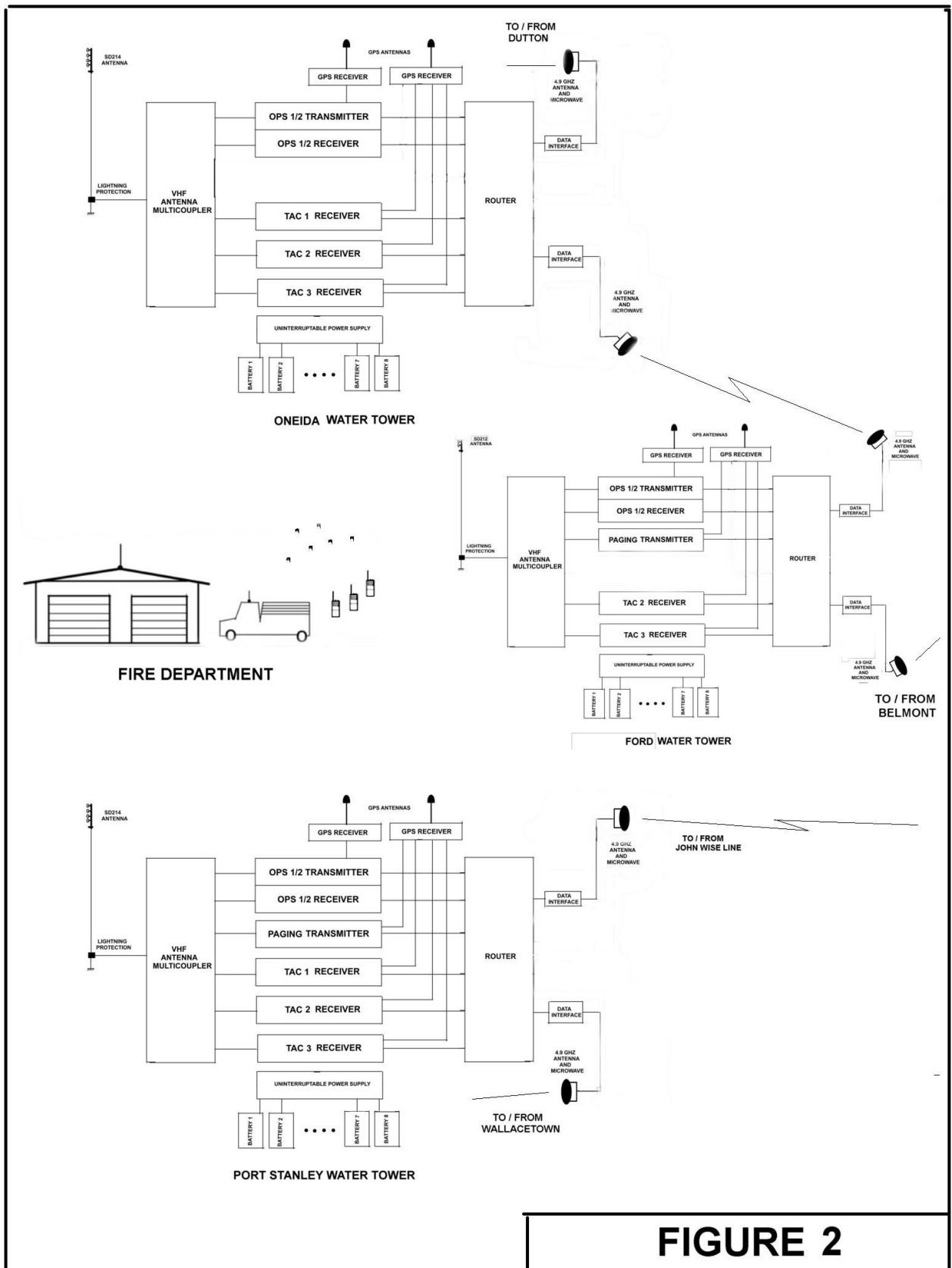
Doing a piece-meal change out might seem to be a way to stretch out the costs; however, the overall benefits to such a plan should be taken into consideration. BearCom themselves stated that the advantage to a “forklift” replacement was having all equipment with the same warranty, rather than a patchwork set.

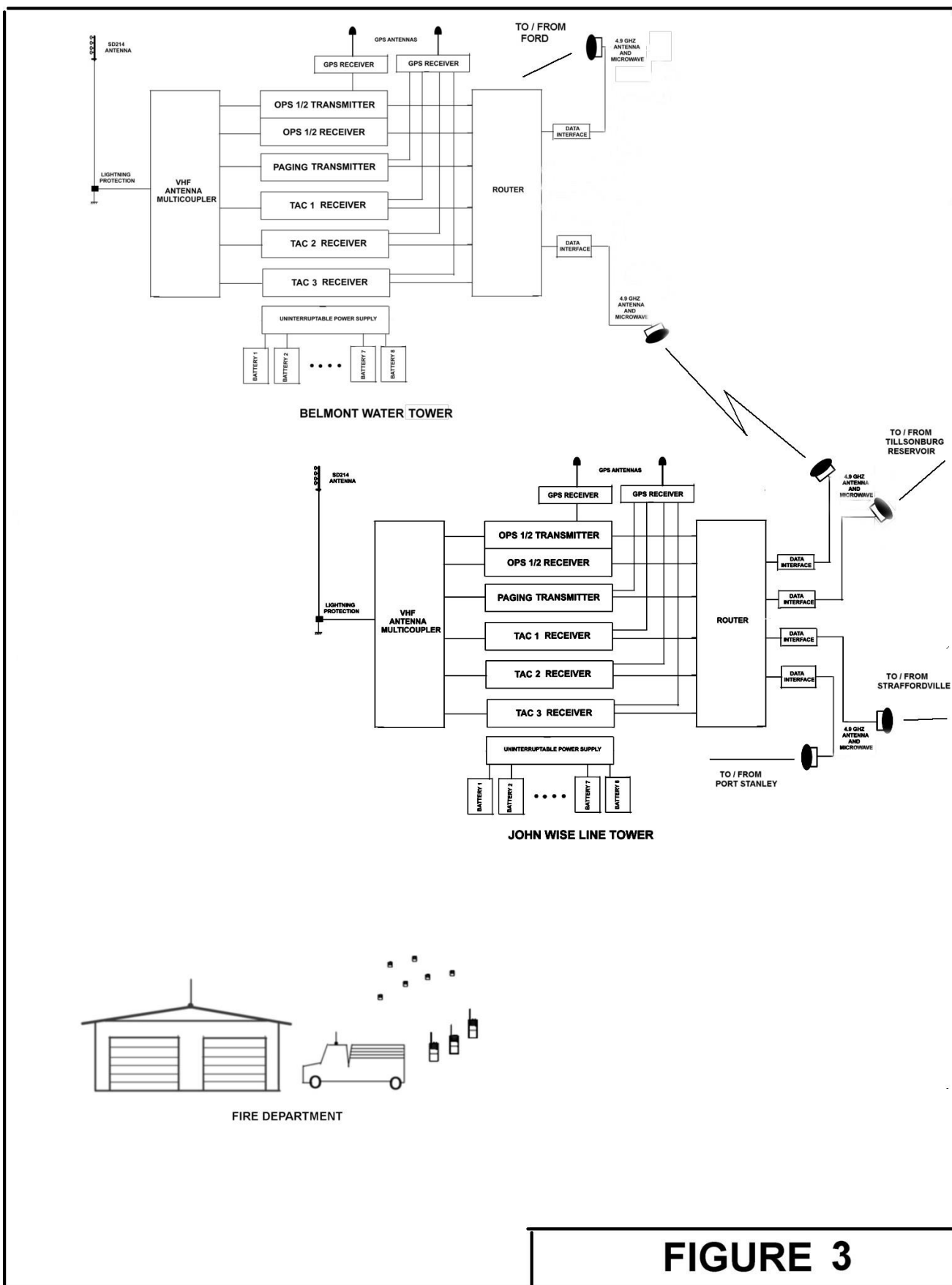
A replacement-in-kind solution would cost in the neighbourhood of \$1,000,000. Therefore, each Department should budget at least \$30,000 per year, over and above their current expenditures, for their System Replacement Fund in order to reach that goal in five years. Hopefully no extraordinary outlay of funds would eat into these reserves.

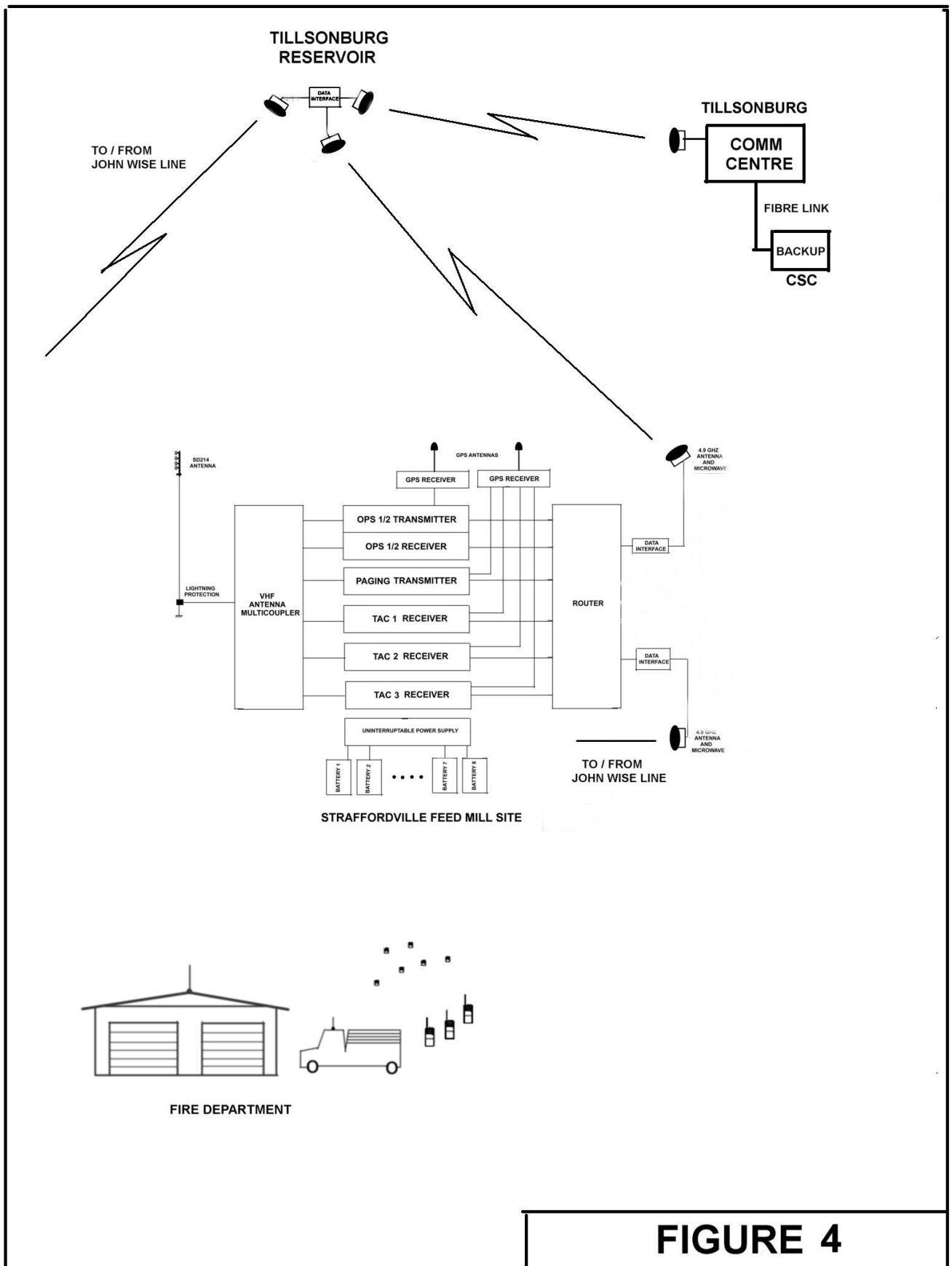
APPENDIX A

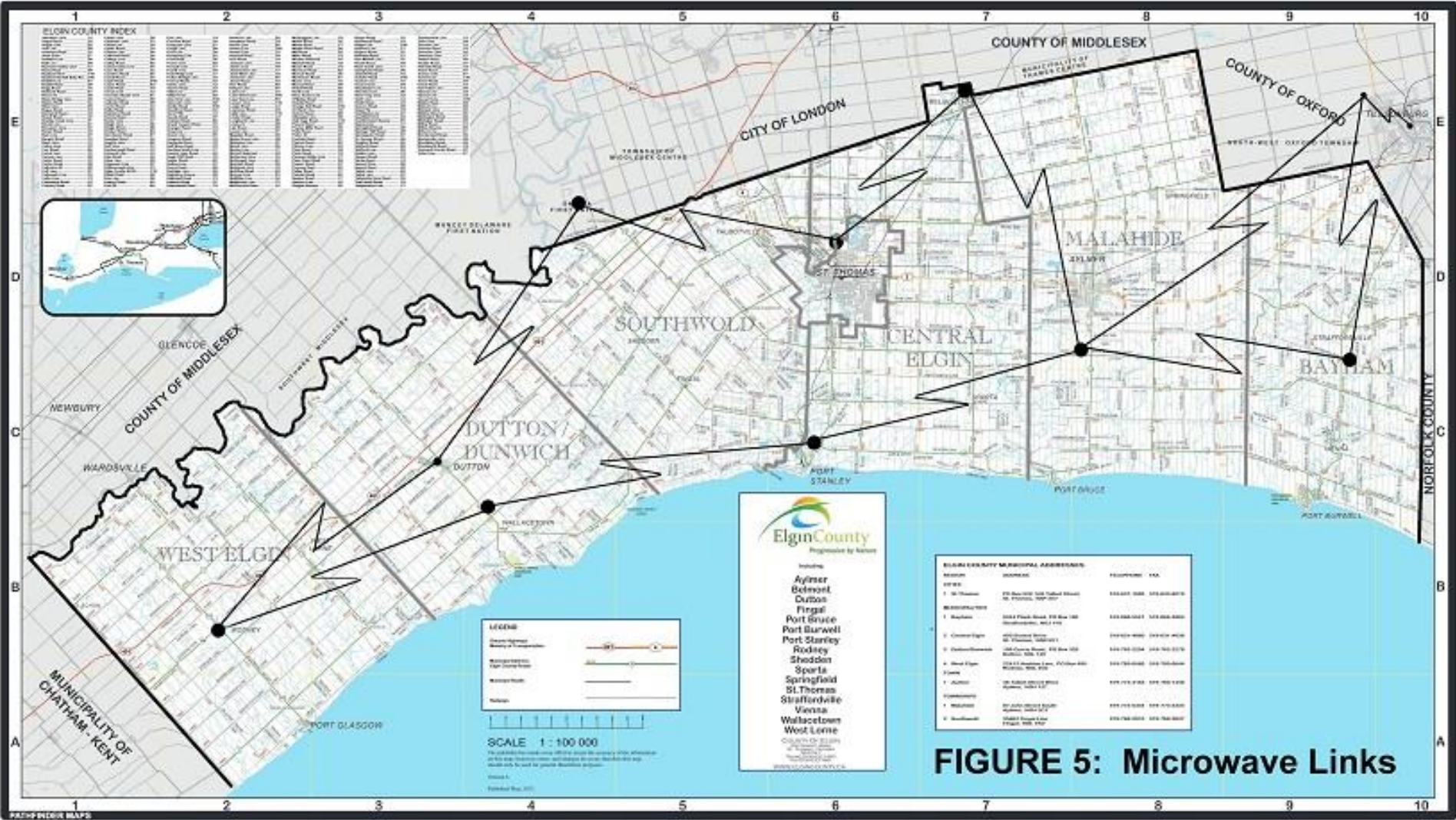
RADIO SYSTEMS BLOCK DIAGRAMS



**FIGURE 2**







APPENDIX B

RADIO COVERAGE MAPS

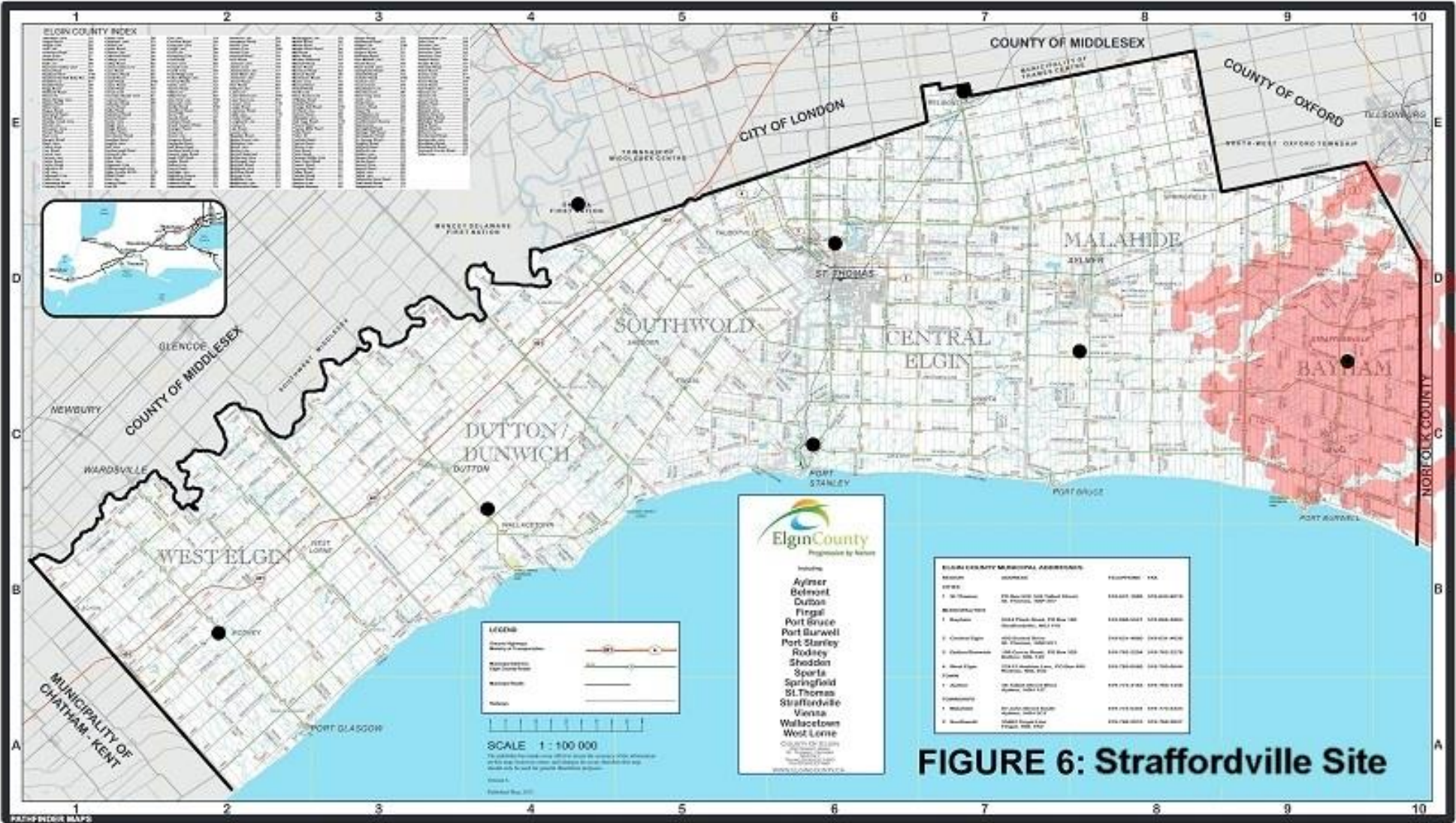
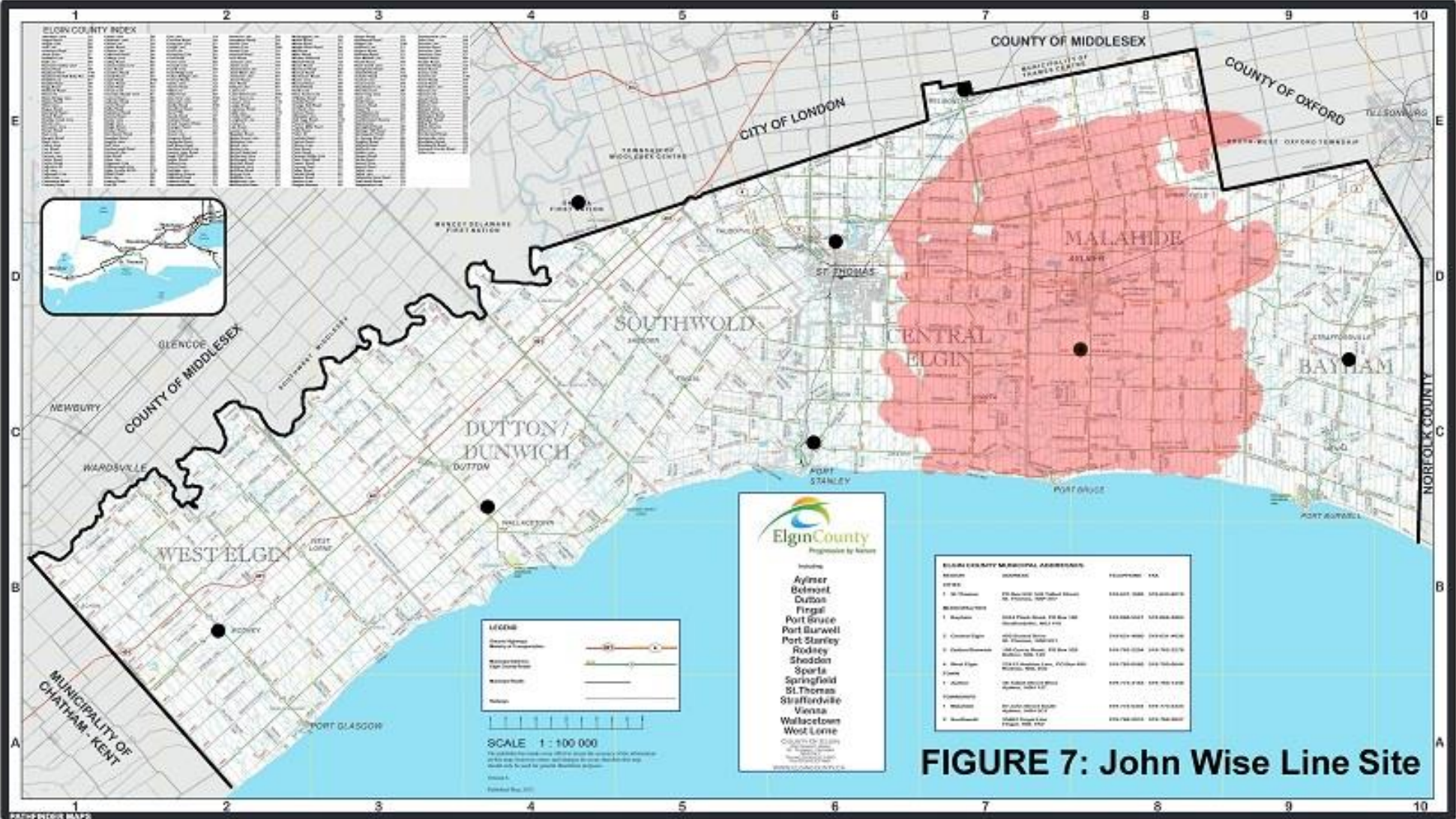
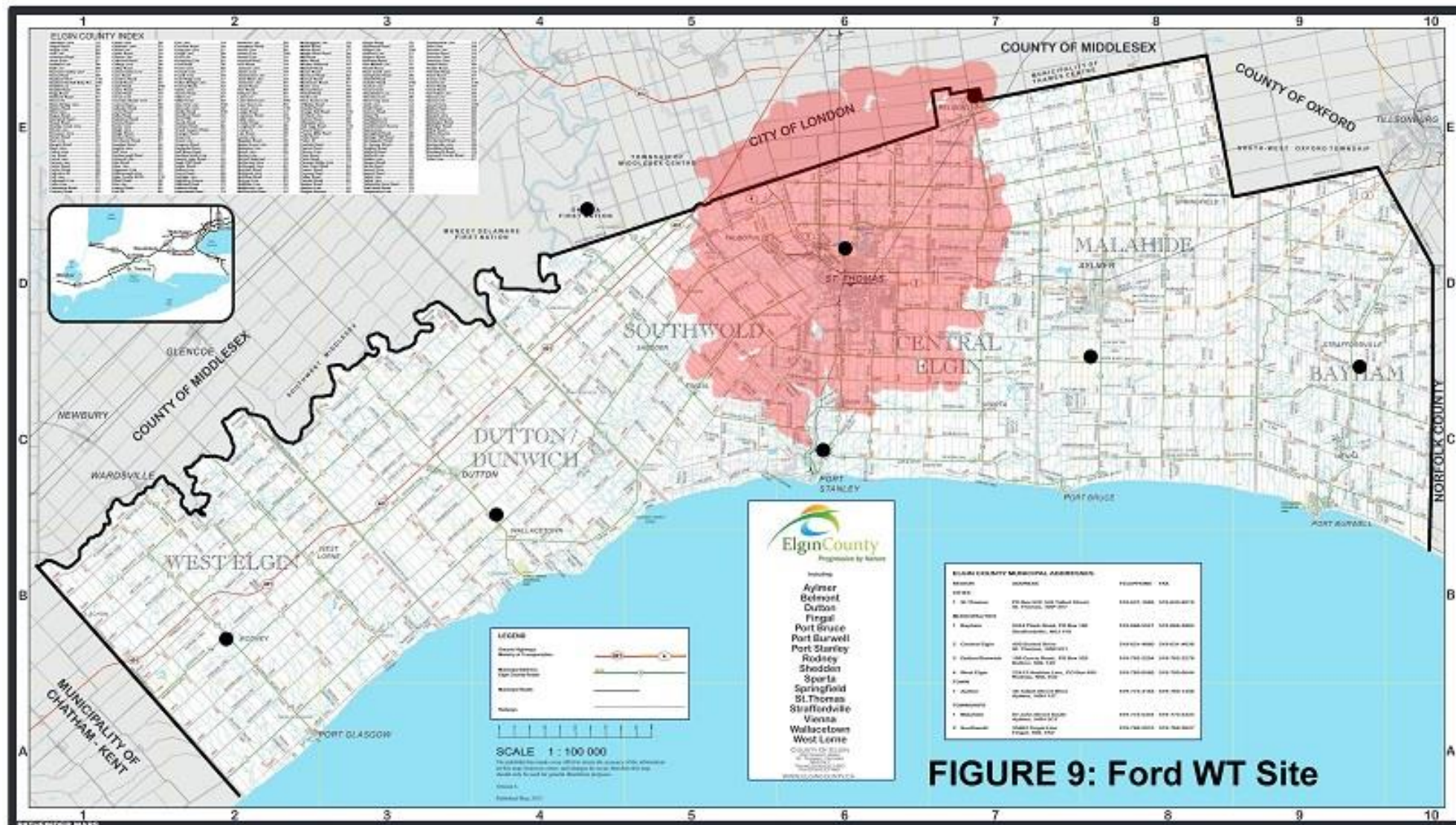


FIGURE 6: Straffordville Site







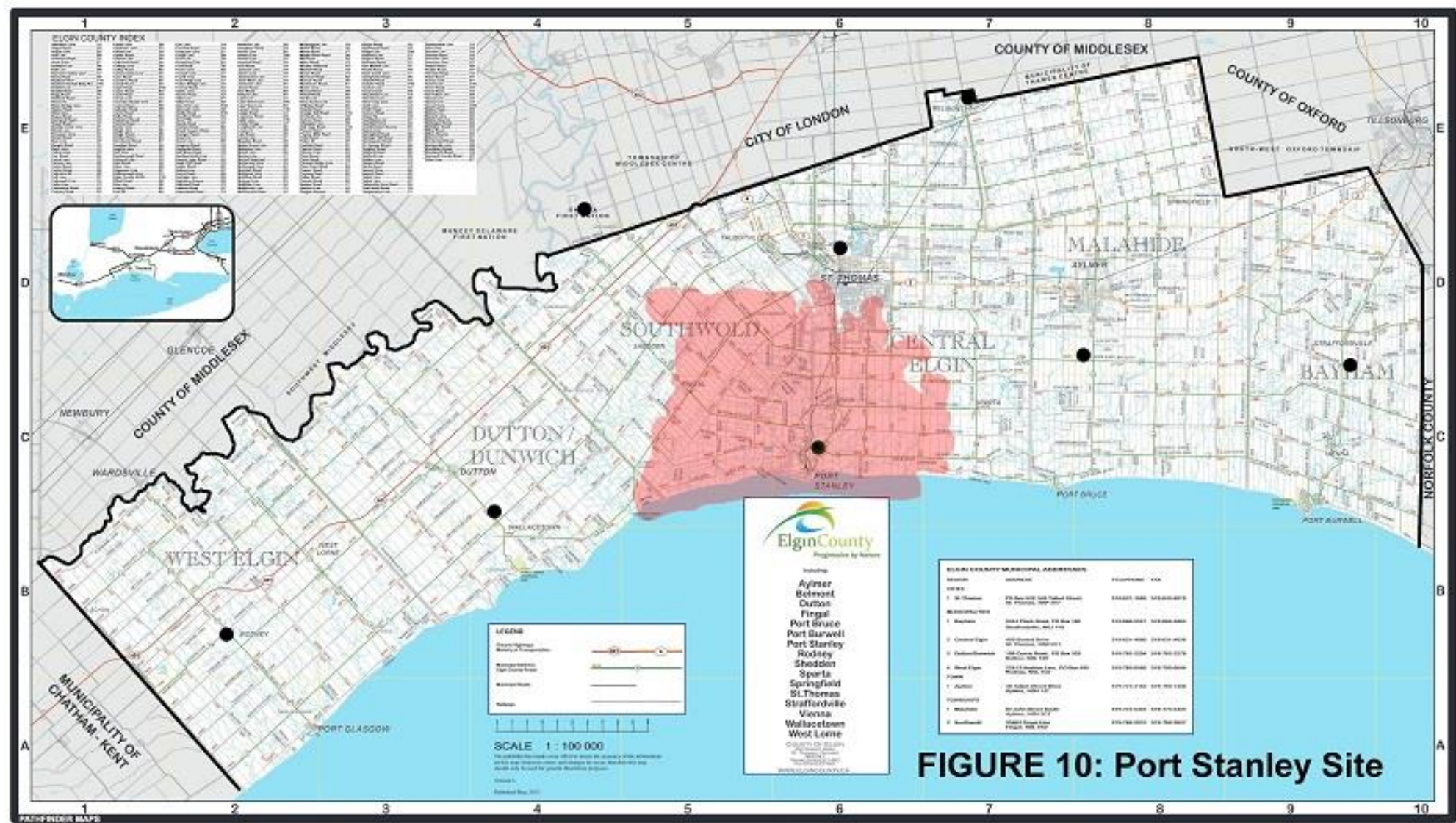


FIGURE 10: Port Stanley Site

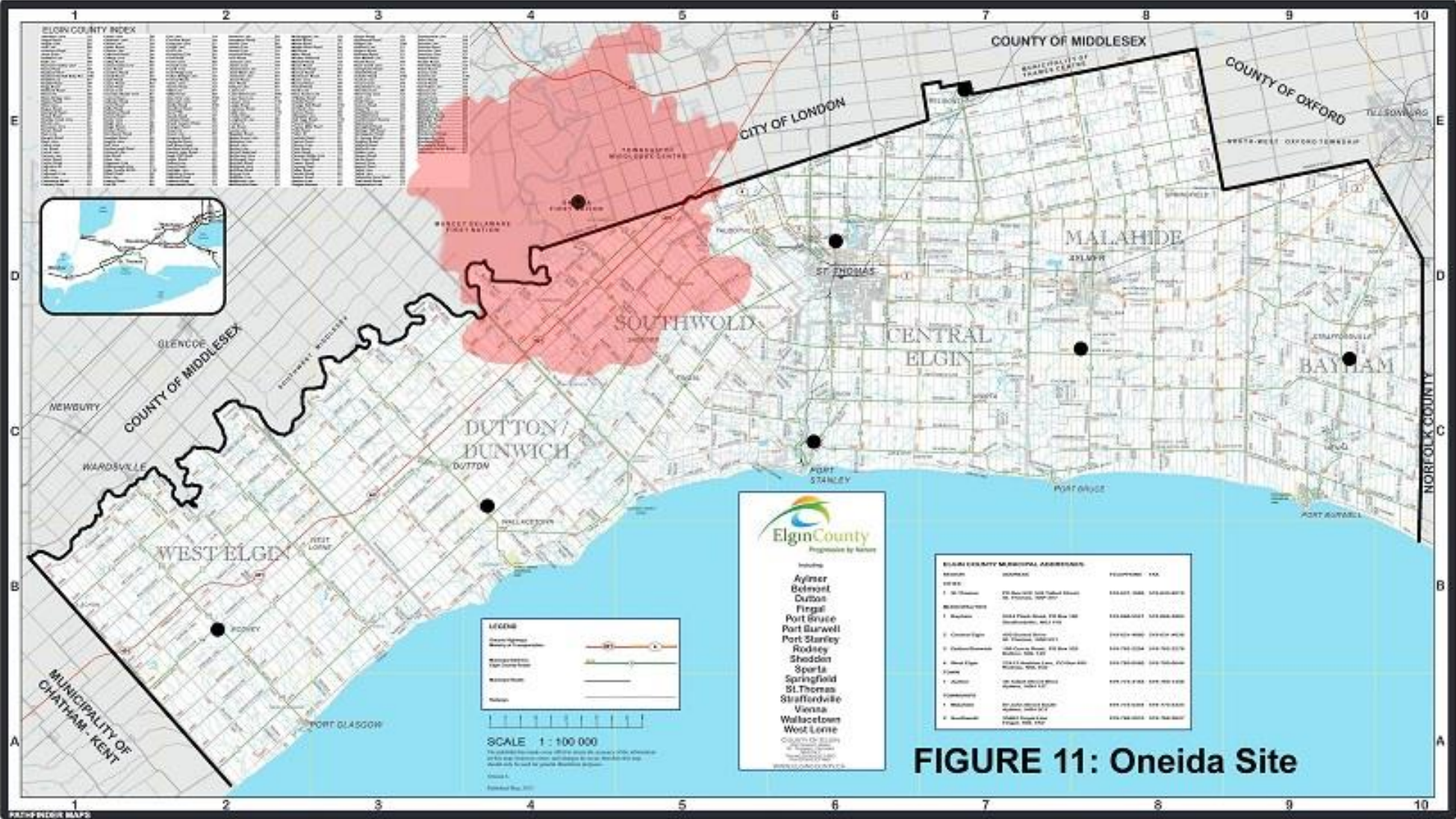
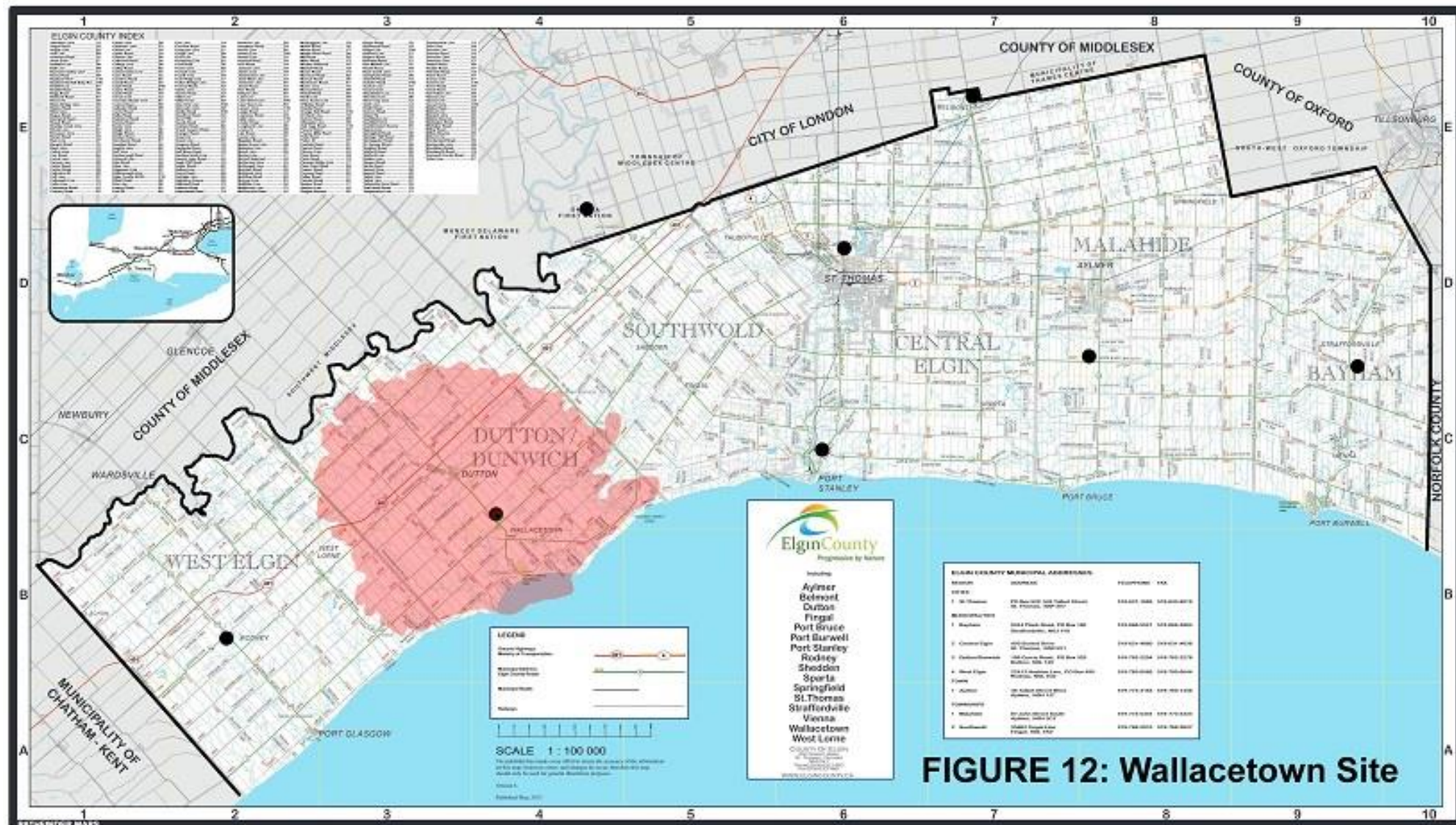
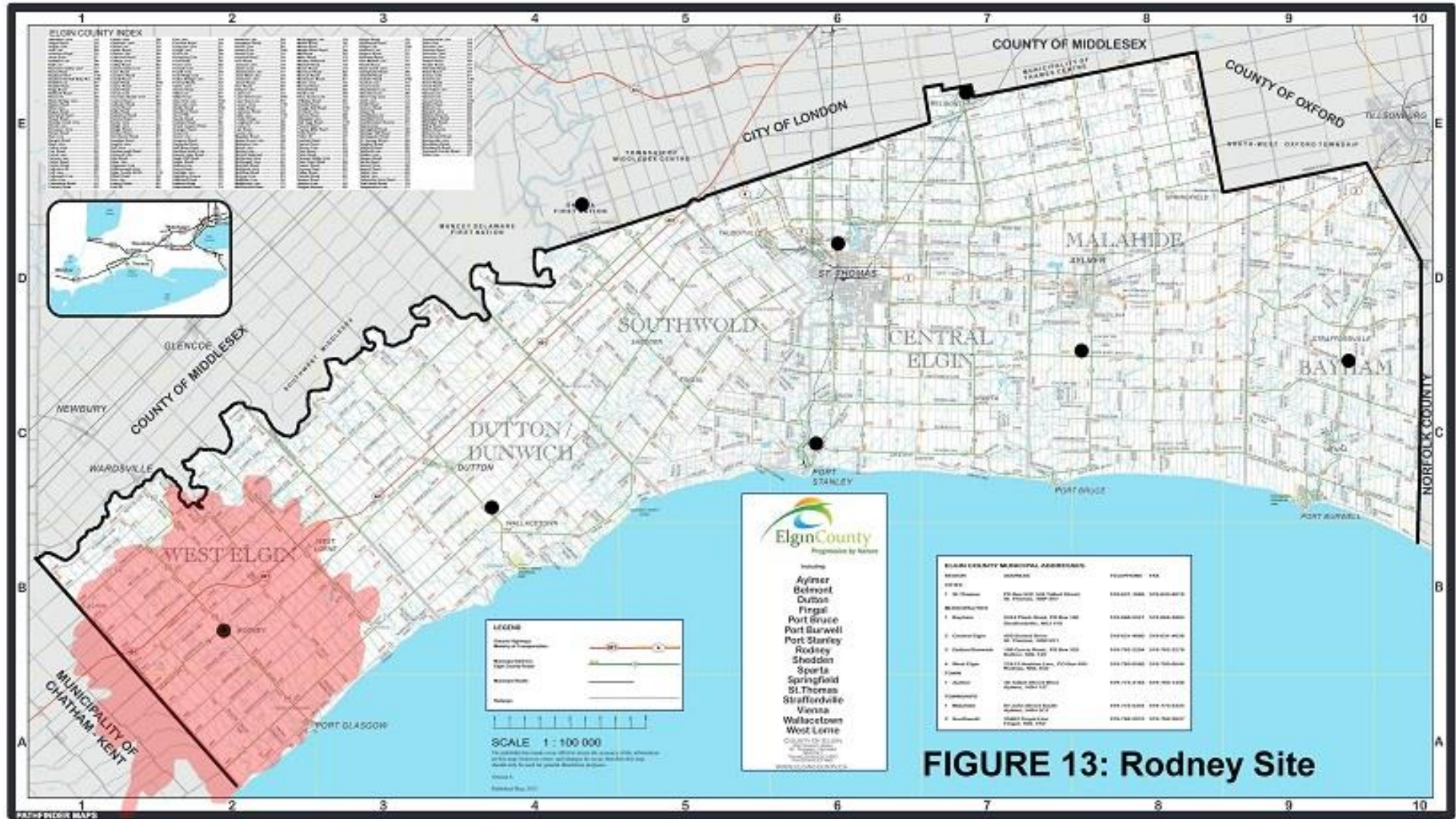


FIGURE 11: Oneida Site





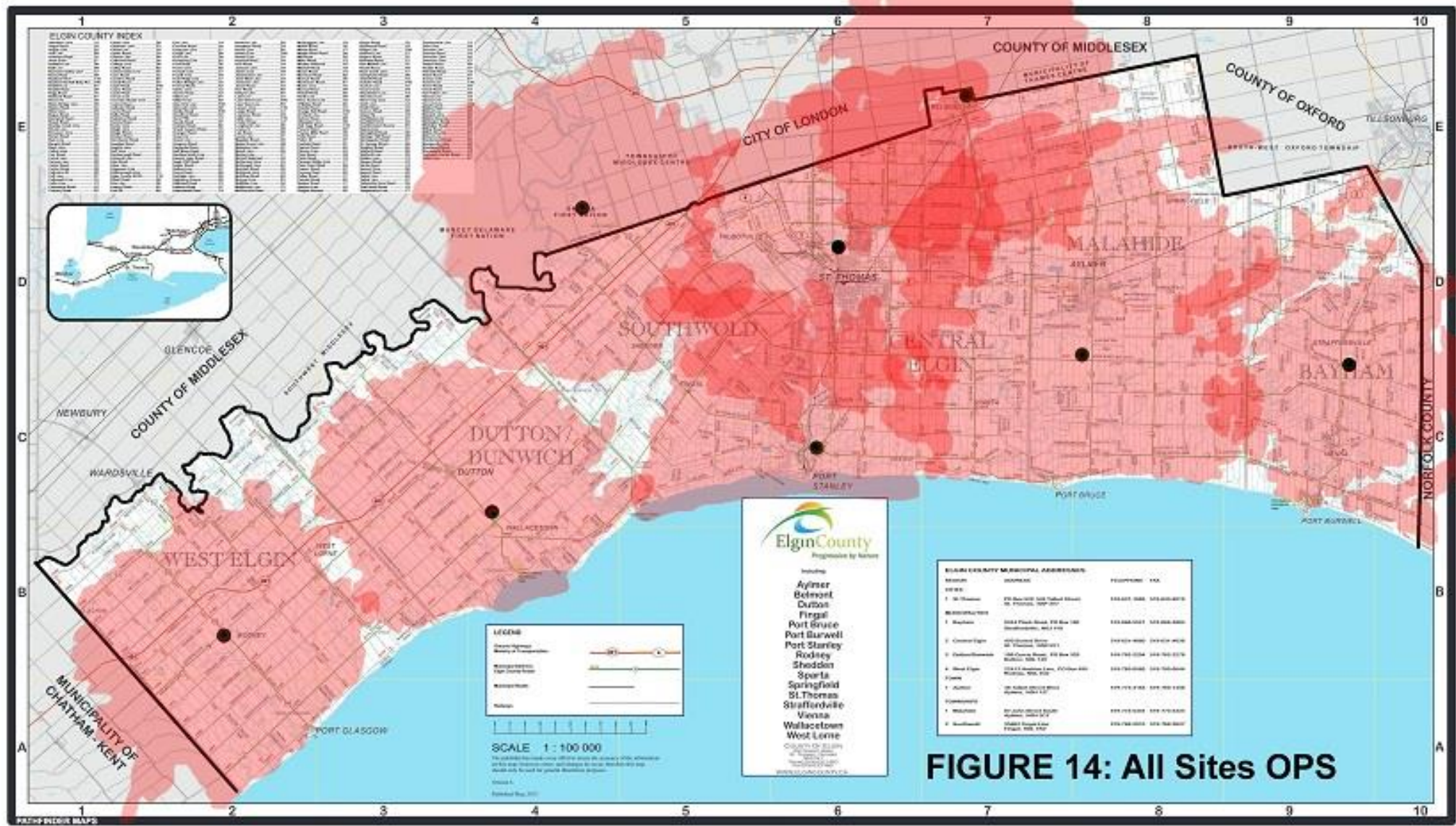


FIGURE 14: All Sites OPS

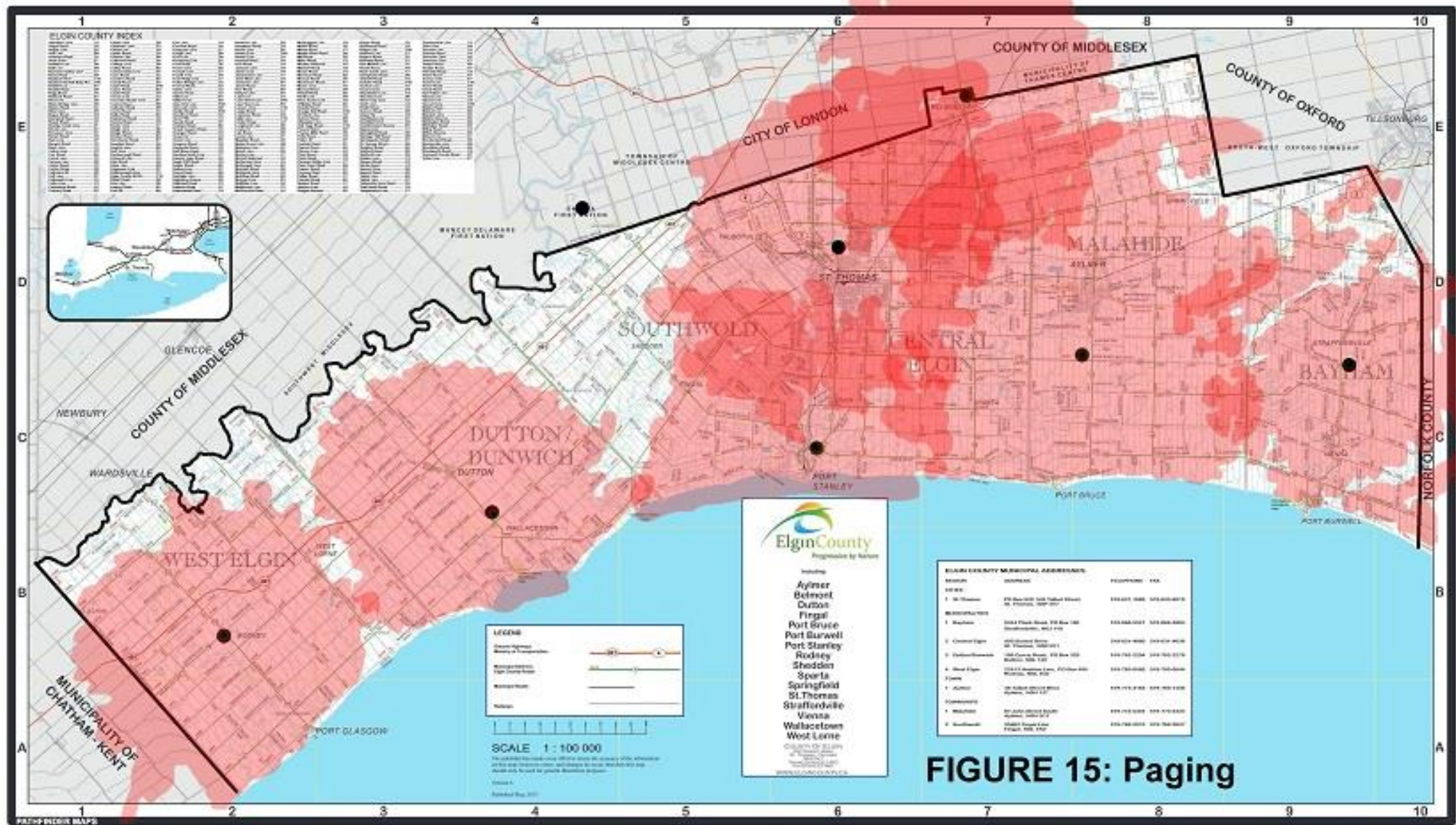


FIGURE 15: Paging

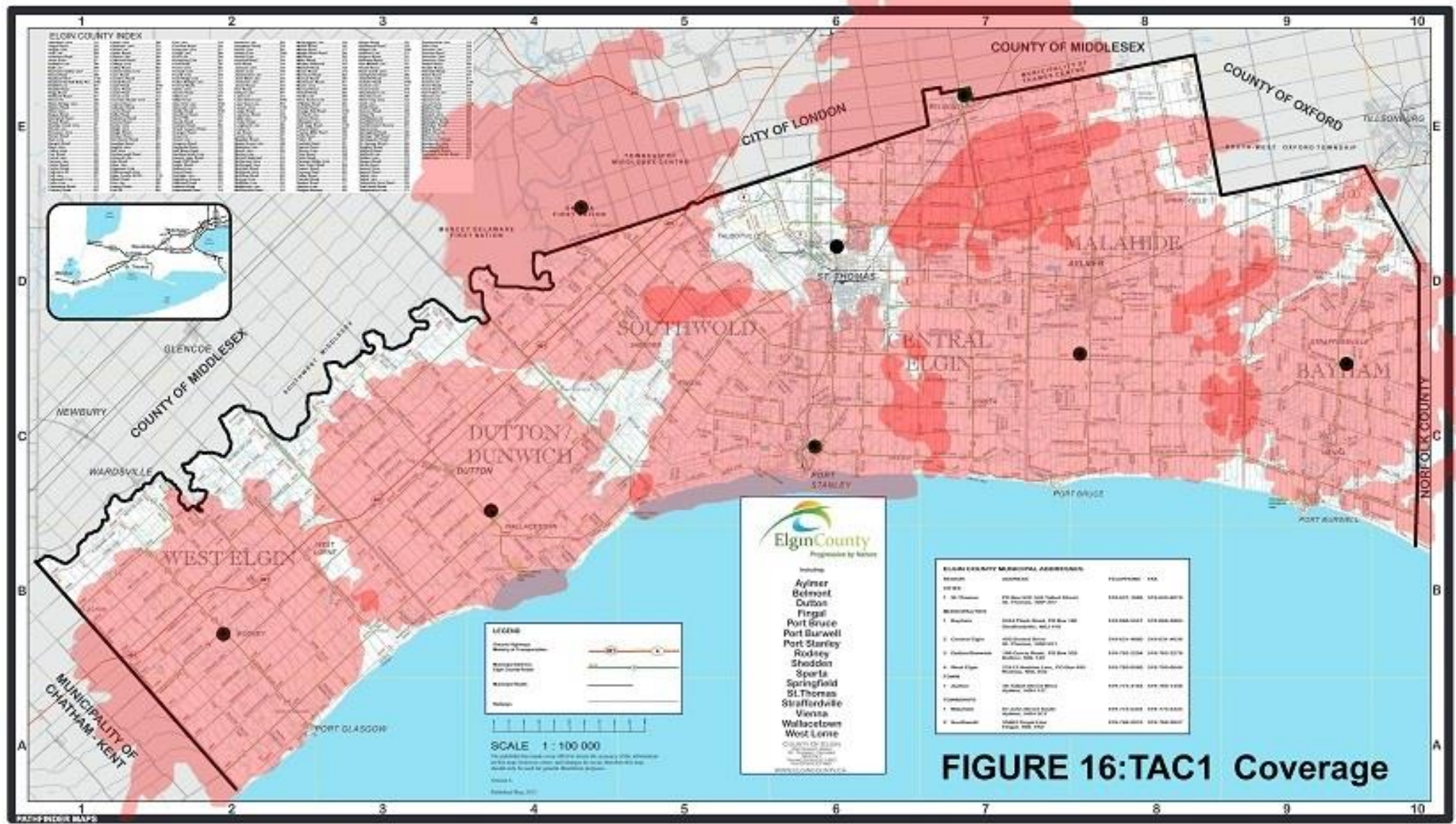


FIGURE 16:TAC1 Coverage