Conseil de la radiodiffusion et des télécommunications canadiennes
Canadian Radio-television and Telecommunications Commission

Ottawa, Canada
K1A 0N2

August 17, 2016

Our reference: 8621-C12-01/08

BY EMAIL

Mr. Chris Kellett
Chair – CISC Emergency Services Working Group (ESWG)
chris.kellett@eswg9-1-1.ca

Re: CRTC Staff Report on Wireless Carriers' 9-1-1 Caller Location Accuracy Performance

Dear Mr. Kellett:

The purpose of this letter is to provide the CISC Emergency Services Working Group (ESWG) with the CRTC staff report on wireless carriers' 9-1-1 caller location accuracy performance, pursuant to the monitoring process established in Telecom Decision 2015-225.[1]

In an effort to improve the location accuracy for wireless enhanced 9-1-1 (E9-1-1) calls, in Telecom Decision 2015-255, the Canadian Radio-television and Telecommunications Commission (CRTC) established a wireless E9-1-1 caller location accuracy monitoring process ("monitoring process"). As part of this monitoring process, wireless carriers were required to submit to the CRTC by 29 February 2016, their individual wireless E9-1-1 caller location accuracy performance results ("the results") for Period 2, the second measurement period of 1 August 2015 to 31 January 2016. These results were filed with the CRTC in confidence.

As set out in the above-mentioned process, Commission staff has subsequently aggregated the confidential individual company results and hereby submits the aggregated results to the ESWG so that it may review and analyse these results and provide recommendations, as appropriate, to the CRTC.

[1] Approval of the recommendations set out in CISC Emergency Services Working Group Consensus Report ESRE0068, *Wireless E9-1-1 Phase II Location Accuracy – Monitoring Process*. 12 March 2015.

As such, an English version of the report is attached. A French version of the report will be submitted to the ESWG shortly.

Sincerely,

Original signed by

Sheehan Carter
Director, Competition and Emergency Services
Telecommunications sector

cc: Joel McGrath, CRTC, 819-635-7485, joel.mcgrath@crtc.gc.ca
Renee Doiron, CRTC, 819-997-2755, renee.doiron@crtc.gc.ca

Attached: Wireless Carriers' 9-1-1 Caller Location Accuracy Performance

Wireless Carriers' 9-1-1 Caller Location Accuracy Performance Report

CRTC Staff Report of Period 2 Results

3 August 2016

This CRTC staff report is for information purposes only, and is based on information provided to the CRTC by wireless carriers.

1. Purpose

In an effort to improve the location accuracy for wireless enhanced 9-1-1 (E9-1-1) calls, the Canadian Radio-television and Telecommunications Commission (CRTC) established a monitoring process[1] whereby wireless carriers are required to periodically report on various indicators that reflect their performance in providing wireless E9-1-1 caller location information to the public safety answering points (PSAPs).

The CRTC determined that to facilitate the monitoring process, Commission staff would aggregate the wireless carriers' results and submit reports on the wireless carriers' initial and follow-up results to the CRTC Interconnection Steering Committee's Emergency Services Working Group (ESWG). Since the information provided by the wireless carriers to the CRTC is designated confidential, this would enable the ESWG, which includes wireless carriers, 9-1-1 network providers, PSAPs, and other 9-1-1 subject-matter experts, to review and analyse the aggregated results and provide recommendations, as appropriate, to the CRTC. The results contained in the reports are to be used by ESWG to review the minimum and target thresholds as appropriate.

2. Executive Summary

The aggregated results for wireless carriers for Period 2 (1 August 2015 to 31 January 2016) indicate that at the national and provincial levels wireless E9-1-1 location systems exceeded the minimum thresholds and minimum yield during the reporting period. This is consistent with results for Period 1 (1 May to 31 July 2015). Period 2 results also exceeded the target threshold and in several cases showed significant improvements over provincial Period 1 results. At the PSAP level, there were only a few isolated instances in which wireless carriers did not meet the minimum thresholds and minimum yield in some PSAP serving areas. These wireless carriers provided their analysis of their results and reasons why they were unable to meet them. The main reasons provided were as follows:

i) some of the PSAPs are located in areas where the wireless carriers had very few cell sites, which limited the performance of their network-based location determination technology, whenever the 9-1-1 caller did not have a Global Positioning System (GPS)-enabled mobile handset;

ii) wireless carriers were unable to exclude test calls that were conducted during the reporting timeframe, which may have negatively affected their results;

iii) some of the PSAPs had not properly configured their internal systems, which negatively impacted the wireless carriers' results;

iv) one wireless carrier had an inefficiently configured 9-1-1 network that negatively impacted routing of 9-1-1 calls and subsequently, their results;

v) one wireless carrier reported that a database corruption negatively impacted their results; and

[1] For more information on this monitoring process and how it was developed, please see Appendix 1.

vi) Within one PSAP, investigation showed one unsubscribed[2] handset generated over 33% of all the locates for Period 2, while another wireless carrier reported that over 27% of 9-1-1 wireless calls were made by unsubscribed or unregistered[3] handsets of which 20% did not generate successful locates.

The wireless carriers in question indicated they expect their results in most of these instances to be above the minimum thresholds and minimum yield during the next reporting period, since most of the issues that negatively affected their results would be resolved. They also indicated that they expect that as the projected penetration of Assisted GPS-enabled[4] mobile handsets among their customer base increases, more accurate 9-1-1 caller location information would likely be provided.

The wireless carriers stated that they would continue to work with 9-1-1 network providers and PSAPs to resolve the issues that adversely impacted their location accuracy performance results.

As per the monitoring process, the ESWG is to review the aggregated results and accompanying information provided in this report and provide recommendations, as appropriate, to the CRTC.

3. Introduction

Effective access to emergency services is critical to the health and safety of citizens, and is an important part of ensuring that Canadians have access to a world-class communication system. Accordingly, the CRTC is continuously looking for ways in which emergency telecommunications services can be improved.

As part of this effort, the CRTC, working with 9-1-1 stakeholders, established an annual monitoring process in which it will monitor wireless carriers' 9-1-1 caller location accuracy performance (referred to hereafter as "the monitoring process").[5] The monitoring process involves the ongoing measurement and compilation of wireless carriers' 9-1-1 caller location accuracy performance results based on E9-1-1 calls made by their subscribers. This process will enable the CRTC and 9-1-1 stakeholders to observe any progress made within the industry, and carriers to compare their own results with other wireless carriers and against the industry average.

As part of the monitoring process, the CRTC also established wireless location performance minimum and target thresholds. Each wireless carrier is required to meet the minimum

[2] An unsubscribed handset is a mobile device for which there is no valid service contract with any commercial mobile radio service provider.

[3] Unregistered handsets have service contracts but have not registered with the serving network (e.g., 9-1-1 dialled immediately after handset turned on and before registering with the network).

[4] Assisted-GPS (A-GPS) location technology is a mobile handset-based position location technology, through which readings are taken from GPS satellites and nearby cellular base stations (towers), with the help of a location server on the network, to determine the location of a caller.

[5] For more information on the monitoring process and how it was developed, please see Appendix 1.

threshold and is to aspire to reach the target threshold. In addition, wireless carriers are required to meet the minimum yield, which is the minimum percentage of successful wireless E9-1-1 caller location coordinates provided to a PSAP from a given number of valid wireless E9-1-1 location requests during the reporting period. The results contained in this report are to be used by ESWG to review the minimum and target thresholds as appropriate.

The CRTC also required all wireless carriers, on an ongoing basis, to monitor their network accuracy performance, perform integrity testing and validation of their wireless network(s), and maintain (e.g. calibrate, upgrade, and validate) their location determination equipment.

Wireless E9-1-1 location technology

Wireless carriers in Canada have deployed advanced commercially available location systems based on GPS and network-based technologies. Specifically, carriers use Assisted-GPS, in combination with network-based technologies, such as Advanced Forward Link Trilateration (AFLT)[6] and Cell ID + Round Trip Time (CI-RTT),[7] with the combination considered by the industry to be the best location technology available on the market.

However, all existing location determination technologies have limitations; consequently, they are only able to provide high location accuracy results in certain situations, and not consistently in all scenarios. Further advances in location determination technology are required to substantially increase wireless E9-1-1 location accuracy in all scenarios, given that numerous factors impact the accurate determination of a wireless E9-1-1 caller's location. These factors include the following:

- environment (e.g. weather and tree cover);
- physical geography (e.g. urban/rural, surrounding tall buildings, underground, or terrain);
- situational (e.g. the 9-1-1 caller is indoors, outdoors, in motion, or stationary); and
- mobile handset ("handset") characteristics (e.g. GPS capability, battery charge, and signal strength).

Terminology used in this report

The following are some of the key terms used to describe wireless location information and parameters.

a. Estimated latitude and longitude coordinates

[6] AFLT is a network-based technology used to determine a caller's location, through which the handset measures signals from nearby cellular base stations (towers), which are then used to triangulate an approximate location of the handset.

[7] CI-RTT is another network-based technology used to determine a caller's location that also relies on measurements of signals from nearby cellular base stations (towers) to triangulate an approximate location of the handset.

These are the latitude and longitude coordinates that indicate the estimated location of a wireless E9-1-1 caller, which are provided by wireless carriers to PSAPs during a wireless E9-1-1 call.

b. Uncertainty value (Uncertainty)

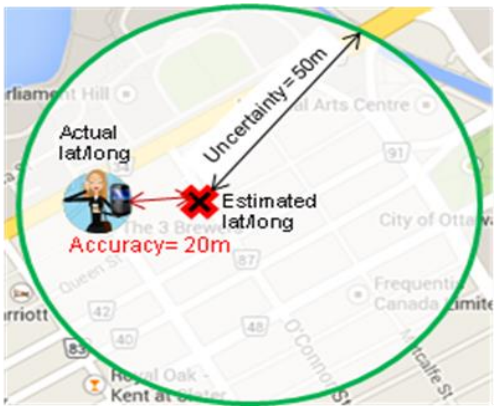
Uncertainty, which is expressed in metres, is a location system parameter that indicates the outer limits of the area around the latitude and longitude coordinates of a wireless handset. Uncertainty can be used by emergency responders to estimate the possible radius of a search area, if a 9-1-1 caller is not located at or near the latitude/longitude coordinates provided. The Uncertainty varies with each wireless E9-1-1 call. The lower the Uncertainty, the better.

c. Confidence level

Confidence, which is expressed as a percentage, indicates the likelihood that the 9-1-1 caller is located at the latitude and longitude coordinates provided, and within the possible location area defined by the Uncertainty. The Confidence level is fixed for all wireless E9-1-1 calls, since the CRTC requires wireless carriers to provide a 9-1-1 caller's location with a 90% Confidence level.[8]

d. Accuracy

Accuracy is defined as the difference between the estimated latitude and longitude coordinates (lat/long in the diagram below) of the calling handset and its actual latitude and longitude coordinates at the time the 9-1-1 call was placed. Accuracy is measured in metres (m). The smaller the number, the better the location accuracy performance.



[8] See Telecom Regulatory Policy 2009-40.

e. 30-second timer to provide location

The CRTC requires wireless carriers to provide a 9-1-1 caller's location within 30 seconds of a wireless E9-1-1 call.[9] If the wireless carrier is not able to determine the location within 30 seconds, it is required to provide the 9-1-1 call taker with a response indicating that the 9-1-1 caller's location could not be determined.

f. Minimum yield

Yield is defined as a percentage of successful wireless E9-1-1 caller location coordinates provided to a PSAP from a given number of valid wireless E9-1-1 location requests during the reporting period. In order to ensure that wireless carriers' location systems are providing wireless E9-1-1 caller location information for as many 9-1-1 calls as possible, all wireless carriers' are required to meet a minimum yield of 95% or higher.[10]

A number of factors could lead to wireless carriers' location systems not being able to determine a 9-1-1 caller's location. In these situations, wireless carriers inform 9-1-1 call takers that the location could not be provided. These include situations in which the location system exceeds the 30-second timer.

The rest of this report will provide information about: the methodology used for measuring, evaluating, and aggregating wireless carrier location accuracy performance; and the aggregated wireless carriers' results with accompanying charts and tables in the Appendices 2 and 3.

4. Methodology for measuring, evaluating, and aggregating wireless carrier location accuracy performance

a. Using Uncertainty to measure location accuracy performance

The limitation of measuring accuracy is that it is not feasible to measure the accuracy of the location of a real life wireless E9-1-1 caller provided to the PSAP, as this would require emergency responders to record the exact location they discovered the incident or caller. Emergency responders indicated it would not be acceptable to do so when responding to emergencies, as they would necessarily be focused on providing assistance and not on taking accuracy location measurements. In addition, there is no process established between PSAPs and emergency responders to report back any measurements and correlate those measurements with each 9-1-1 call made. Consequently, in the monitoring process, Uncertainty is used to monitor wireless carriers' overall location accuracy performance.

While Uncertainty is not the same as accuracy, the Uncertainty generated by wireless carriers' location systems is, nonetheless, a good proxy for accuracy. This is because Uncertainty is over

[9] See Telecom Regulatory Policy 2009-40.

[10] See Telecom Decision CRTC 2014-662.

a large sample size statistically related and proportional to accuracy. The lower the Uncertainty, the higher the accuracy.

The benefits of measuring and monitoring Uncertainty are as follows: Uncertainty results constitute real-time/live results as seen by 9-1-1 call takers for each 9-1-1 call, where the calculation is possible. These real-time measurements can therefore provide indicators of potential location determination degeneration (e.g. after system upgrade or modification). This approach also enables PSAPs to collect and analyze 9-1-1 call information to determine whether Uncertainty measurements fall within the best practices range or minimum thresholds, and if not, PSAPs can work directly with wireless carriers to take immediate actions to improve accuracy.

Therefore, the monitoring process and the results in this report are based on E9-1-1 calls made by wireless carriers' subscribers. Consequently, the results reflect real-world scenarios, including calls made both indoors and outdoors, calls made from handsets that may or may not have GPS capabilities, as well as the use of different types of network technology and location determination systems.

b. Minimum and target thresholds

The CRTC has established wireless location accuracy performance minimum and target thresholds for all wireless carriers.[11] Each wireless carrier has to meet a minimum threshold and aim for the target threshold, measured by the percentage number of times the Uncertainty provided with location information for wireless E9-1-1 calls had an Uncertainty of less than 150 m and less than 1000 m in each PSAP area they served, (see Table 1 below). These two Uncertainty values indicate wireless carriers' performance relative to the low (less than 150 m) and high end (less than 1000 m) of the spectrum of expected Uncertainty values.

The minimum and target thresholds are segregated based on whether the PSAPs in question are large metro[12] or small/rural PSAPs[13] (see Table 1 below). This is because of the difference in the performance of location systems in each of those types of areas, due to factors including the environment (e.g. weather and tree cover), physical geography (e.g. urban/rural, surrounding tall buildings, underground building floors, and type of terrain), and situational factors (e.g. the 9-1-1 caller is indoors, outdoors, in motion or stationary).

[11] See Telecom Decision CRTC 2014-662.

[12] Large metro PSAPs serve areas that are census metropolitan areas, which encompass a very large urban area (known as the urban core), together with the adjacent urban and rural areas that have a high degree of social and economic integration with the urban core. A metropolitan area has an urban core population of at least 100,000, based on the last census.

[13] Small/rural PSAPs serve areas with an urban core population of less than 100,000, because it is either a mostly rural area or a small urban area.

Table 1: Wireless E9-1-1 location accuracy minimum and target thresholds					
Thresholds established		**Threshold categories**			
		Uncertainty <150 m for rural/small PSAPs	**Uncertainty <150 m for Large metro PSAPs**	**Uncertainty <1000 m for rural/small PSAPs**	**Uncertainty <1000 m for Large metro PSAPs**
% number of times location info from E9-1-1 calls provided by a wireless carrier, was below Uncertainty level in threshold category	**Minimum threshold**	33%	33%	60%	72%
	Target threshold	48%	48%	74%	86%
Note: The target thresholds are based on the mean Uncertainty measurements. These are the initial minimum and target thresholds, and will be reassessed and fine-tuned over time as necessary, for example, as location determination technologies evolve and improve.					

The initial national minimum and target thresholds were set by the CRTC based on the recommendations of wireless carriers, PSAPs, and other 9-1-1 stakeholders in the CRTC interconnection Steering Committee (CISC) Emergency Services Working Group (ESWG).

The minimum and target thresholds enable (i) carriers to compare their own performance relative to the minimum and target thresholds and the industry average, (ii) the CRTC, wireless carriers, and PSAPs to observe any progress made within the industry, and (iii) the CRTC to reassess the minimum and target thresholds as necessary to improve performance. Therefore, in the long run, the monitoring process will ensure that wireless carriers location systems are able to provide the most accurate 9-1-1 caller location possible. This will be beneficial to the health and safety of Canadians, as it will enable emergency responders to quickly go to the location of an emergency and provide the needed assistance.

c. Methodology to aggregate wireless carriers' results

Wireless carriers are required to report to the CRTC the percentage of location requests from wireless E9-1-1 calls, where the location Uncertainty value provided to the PSAP was below the various Uncertainty values, in the minimum and target threshold categories in Table 1 above, for each PSAP that provides wireless E9-1-1 service in the wireless carrier's serving territory. The wireless carriers are also required to aggregate their results on a provincial and national basis. The wireless carriers submitted their initial Period 1 results based on their data collected over the three-month period of 1 May 2015 to 31 August 2015.

In February 2016, the wireless carriers were required to submit to the CRTC follow-up reports with their results, based on Period 2 data collected between 1 August 2015 and 31 January 2016. Thereafter, the wireless carriers are required to submit reports annually by the end of February of each year for the data collected in the preceding year.

CRTC staff has aggregated all of the wireless carriers' Period 2 results to show their combined performance at the national, provincial, and PSAP levels. CRTC staff compiled aggregated tables, histograms, and normal distribution charts of the results for each minimum and target threshold category. These tables and charts show the national distribution of all the location accuracy performance results reported by all wireless carriers, and their performance compared to the minimum and target thresholds (see Appendix 2). In the two cases where there were only one or two wireless carriers in a PSAP serving area, this information could not be provided in an aggregated form that would maintain the confidentiality of the information. As a result, the aggregated results at the PSAP level for these two PSAPs are not included in Appendix 3 of this report.

In addition, CRTC staff has calculated the weighted average of the combined results of all wireless carriers at the national, provincial, and PSAP levels. The weight used in calculating the weighted average was the reported number of times location information was successfully provided to PSAPs, as a result of wireless E9-1-1 calls. The results for Period 1 have been restated in this report (compared to the Period 1 Report issued 22 January 2016) as the formula to calculate weighted averages of combined results was adjusted to more accurately associate Rural/Small accuracy results with the number of times Rural/Small location information was successfully provided to PSAPs. A similar adjustment was made to the formula for Large/Metro weighted averages. The impact on the results is very small, usually within one percentage point of the previous result.

5. Summary of wireless carriers' aggregated results and their analyse of their results

The aggregated results for wireless carriers for Period 2 indicate that at the national and provincial levels wireless E9-1-1 location systems exceeded the minimum thresholds and minimum yield during the reporting period. This is consistent with results for Period 1. Period 2 results also exceeded the target threshold with significant improvements in several cases in provincial Period 1 results. At the PSAP level, there were only a few isolated instances in which wireless carriers did not meet the minimum thresholds and minimum yield in some PSAP serving areas. The following are the analysis and explanations provided by wireless carriers regarding those instances, as well as the aggregated results of all wireless carriers' submissions.

a. Minimum and target thresholds

Table 2 below illustrates the aggregated results[14] of all wireless carriers on a national and a provincial basis. The results indicate that the wireless carriers exceeded, on a national level, the minimum and target thresholds in all cases. They also indicate that, on a provincial level, the minimum thresholds were exceeded in all cases and target thresholds in all cases but one (New Brunswick), for Period 2.

Table 2: Aggregated national and provincial results for all wireless carriers for each minimum and target threshold category indicating the percentage of location results from E9-1-1 calls reported and the percentage Yield

	<150m for Rural / Small PSAPs		<150m for Large / Metro PSAPs		<1000m for Rural / Small PSAPs		<1000m for Large / Metro PSAPs		Successful Locate Count		Locate Failure Count for all wireless carriers		% Yield (Successful Locates percent of total)	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Minimum threshold	33%	33%	33%	33%	60%	60%	72%	72%					95%	95%
Target threshold	48%	48%	48%	48%	74%	74%	86%	86%					95%	95%
National	**68.0%**	**68.1%**	**64.8%**	**64.7%**	**80.5%**	**81.3%**	**93.4%**	**91.2%**	**1,570,052**	**2,742,472**	**41,702**	**78,869**	**97.4%**	**97.2%**
British Columbia	67.1%	65.7%	64.4%	63.8%	79.3%	79.0%	87.2%	86.5%	211,966	373,677	3,744	8,139	98.3%	97.9%
Alberta	69.6%	69.0%	66.1%	65.5%	79.6%	79.8%	89.0%	88.6%	195,988	354,616	3,719	6,934	98.1%	98.1%
Saskatchewan	52.9%	57.6%	62.7%	62.2%	72.1%	78.6%	89.6%	93.3%	46,093	83,188	2,622	4,113	94.6%	95.3%
Manitoba	78.0%	77.4%	67.7%	66.5%	85.4%	85.1%	92.2%	92.0%	49,316	84,551	1,930	3,039	96.2%	96.5%
Ontario	67.7%	68.5%	65.3%	65.7%	85.3%	85.5%	91.7%	92.2%	552,998	892,746	9,001	17,219	98.4%	98.1%
Quebec	69.3%	68.9%	63.8%	63.6%	81.8%	81.9%	92.5%	93.5%	463,918	867,386	19,995	38,346	95.9%	95.8%
New Brunswick	64.8%	65.1%	63.8%	66.0%	76.1%	77.4%	81.7%	83.7%	19,903	36,023	316	447	98.4%	98.8%
Nova Scotia	63.4%	64.7%	63.9%	66.0%	75.9%	77.1%	89.0%	90.5%	26,070	44,338	343	567	98.7%	98.7%
Prince Edward Island	62.2%	66.9%			76.6%	81.5%			3,800	5,947	32	65	99.2%	98.9%

The wireless carriers' aggregated results on a per-PSAP basis indicate that the wireless carriers exceeded on an aggregated basis the minimum threshold for all PSAPs. In most cases, the wireless carriers also exceeded the target threshold on a per-PSAP basis. A detailed breakdown of the aggregated results, by PSAP, is available in Appendix 3.

[14] Results were reported by each wireless carrier on a national, provincial, and per-PSAP basis. These results were then aggregated for all wireless carriers.

As indicated in Table 3 below, there were only four instances[15], or 0.5% of all instances, in which wireless carriers individually did not meet the minimum threshold in three PSAP serving areas. To respect the confidentiality of the information they provided, these PSAPs will be referred to in this report as PSAP A, PSAP B, and PSAP C.

Table 3: The number and percentage of instances in which wireless carriers' results were below the minimum and target thresholds

	Uncertainty <150m for Rural / Small PSAPs		<150m for Large / Metro PSAPs		<1000m for Rural / Small PSAPs		<1000m for Large / Metro PSAPs		% Yield	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Minimum Threshold	0	0	1 or 0.5%	1 or 0.5%	3 or 2%	2 or 1%	1 or 0.5%	1 or 0.5%	34 or 9%	52 or 14%
Target Threshold	4 or 2%	1 or 0.5%	3 or 2%	1 or 0.5%	29 or 15%	25 or 13%	43 or 22%	37 or 19%		

Of the four instances reported in Period 2 in which the wireless carriers did not meet the minimum thresholds, two instances occurred in the serving area of PSAP A, one in the serving area of PSAP B, and one in the serving area of PSAP C.

The wireless carriers that reported these four instances indicated that the following factors impacted their ability to meet the minimum and target thresholds:

i. Some of these PSAPs are located in areas where the wireless carriers have very few cell sites, with extensive distance between cell sites. This means that the wireless carriers' ability to use network-based methods to determine location was limited. This is particularly a concern in cases where the 9-1-1 caller does not have a handset that could determine location using handset-based A-GPS technology and had to rely on network-based methods.

ii. A vast majority of the wireless E9-1-1 calls made were delivered to two PSAPs without the benefit of A-GPS. The wireless carriers indicated that despite the fact that A-GPS is their primary 9-1-1 location determination technology, and that most of their subscribers have A-GPS-enabled handsets, for PSAP A, only 16% of 9-1-1 callers' locations were determined using A-GPS, and 48% for PSAP B. The steady increase in the use of AGPs-enabled handsets (from 2010 to 2015 percent of AGPS handset rose from 32% to 75%) is expected to continue which will result in the decline of the number of inferior locates sent to PSAPs.

iii. For one PSAP, 246 locates (33% of the total of 747) were generated from one single unregistered. Investigation is underway to determine the owner/user of this handset. Although not specific to one of the three PSAPs that did not meet the minimum thresholds, one wireless carrier determined that 27% of all wireless 9-1-1 calls made during Period 2 in their serving territory were made by unsubscribed or unregistered

[15] The total of four instances is determined from Table 3 by summing the P2 results for the four categories; 0 for Uncertainty < 150m for Rural/Small PSAPs, 1 for <150 M for Large/Metro PSAPs, 2 for <1000m for Rural/Small PSAPs and 1 for <1000m for Large/Metro PSAPs

handsets, of which over 20% did not generate a successful locate (which represents 5% of total calls).

b. Yield of the successful provision of wireless E9-1-1 caller location to PSAPs

The results submitted by the wireless carriers indicate that the aggregated national and provincial Yields were above the 95% minimum yield. At a per-PSAP level, wireless carriers were able to successfully provide wireless E9-1-1 callers' location including latitude and longitude co-ordinates, for more than 95% of valid location requests from wireless E9-1-1 calls, to all but eleven PSAPs. For the wireless carriers that fell below the 95% minimum yield, the results were close to the minimum yield with eight PSAPs at 94%, 93% for one PSAP and 92% for two PSAPs (see table in Appendix 3).

Wireless carriers also submitted that in 52 instances (or 14% of all instances) in which the wireless carriers did not individually meet the 95% minimum yield in a PSAP serving area. In most of these instances, the Yield results were close to 95% or above 90%.

The wireless carriers that did not meet the 95% minimum yield submitted the following explanations:

i. Most commonly, major network and system upgrades were being undertaken by either the wireless carriers, the PSAPs, or the 9-1-1 network providers within the measurement period. This resulted in (i) a much-higher-than-usual number of test calls to 9-1-1, which the wireless carriers submitted could not be filtered from live 9-1-1 calls and which were included in the wireless carriers' results as errors, and (ii) the minimum yield not being met in some PSAP serving areas where the testing was being conducted.

ii. In many instances, PSAPs had improperly configured computer-aided dispatch (CAD) systems for testing and implementation of the In-call Location Update (ICLU) feature[16]. Some PSAPs' CAD software was configured to automatically make an ICLU request, with the timer well below the 35-second minimum time interval after the previous location request. Any locate requests sent within the 35-second time interval would potentially result in an error, whereby the 9-1-1 location information is not provided 9-1-1 call taker, and therefore negatively affects wireless carriers' yield results. ICLU is set-up for manual ICLU requests by the 9-1-1 call taker, configuration of automatic ICLU requests is not supported, and cause a significant number of error messages. Discussions with the PSAPs involved are underway to ensure their CAD systems are configured properly

iii. One wireless carrier discovered a database corruption issue that intermittently impacted the success locate yield for the better part of Period 2 and was experienced through areas across Canada. The issue has been resolve and future yield requirements should be met.

[16] A feature that allows 9-1-1call takers to request an updated location information of a wireless E9-1-1 caller. The updated location information enables 9-1-1 call takers to receive the new location of a caller who, for example, is in motion or has changed location, and therefore assist emergency agencies in responding to the emergency.

iv. One wireless carrier found that although their 9-1-1 calls are routed to PSAPs in a robust manner, there is too much complexity in the call flow which negatively affects the timeliness of call delivery. The wireless carrier has initiated a project to interconnect directly with the 9-1-1 service provider which improve call flow, processing times and, ultimately, yield results.

6. Conclusion

In general, the results indicate that, for Period 2, wireless carriers are meeting, and often exceeding, both the minimum and target thresholds at the national, provincial, and PSAP levels.

For the isolated instances in which individual wireless carriers did not meet the minimum thresholds and minimum yield in a particular PSAP's serving area, the wireless carriers have provided explanations as to why they were unable to meet a minimum threshold.

The wireless carriers in question indicated that for most instances, they expect their results to be above the minimum thresholds or minimum yield in the next reporting period, since most of the issues that negatively affected the results would likely be resolved. For example, 9-1-1 network providers and wireless carriers are working with PSAPs to fix the PSAPs' ICLU configuration, in accordance with the way the ICLU feature was designed. Some of the PSAPs have already fixed their CAD systems, and others are in the process of doing so.

The wireless carriers in question also indicated that for the PSAPs located in areas where wireless carriers have very few cell sites, with extensive distances between cell sites, they expect that an increase in the penetration of A-GPS-capable handsets will enable them to provide more accurate 9-1-1 caller location information since A-GPS is highly reliable when used in these types of areas.

The wireless carriers indicated that they expect to continue to work with 9-1-1 network providers and PSAPs to resolve the issues that adversely impacted the performance of their 9--1-1 caller location systems or their location accuracy performance results.

The continued monitoring of such results is important to enable wireless carriers to compare their results with the industry average so that individual carriers may seek to improve their results. Additionally, it will enable the CRTC and 9-1-1 stakeholders to observe the wireless industry's progress in improving the accuracy of the 9-1-1 caller location information delivered to PSAPs.

Pursuant to the monitoring process approved by the CRTC in Telecom Decision 2014-415[17] and Telecom Decision 2015-225,[18] CRTC staff provides this report to the ESWG. The ESWG is to review and analyze the aggregated results and accompanying information provided in this report and provide recommendations, as appropriate, to the CRTC.

[17] Approval of the recommendations set out in CISC Emergency Services Working Group Consensus Report ESRE0064, *Wireless E9-1-1 Phase II Location Accuracy Requirements in Canada*. 16 January 2014.

[18] Approval of the recommendations set out in CISC Emergency Services Working Group Consensus Report ESRE0068, *Wireless E9-1-1 Phase II Location Accuracy – Monitoring Process*. 12 March 2015.

Appendix 1: Establishment of monitoring process

In Telecom Regulatory Policy 2009-40, the CRTC required wireless carriers to implement wireless Phase II enhanced 9-1-1 (E9-1-1) service, wherever wireline E9-1-1 is available across Canada. This new service provided substantial public safety improvements by enabling the transmission to PSAPs of a wireless E9-1-1 caller's location that was much more precise. The wireless E9-1-1 caller's location was to be determined through wireless E9-1-1 location technologies using handset-based GPS or network-based trilateration technologies.

In Telecom Regulatory Policy 2014-342, the CRTC set out its 9-1-1 action plan, which includes key initiatives aimed at enhancing 9-1-1 services. One of these initiatives is to improve the 9-1-1 caller location information provided by wireless carriers to PSAPs.

In Telecom Decision 2014-415, the CRTC approved the CISC ESWG's proposed national minimum and target thresholds that wireless carriers must meet to measure their performance in wireless E9-1-1 caller location accuracy.[19] The CRTC also required all wireless carriers, on an ongoing basis, to monitor their network accuracy performance; perform integrity testing and validation of their wireless network(s); and maintain (e.g. calibrate, upgrade, and validate) their location determination equipment.

The CRTC also requested that the ESWG submit a report for CRTC approval, within six months of the date of that decision, outlining a recommended monitoring process regarding the wireless E9-1-1 caller location accuracy performance of all wireless carriers.

In Telecom Decision 2015-255, the CRTC approved the CISC ESWG's recommended monitoring process that created a standard format and methodology for collecting and reporting the results of wireless carriers' E9-1-1 caller location accuracy performance.[20] The aim of the process was to enable wireless carriers, the CRTC, and other 9-1-1 stakeholders to analyze wireless carriers' location accuracy performance, make changes to the minimum and target thresholds as appropriate, and for wireless carriers to take remedial actions when necessary or when the minimum thresholds are not being met.

The CRTC also directed wireless carriers to provide, by 31 August 2015, the initial report of their wireless E9-1-1 caller location accuracy results for all PSAPs that provide wireless E9-1-1 service in the wireless carrier's serving area. The initial report was to include the aggregated results for each province the wireless carrier serves, and was to be based on data collected by the wireless carrier covering 1 May to 31 July 2015. Wireless carriers were also directed to submit follow-up reports to the CRTC in February 2016 based on data from 1 August 2015 to 31 January 2016, and thereafter to submit reports annually by the end of February.

[19] Wireless E9-1-1 Phase II Location Accuracy Requirements in Canada, Version 1.0, 16 January 2014 (ESRE0064)

[20] Wireless E9-1-1 Phase II Location Accuracy – Monitoring Process, Version 1.0, 12 March 2015 (ESRE0068)

Appendix 2: Aggregated 9-1-1 location accuracy performance results

The histograms and normal distribution charts below are based on the results reported by wireless carriers for each PSAP in their serving territory, for Period 2, the six-month period of 1 August 2015 to 31 January 2016. To demonstrate wireless carriers' performance relative to each minimum and target threshold category, the charts and tables are based on the results for the percentage of wireless E9-1-1 calls[21] with location information that had an Uncertainty of less than 150 m or 1000 m, and by small/rural PSAPs or large metro PSAPs.

The charts and tables in sections a) to d) below show the distribution and frequency with which all wireless carriers reported various percentages of wireless E9-1-1 calls made per PSAP for each minimum and target thresholds category. For example, for section a), the charts and table shows the distribution and frequency with which all wireless carriers reported various percentages of wireless E9-1-1 calls with an Uncertainty of less than 150 m made in the serving areas of small/rural PSAPs. The X-axis represents the percentage of wireless E9-1-1 calls from a wireless carrier in a PSAP serving area, and the Y-axis represents the frequency (the number of times a particular percentage was reported) and the percentage frequency of all reported results for the particular minimum and target threshold category. This is shown as a percentage (left) and in the number of instances (right) of the histogram charts.

The charts and table in section e) show the distribution and frequency of the various Yield results reported by wireless carriers across all PSAPs. All wireless carriers reported a percentage Yield for each PSAP in their serving territory. For example, a wireless carrier reported that 99% of valid location requests from wireless E9-1-1 calls included wireless Phase II E9-1-1 location information in a particular small/rural PSAP serving area during the measurement period.

The table in section f) provides information on the maximum, minimum, mean, and standard deviation of the percentage of E9-1-1 calls reported by all wireless carriers for each minimum and target threshold category, and the reported Yield results. The maximum is the highest reported percentage of E9-1-1 calls by a wireless carrier across all PSAPs for that minimum and target threshold category, and the minimum is the lowest percentage of E9-1-1 calls reported.

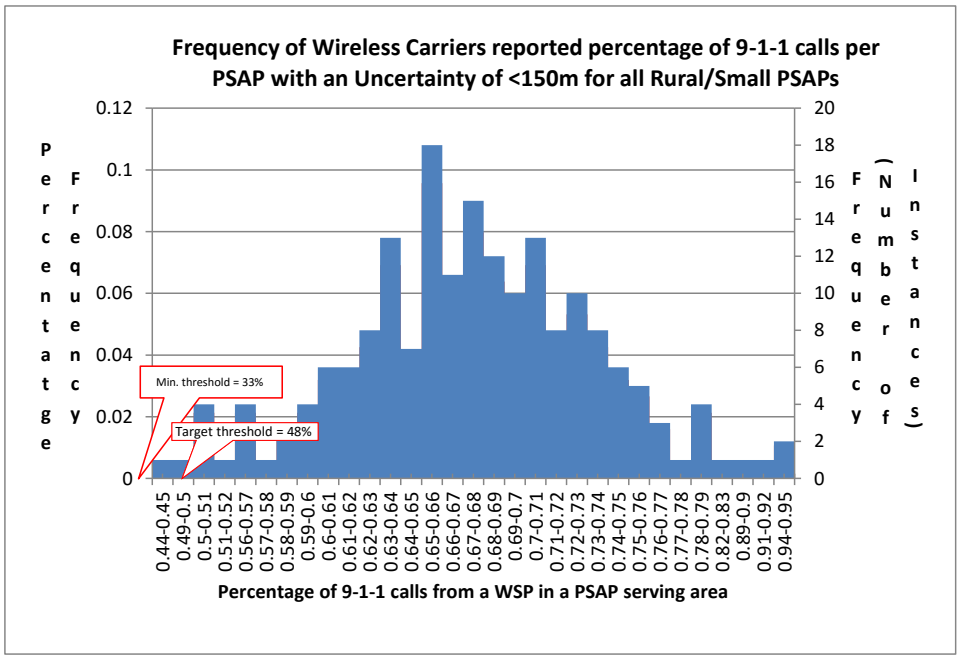
The mean is the average of all reported results for each minimum and target threshold category. The standard deviation indicates the variation or dispersion of the set of reported results in relation to the mean for each minimum and target threshold category. A standard deviation close to 0 indicates that the data points tend to be very close to the mean of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values. In a normal distribution, the mean is the same as the median.

[21] Referred to in this section, as the percentage of 9-1-1 calls, for simplicity to enable the understanding of the charts and tables. However, given that PSAPs can make a number of in-call location updates (rebid) requests per wireless E9-1-1 call, this represents the percentage number times wireless E9-1-1 call location information was provided by a wireless carrier to a PSAP, below the Uncertainty level in each threshold category.

a. Rural/small PSAPs for Uncertainty of <150 m (minimum threshold 33%, target threshold 48%)

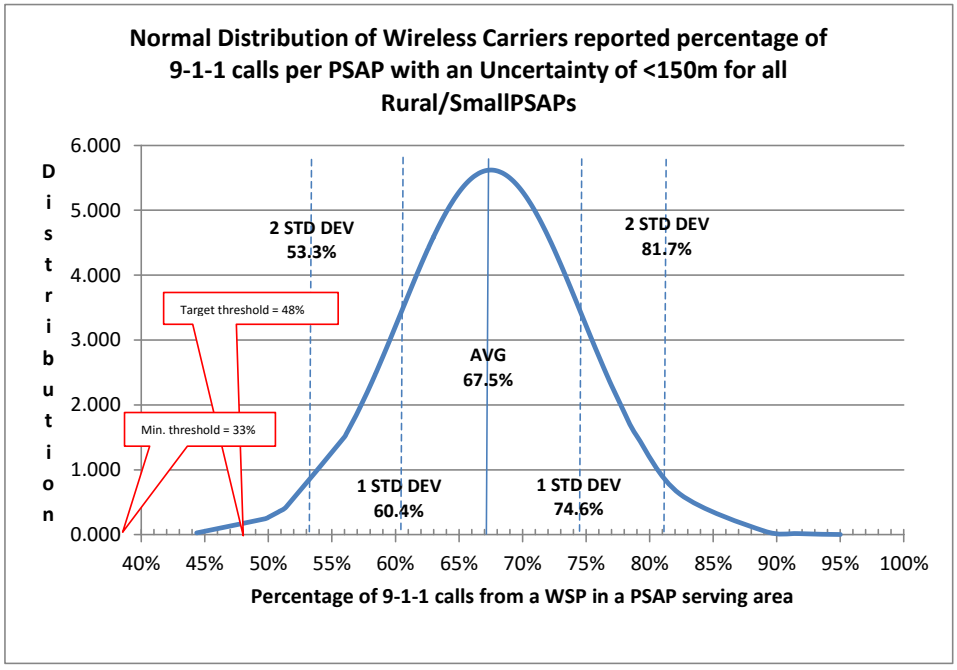
Frequency – the number of instances in which wireless carriers reported a particular percentage of 9-1-1 calls made in a PSAP serving territory for each minimum and target threshold category.

% Frequency – frequency as a percentage of the total number of instances reported for each minimum and target threshold.



Instances below Min Threshold = 0

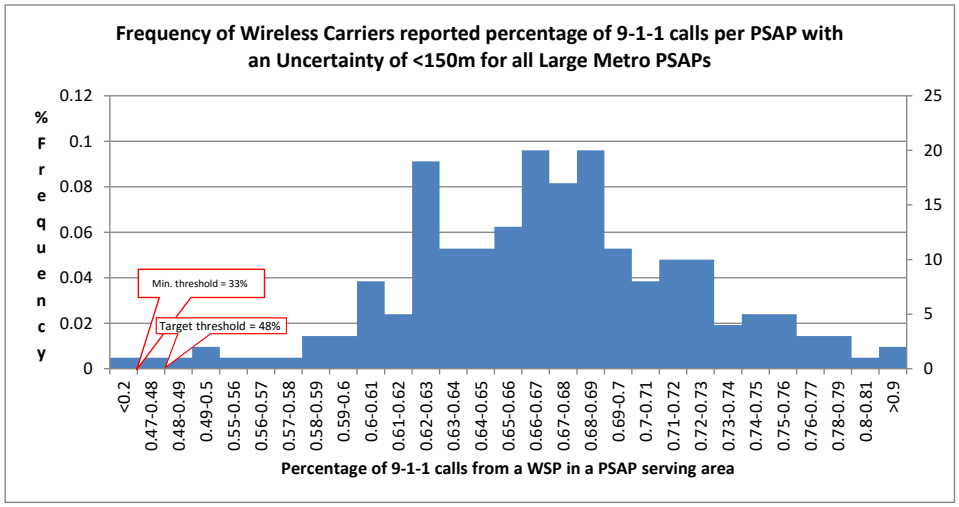
Instances below Target Threshold = 1 or 0.5 %



Mean = 67.5%
Standard Deviation =7.1%

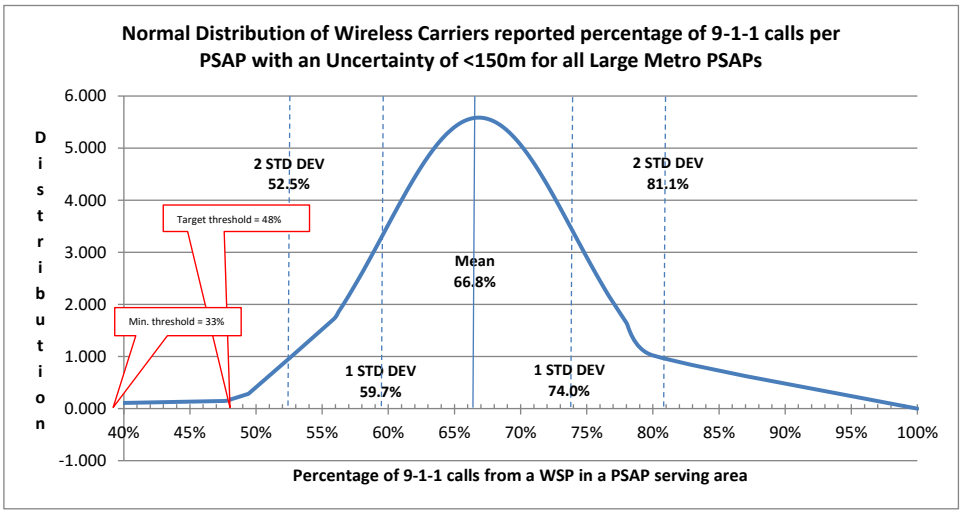
The frequency WSPs reported a certain % of 9-1-1 calls with an uncertainity of <150m for Rural / Small PSAPs		
	Values	
% of 9-1-1 calls from a WSP in a PSAP serving area	Frequency	% Frequency
0.44-0.45	1	0.53%
0.49-0.5	1	0.53%
0.5-0.51	4	2.13%
0.51-0.52	1	0.5%
0.56-0.57	4	2.1%
0.57-0.58	1	0.5%
0.58-0.59	3	1.60%
0.59-0.6	4	2.1%
0.6-0.61	6	3.2%
0.61-0.62	6	3.2%
0.62-0.63	8	4.3%
0.63-0.64	13	6.9%
0.64-0.65	7	3.7%
0.65-0.66	18	9.6%
0.66-0.67	11	5.9%
0.67-0.68	15	8.0%
0.68-0.69	12	6.4%
0.69-0.7	10	5.3%
0.7-0.71	13	6.9%
0.71-0.72	8	4.3%
0.72-0.73	10	5.3%
0.73-0.74	8	4.3%
0.74-0.75	6	3.2%
0.75-0.76	5	2.7%
0.76-0.77	3	1.6%
0.77-0.78	1	0.5%
0.78-0.79	4	2.1%
0.82-0.83	1	0.5%
0.89-0.9	1	0.53%
0.91-0.92	1	0.53%
0.94-0.95	2	1.06%
Grand Total	**188**	**100.00%**

b. Large metro PSAPs for Uncertainty of <150 m (minimum threshold 33%, target threshold 48%)



Instances below Min Threshold = 1 or 0.5%

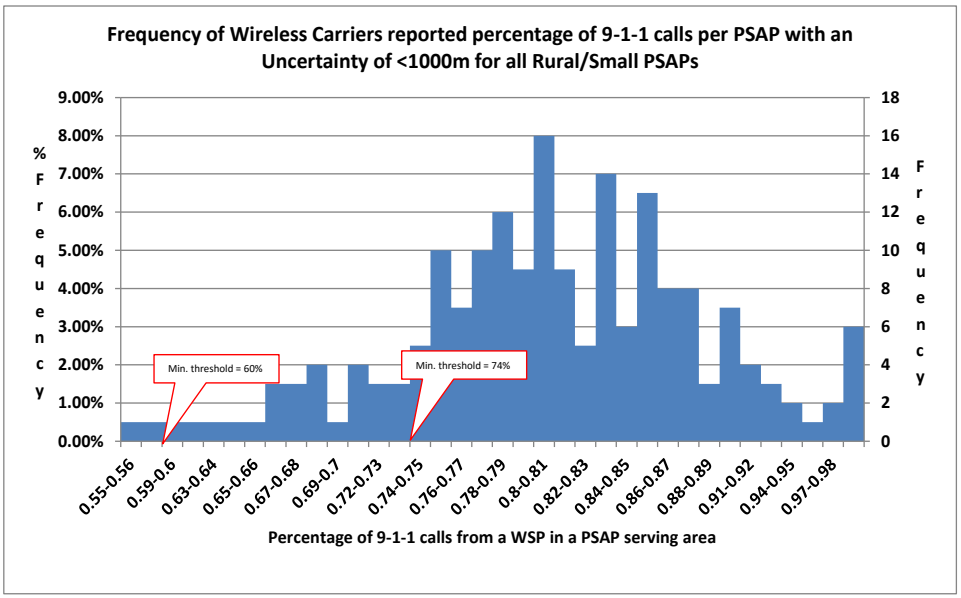
Instances below Target Threshold = 4 or 2 %



Mean = 66.8%
Standard Deviation =7.1%

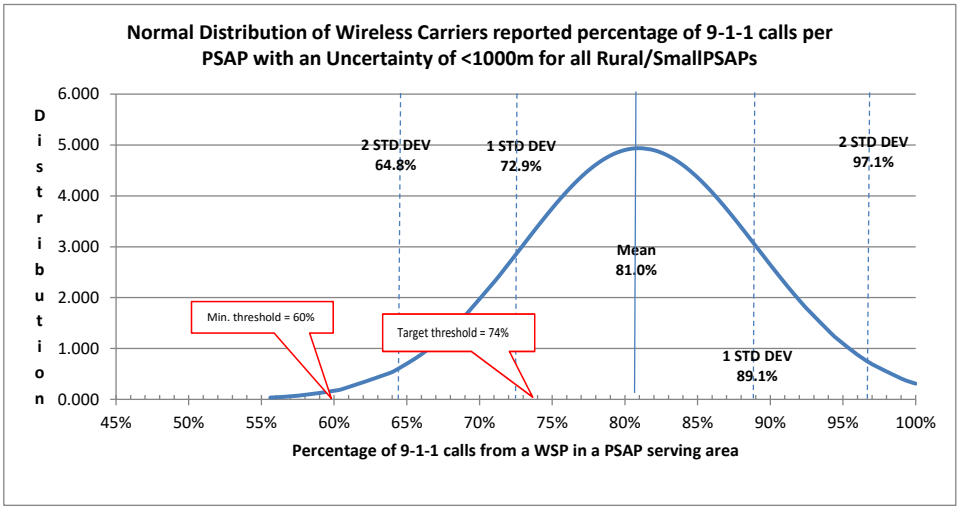
The frequency of WSPs reported percentage of 9-1-1 calls per PSAP with an uncertainty of <150m for all Large Metro PSAPs		
% of 9-1-1 calls from a WSP in a PSAP serving area	Values Frequency	%Frequency
<0.2	1	0.5%
0.47-0.48	1	0.50%
0.48-0.49	1	0.5%
0.49-0.5	2	1.00%
0.55-0.56	1	0.5%
0.56-0.57	1	0.5%
0.57-0.58	1	0.5%
0.58-0.59	3	1.5%
0.59-0.6	3	1.5%
0.6-0.61	8	4.0%
0.61-0.62	5	2.5%
0.62-0.63	19	9.5%
0.63-0.64	11	5.5%
0.64-0.65	11	5.5%
0.65-0.66	13	6.5%
0.66-0.67	20	10.0%
0.67-0.68	17	8.5%
0.68-0.69	20	10.0%
0.69-0.7	11	5.5%
0.7-0.71	8	4.0%
0.71-0.72	10	5.0%
0.72-0.73	10	5.0%
0.73-0.74	4	2.0%
0.74-0.75	5	2.5%
0.75-0.76	5	2.5%
0.76-0.77	3	1.5%
0.78-0.79	3	1.5%
0.8-0.81	1	0.50%
>0.9	2	1.00%
Grand Total	**200**	**100.00%**

c. Rural/small PSAPs for <1000 m (minimum threshold 60%, target threshold 74%)



Instances below Min Threshold = 2 or 1%

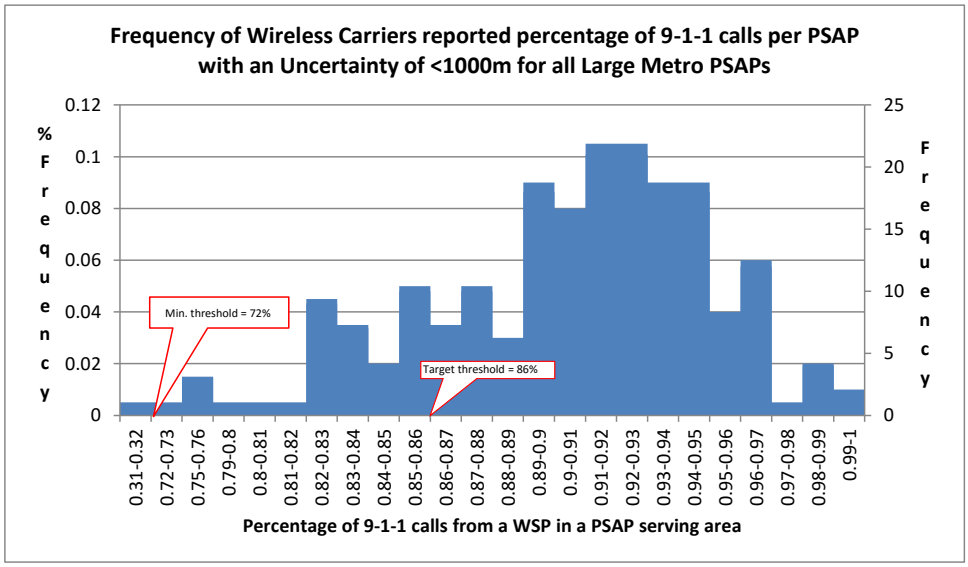
Instances below Target Threshold = 32 or 30%



Mean =81.0%
Standard Deviation =8.1%

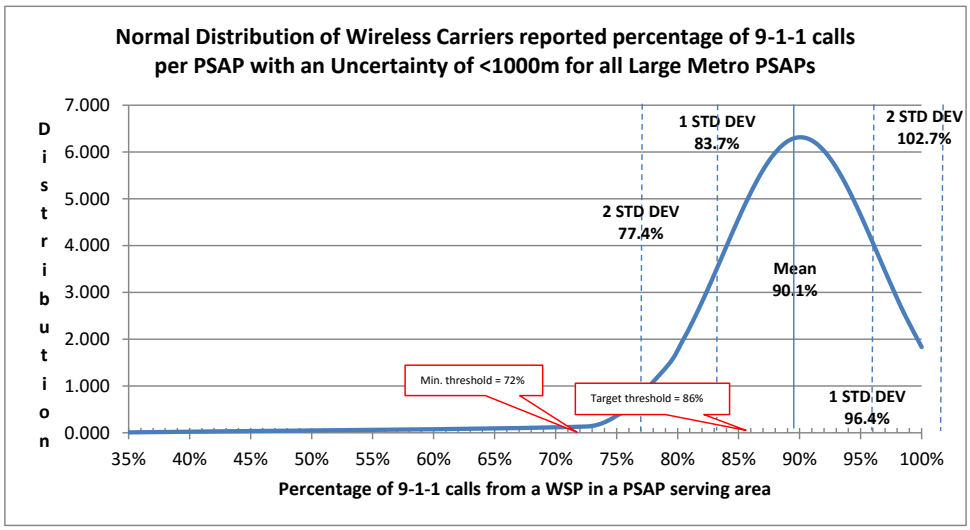
The frequency of WSPs reported percentage of 9-1-1 calls per PSAP with an uncertainty of <1000m for all Rural / Small PSAPs		
	Values	
% of 9-1-1 calls from a WSP in a PSAP serving area	Frequency	% Frequency
0.55-0.56	1	0.53%
0.57-0.58	1	0.53%
0.59-0.6	1	0.53%
0.6-0.61	1	0.53%
0.63-0.64	1	0.53%
0.64-0.65	1	0.53%
0.65-0.66	1	0.53%
0.66-0.67	3	1.60%
0.67-0.68	3	1.60%
0.68-0.69	4	2.13%
0.69-0.7	1	0.53%
0.71-0.72	4	2.13%
0.72-0.73	3	1.60%
0.73-0.74	3	1.60%
0.74-0.75	5	2.66%
0.75-0.76	10	5.32%
0.76-0.77	7	3.72%
0.77-0.78	10	5.32%
0.78-0.79	12	6.38%
0.79-0.8	9	4.79%
0.8-0.81	16	8.51%
0.81-0.82	9	4.79%
0.82-0.83	5	2.66%
0.83-0.84	14	7.45%
0.84-0.85	6	3.19%
0.85-0.86	13	6.91%
0.86-0.87	8	4.26%
0.87-0.88	8	4.26%
0.88-0.89	3	1.60%
0.9-0.91	7	3.72%
0.91-0.92	4	2.13%
0.92-0.93	3	1.60%
0.94-0.95	2	1.06%
0.96-0.97	1	0.53%
0.97-0.98	2	1.06%
0.99-1	6	3.19%
Grand Total	**188**	**100.00%**

d. Large metro PSAPs for <1000 m (minimum threshold 72%, target threshold 86%)



Instances below Min Threshold = 1 or 0.5%

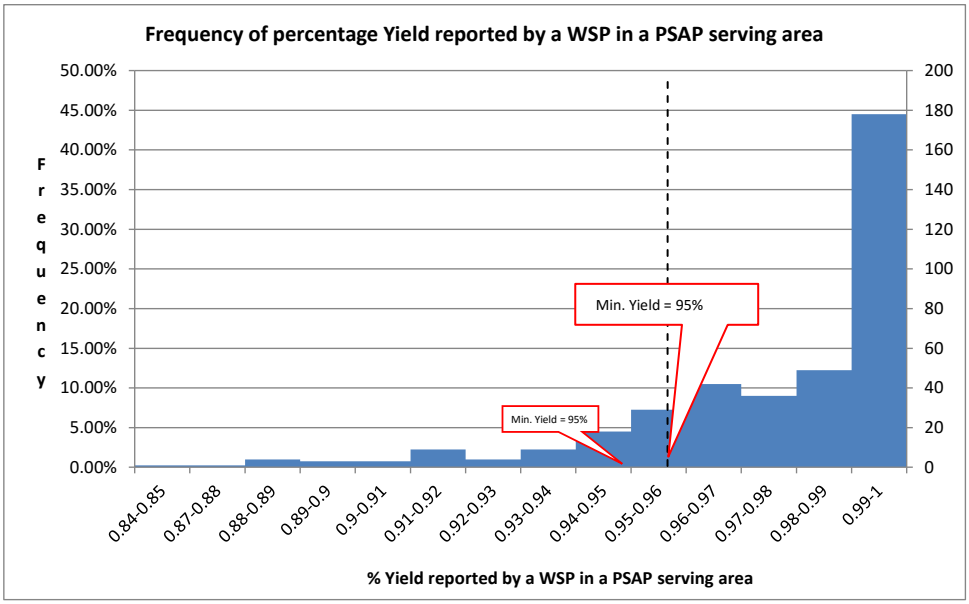
Instances below Target Threshold = 37 or 19%



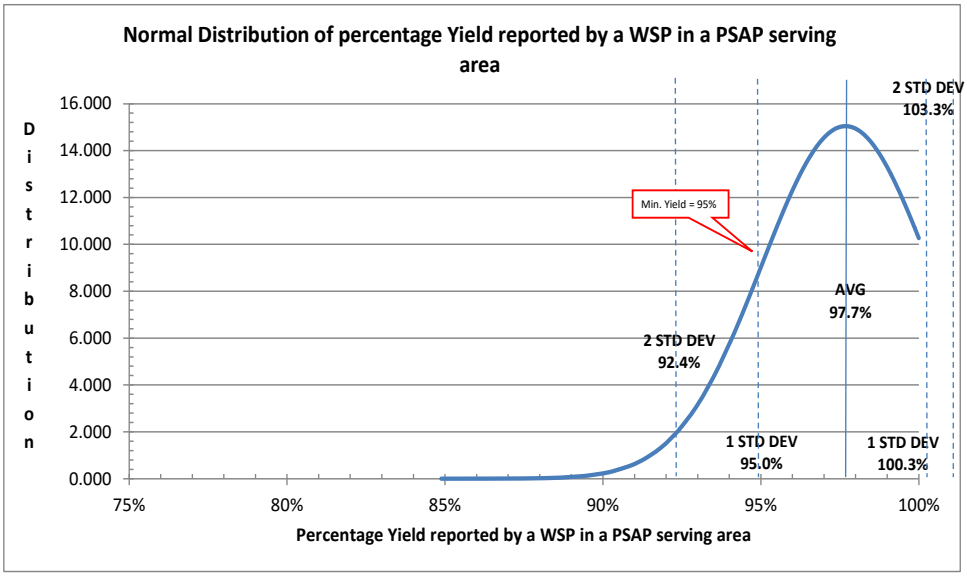
Mean = 90.1%
Standard Deviation = 6.3%

The frequency of WSPs reported percentage of 9-1-1 calls per PSAP with an uncertainty of <1000m for all Large Metro PSAPs		
	Values	
% of 9-1-1 calls from a WSP in a PSAP serving area	Frequency	% Frequency
0.31-0.32	1	0.50%
0.72-0.73	1	0.50%
0.75-0.76	3	1.5%
0.79-0.8	1	0.5%
0.8-0.81	1	0.5%
0.81-0.82	1	0.5%
0.82-0.83	9	4.5%
0.83-0.84	7	3.5%
0.84-0.85	4	2.0%
0.85-0.86	10	5.0%
0.86-0.87	7	3.5%
0.87-0.88	10	5.0%
0.88-0.89	6	3.0%
0.89-0.9	18	9.0%
0.9-0.91	16	8.0%
0.91-0.92	21	10.5%
0.92-0.93	21	10.5%
0.93-0.94	18	9.0%
0.94-0.95	18	9.0%
0.95-0.96	8	4.0%
0.96-0.97	12	6.0%
0.97-0.98	1	0.5%
0.98-0.99	4	2.0%
0.99-1	2	1.00%
Grand Total	**200**	**100.00%**

e. Yield of the successful provision of location information (minimum 95%)



Instances below Min Yield = 37 or 9.3%



Mean = 97.7%
Standard Deviation = 2.7%

Frequency of percentage Yield reported by a WSP in a PSAP serving area		
% Yield	Values Frequency of % Yield	Frequency of % Yield
0.84-0.85	1	0.26%
0.87-0.88	1	0.26%
0.88-0.89	4	1.04%
0.89-0.9	3	0.78%
0.9-0.91	3	0.78%
0.91-0.92	9	2.33%
0.92-0.93	4	1.04%
0.93-0.94	9	2.33%
0.94-0.95	18	4.66%
0.95-0.96	29	7.51%
0.96-0.97	42	10.88%
0.97-0.98	36	9.33%
0.98-0.99	49	12.69%
0.99-1	178	46.11%
Grand Total	**386**	**100.00%**

f. Table of the maximum, minimum, mean, and standard deviation of the wireless carriers' aggregated results

Maximum, minimum, mean, and standard deviation of the wireless carriers' aggregated results					
	Uncertainty <150 m for rural/small PSAPs	**Uncertainty <150 m for large metro PSAPs**	**Uncertainty <1000 m for rural/small PSAPs**	**Uncertainty <1000 m for large metro PSAPs**	**Yield**
Maximum	95.0%	100.0%	100.0%	100.0%	100.0%
Minimum	44.4%	16.7%	55.6%	31.7%	84.9%
Mean	67.5%	66.8%	81.0%	90.1%	97.7%
Standard deviation	7.1%	7.1%	8.1%	6.3%	2.7%

Maximum – the highest reported percentage of 9-1-1 calls by a wireless carrier across all PSAPs for that minimum and target threshold category.

Minimum – the lowest percentage of 9-1-1 calls reported by a wireless carrier across all PSAPs for that minimum and target threshold category.

Mean – the average of all reported results by all wireless carriers for all PSAPs for a particular minimum and target threshold category.

Standard deviation – the variation or dispersion of the set of reported results in relation to the mean for each minimum and target threshold category. A standard deviation close to 0 indicates that the data points tend to be very close to the mean of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values.

Appendix 3: Aggregated wireless carriers' results on a national and provincial basis

Aggregated national and provincial results for all wireless carriers for each minimum and target threshold category indicating the percentage of location results from E9-1-1 calls reported and the percentage Yield														
	<150m for Rural / Small PSAPs		<150m for Large / Metro PSAPs		<1000m for Rural / Small PSAPs		<1000m for Large / Metro PSAPs		Successful Locate Count		Locate Failure Count for all wireless carriers		% Yield (Successful Locates percent of total)	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Minimum threshold	33%	33%	33%	33%	60%	60%	72%	72%					95%	95%
Target threshold	48%	48%	48%	48%	74%	74%	86%	86%					95%	95%
National	**68.0%**	**68.1%**	**64.8%**	**64.7%**	**80.5%**	**81.3%**	**93.4%**	**91.2%**	**1,570,052**	**2,742,472**	**41,702**	**78,869**	**97.4%**	**97.2%**
British Columbia	67.1%	65.7%	64.4%	63.8%	79.3%	79.0%	87.2%	86.5%	211,966	373,677	3,744	8,139	98.3%	97.9%
Alberta	69.6%	69.0%	66.1%	65.5%	79.6%	79.8%	89.0%	88.6%	195,988	354,616	3,719	6,934	98.1%	98.1%
Saskatchewan	52.9%	57.6%	62.7%	62.2%	72.1%	78.6%	89.6%	93.3%	46,093	83,188	2,622	4,113	94.6%	95.3%
Manitoba	78.0%	77.4%	67.7%	66.5%	85.4%	85.1%	92.2%	92.0%	49,316	84,551	1,930	3,039	96.2%	96.5%
Ontario	67.7%	68.5%	65.3%	65.7%	85.3%	85.5%	91.7%	92.2%	552,998	892,746	9,001	17,219	98.4%	98.1%
Quebec	69.3%	68.9%	63.8%	63.6%	81.8%	81.9%	92.5%	93.5%	463,918	867,386	19,995	38,346	95.9%	95.8%
New Brunswick	64.8%	65.1%	63.8%	66.0%	76.1%	77.4%	81.7%	83.7%	19,903	36,023	316	447	98.4%	98.8%
Nova Scotia	63.4%	64.7%	63.9%	66.0%	75.9%	77.1%	89.0%	90.5%	26,070	44,338	343	567	98.7%	98.7%
Prince Edward Island	62.2%	66.9%			76.6%	81.5%			3,800	5,947	32	65	99.2%	98.9%