Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Expanding the Economic and Innovation	)	GN Docket No. 12-268
Opportunities of Spectrum Through	)	
Incentive Auctions	)	
Office of Engineering and Technology	)	
Seeks to Supplement the Incentive Auction	)	
Proceeding Record Regarding Potential	)	ET Docket No. 14-14
Interference Between Broadcast Television	)	
And Wireless Services	)	

COMMENTS OF SPRINT CORPORATION

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March 18, 2014

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COMMENTS OF SPRINT CORPORATION

I. INTRODUCTION AND SUMMARY

Sprint Corporation ("Sprint") respectfully submits these comments in response to the Public Notice issued by the Federal Communications Commission ("the Commission") on January 29, 2014, seeking to supplement the record with respect to issues concerning the 600 MHz band.[1] Sprint appreciates the efforts of the Commission's Office of Engineering and Technology ("OET") to develop a methodology for predicting interference between broadcast television and licensed wireless services ("the OET Plan").

As Sprint has consistently emphasized, the 600 MHz Incentive Auction presents an important opportunity for wireless operators to obtain critical low-band spectrum (*i.e.*, spectrum

[1] *Office of Engineering and Technology Seeks to Supplement the Incentive Auction Proceeding Record Regarding Potential Interference Between Broadcast Television and Wireless Services*, Public Notice, GN Docket No. 12-268, ET Docket No. 14-14, DA 14-98 (Jan. 29, 2014) ("*Public Notice*").

below 1 GHz). Low-band spectrum represents an especially impactful component of any operator's spectrum portfolio. Most notably, the superior propagation characteristics of bands such as the 600 MHz band enable an operator to deploy fewer cell sites to provide coverage and effective in-building penetration, resulting in significantly lower capital and operating costs and faster deployment than using higher-frequency spectrum. Precisely because of the importance of low-band spectrum, Sprint has consistently argued that the Commission should make every effort to develop a band plan that maximizes the amount of bi-directional (*i.e.*, providing both uplink and downlink capability) 600 MHz spectrum made available through the incentive auction in major markets on a nationwide or nearly nationwide basis.

As the OET Plan notes, the Commission has expressed "a strong interest in establishing a band plan framework that is flexible enough to accommodate market variation (*i.e.*, offering varying amounts of spectrum in different geographic locations, depending on the spectrum recovered) to maximize the amount of spectrum repurposed."[2] While Sprint encourages the Commission to take steps to minimize the amount of band plan variability that might occur between markets (particularly in major markets), Sprint believes it is likely that some degree of market variability is unavoidable if the Commission is to realize its goal of maximizing the amount of 600 MHz spectrum available for auction on a nearly-nationwide basis. Not permitting band plan variability between markets would likely unnecessarily and unduly restrict the amount of 600 MHz spectrum available throughout large portions of the country to the amount obtained and repurposed in a few, spectrum-constrained markets. The great pro-competitive potential of the 600 MHz band would not be realized if, for example, markets which may have less spectrum available for auction (for instance, markets along the United States/Canadian or United

[2] *Id.* at 1.

States/Mexican border with foreign broadcast operations requiring protection) drive the rest of the country – or even undue portions of the country covering a significant percentage of the population – towards a "lowest common denominator" band plan. The Commission and wireless carriers should thus strive to limit the "daisy chain" effect of limited 600 MHz availability in certain large markets.

Sprint believes that wireless operators have a number of tools that can be used to deploy and adjust their networks so as to mitigate interference problems that otherwise might exist with remaining television broadcasters on the same frequencies (*i.e.*, co-channel) in different locations, or with television broadcasters operating in the same location on nearby (*i.e.*, adjacent-channel) spectrum. Sprint believes it is critical for the Commission to clearly identify and auction any spectrum blocks in locations where there is a reasonable potential for predicted harmful interference problems to be avoided or rectified by a potential wireless licensee. The Commission should also consider taking steps to facilitate co-existence by providing wireless licensees and remaining television broadcasters sufficient regulatory flexibility to negotiate agreements to tolerate greater or lesser degrees of interference.

The OET Plan provides the basis for a reasonable approach for assessing the potential for harmful interference between the operations of forward auction winners and remaining television stations. The results of that assessment should be made readily available to forward auction participants so that bidders can assess potential harmful interference levels before making bids on any designated "impaired" spectrum.[3] *Adoption of an inter-service interference methodology*

[3] Sprint recognizes that auction of both unimpaired and impaired or restricted spectrum, as discussed *infra*, could lessen the fungibility of auctioned blocks within the 600 MHz auction. Sprint appreciates the value of auctioning fungible spectrum in terms of promoting interoperability throughout the 600 MHz band. Nonetheless, a public policy goal to promote interoperability should not undermine the Commission's separate (and overriding) public policy goal of maximizing the amount of bi-directional, paired spectrum available at auction. Focusing on

such as that contained in the OET Plan represents a far superior and spectrally efficient approach over reliance on predefined separation distances, which may be overly conservative, inflexible, and spectrally inefficient. Sprint encourages the Commission to implement the former approach, which will function as a critical component of the incentive auction process.

II. SPRINT GENERALLY SUPPORTS THE PROPOSED OET PLAN FOR AN ALTERNATIVE METHODOLOGY TO PREDICT HARMFUL INTERFERENCE BETWEEN SERVICES

As the *Public Notice* accurately describes, adopting a predictive methodology over predefined generic separation distances presents a balance between efficient spectrum use and technical certainty.[4] Sprint appreciates the effort and deliberation of OET in developing the alternative methodology and presenting it to stakeholders, both in the *Public Notice* and in the context of the OET's Inter-Service Interference Prediction Workshop.

A. The OET Plan's Parameters and Technical Assumptions Are Essentially Realistic

Sprint respectfully submits that the OET Plan for the most part adopts realistic parameters and technical assumptions. Notably, the Commission accurately identifies the four key interference scenarios implicated by a variable band plan and correctly ranks them in their order of severity and likelihood.[5] Sprint also considers the technical specifications contained in

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interoperability through spectrum block fungibility, for example, could result in the undesirable and unneeded adoption of a spectrum-constrained band plan in markets in which additional spectrum could be cleared and auctioned. As Sprint describes below, the Commission should adopt an approach that facilitates use of these interstitial areas for mobile broadband by minimizing the designation of "prohibited" areas and permitting operation in certain "restricted areas" (while also minimizing the number and size of those areas). The best approach to ensuring interoperability across the 600 MHz band is for the Commission to adopt interoperability requirements that would ensure that LTE equipment operating at 600 MHz is capable of operating on all 600 MHz channels, regardless of whether the channel is impaired on a nationwide basis, or impaired or restricted in parts of the country.

4 *Id.* at 4.

5 *Id.* at 2-4.

the OET Plan reasonable for assessing the potential for harmful interference from DTV to wireless and vice versa.[6]

With respect to selecting the appropriate propagation model for the four interference scenarios described in the *Public Notice*, Sprint supports the use of the Longley-Rice propagation model for any calculations involving DTV coverage, as well as for interference case one, DTV transmitter-into-wireless base station (uplink), and interference case two, DTV transmitter-into-wireless user equipment (downlink). Longley-Rice has been used to accurately model television signal propagation for many years, and Sprint has no reason to believe Longley-Rice wouldn't be just as accurate a model for assessing potential inter-service interference from DTV transmitters to wireless operations. Sprint, with the assistance of the telecommunications consulting engineering firm Kessler and Gehman Associates ("KGA"), also compared the predicted wireless signal levels for areas around wireless base stations using both the Longley-Rice and Hata propagation models. This comparison was done in three different markets using both F(50,50) and F(50,10) confidence levels.[7] Based on results from this modeling, Sprint finds that

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[6] *Id.* at 19-23. While Sprint considers the parameters contained in the OET Plan reasonable for the purpose of *modeling*, Sprint notes that these parameters do not necessarily precisely reflect the parameters that a wireless operator would use *in actual deployment*. For example, while Sprint concurs with the observation that a base station effective noise figure N_e of 6 dB would represent the minimum effective noise figure that might be acceptable pursuant to a 3GPP standard, Sprint (and other wireless operators) may choose to impose even lower noise figure requirements on base station vendors in order to improve network performance and coverage. Nevertheless, such an operator-specific requirement does not need to be captured in the Commission's interference assessment methodology. Rather, each auction bidder can, on its own accord, make adjustments to the interference assessment it uses to inform its bidding decisions (and deployment choices), based on its specific guidelines and expectations.

[7] The basic Hata propagation model, also known as the Okamura-Hata model, is commonly used by the wireless communications industry for predicting wireless propagation at distances of 1-20 km for frequencies between 150-1500 MHz. Several extensions to the basic Hata model have been developed over the years to extend the distances and frequency bands covered. KGA compared Longley-Rice propagation with a Hata model that had been extended for greater distances and also included the Epstein-Peterson method for handling multiple obstacle diffraction losses. F(50,50) indicates that the propagation model parameters were set so that the field strength is predicted to exceed the indicated level at 50% of the potential receiver locations for at least 50% of the time. F(50,10) indicates that the field strength is predicted to exceed the indicated level at 50% of the potential receive locations at least 10% of the time.

the Longley-Rice model yields remarkably similar results to those derived from the Hata model for the markets studied, as shown in Figures 1 and 2.[8]

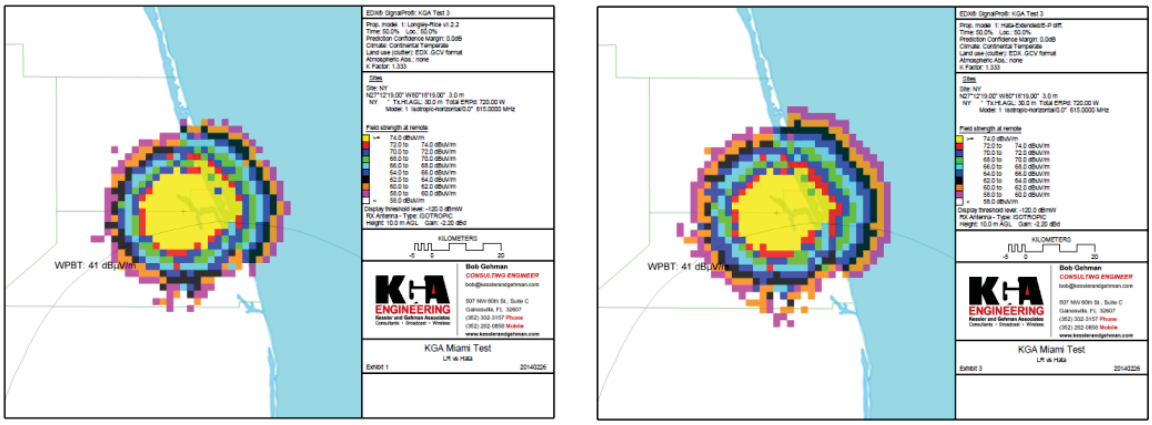

Figure 1: Longley-Rice vs. Hata F(50,50) near WPBT, Miami, FL

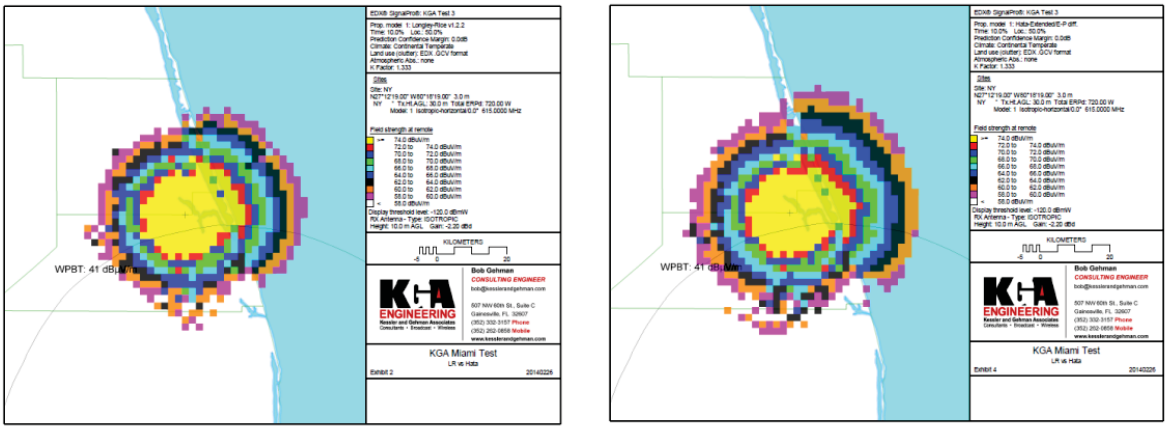

Figure 2: Longley-Rice vs. Hata F(50,10) near WPBT, Miami, FL

Accordingly, given the advantages of using a consistent methodology, Sprint also favors use of the Longley-Rice model for interference case three, wireless base station (downlink)-into-

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[8] Full size maps of the predicted signal levels using Longley-Rice and Hata models in all three markets (Miami, FL, San Jose, CA, and New York, NY) are attached.

DTV receiver interference, although Sprint remains open to further consideration of other propagation models that may be entered into the record of this proceeding. Sprint agrees with the OET Plan's suggestion that interference case four studies, involving potential wireless user equipment (uplink)-into-DTV receiver interference, are unlikely to be necessary due to the much shorter distances at which such interference could occur.

In terms of the methodology to determine DTV interference into wireless operations, Sprint generally concurs with the proposed methodology to determine the level of harmful interference from a co- and adjacent-channel DTV transmitter to wireless base stations within a market. In particular, Sprint supports the proposed calculation of field strength levels at grid points separated by 2 kilometers within the wireless market area. The OET Plan proposes that "the total market impairment would be based on the sum of the populations in those unique grid cells where the calculated field strength exceeds the applicable interference threshold value."[9] Sprint concurs that such a measurement of market impairment would be useful. However, Sprint suggests that the Commission should additionally provide information on the number of grid cells that were analyzed within the wireless market and a percentage indicating how many of those grid cells were considered impaired based on modeling. This additional, more granular information on the level of impairment should be readily available from the proposed analysis and could provide additional details useful to a forward auction participant.

In order to calculate the field strength for DTV-to-wireless interference scenarios, the OET Plan proposed use of a confidence level of F(50,50); that is, the field strength would be predicted to exceed the proposed level at 50% of the potential receiver locations for at least 50% of the time. Sprint suggests, however, that the Commission make such calculations using

[9] *Id.* at 14.

F(50,10) confidence (in other words, field strength would exceed the proposed level at 50% of the potential receiver locations for at least 10% of the time). While the Commission is not incorrect in assuming that base stations can more easily reject unwanted signals than, for instance, user devices, wireless operators nonetheless set high standards for reliability of their network operations. Even assuming adoption of conventional mitigation techniques, wireless operators would likely find 600 MHz spectrum of little value if harmful interference occurred 50%, or even 10%, of the time, at base station receivers. To be sure, each operator's goals (and definition) for acceptable reliability for 600 MHz spectrum may vary. While some wireless operators may be willing to take extra steps to mitigate potential harmful interference impairment from DTV to wireless base stations, particularly if the operator's network can fall back to other spectrum if harmful interference does occur, other operators may insist on access to unimpaired spectrum blocks. Having an accurate understanding, for each spectrum block in each market area, will be particularly important for those bidders that do not have access to, or only have limited access to, comparable low-band spectrum. Sprint believes that a 600 MHz forward auction bidder would have a better understanding of the potential interference impairment from DTV to wireless base stations in a market if the calculations were based on F(50,10) propagation, particularly in light of the OET Plan's proposal to use a minimum effective noise figure for such base stations.

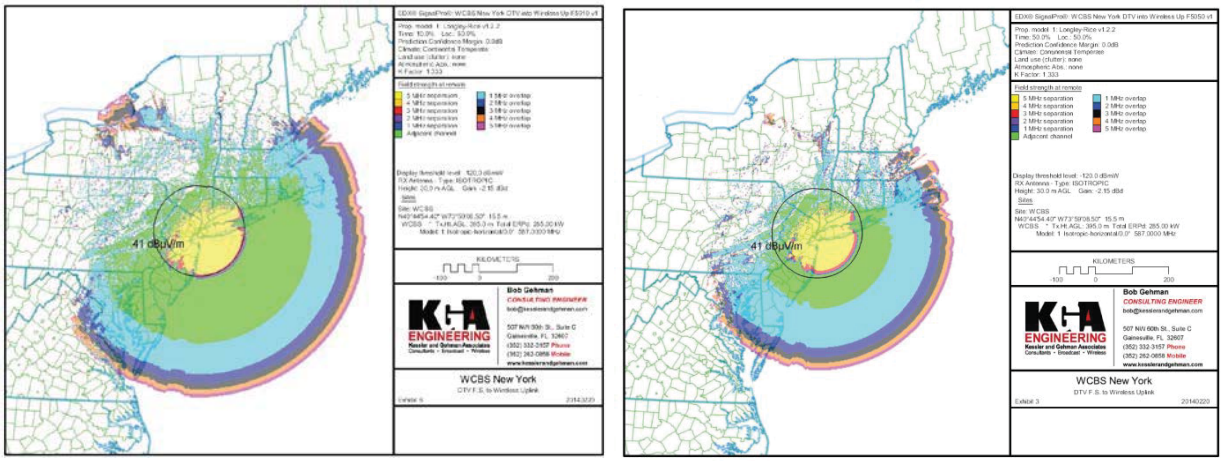

Figure 3: F(50,10) vs. F(50,50) Predicted Field Strength from WCBS, New York, NY

Sprint recognizes that use of a F(50,10) confidence level will result in higher levels of predicted harmful interference to wireless base stations from DTV transmitters, and thus larger predicted "impaired" areas. Nonetheless, Sprint believes forward auction participants will want the most realistic possible assessment of the potential for harmful interference so as to better determine whether they can address such impairment levels should they make a bid for, and ultimately win, spectrum in an affected wireless market. By contrast, use of a F(50,50) statistical confidence level could unnecessarily chill bidder participation by introducing significantly more uncertainty into forward auction participant expectations of network reliability.[10]

B. The Commission Should Not Bar Auction of Spectrum in Areas Where Desired/Undesired (D/U) Ratios Are Minimally Exceeded

Sprint also generally supports the OET Plan's proposed methodology for determining potential harmful interference from wireless operations to co-channel or adjacent channel DTV

[10] Stated another way, the choice of the confidence level presents a choice between the preferability of potential false positives or false negatives. While a F(50,10) confidence level analysis may result in identification of harmful interference in areas in which, under actual deployment, such interference is non-existent or easily mitigated, a F(50,50) confidence level analysis will likely result in *failure* to identify areas where harmful interference is potential or even likely. While bidders can appropriately factor false positives into their bids, the potential for false negatives can outright chill bidder participation.

operations. In particular, Sprint believes that the OET Plan's approach of calculating the D/U ratio values based on a 2-kilometer grid with hypothetical wireless base stations spaced uniformly at 10-kilometer intervals, and transmitting antennas 30 meters above ground, provides a reasonable estimation of potential harmful interference from wireless base stations to DTV receivers.

However, Sprint has concerns with the OET Plan's proposal to define "restricted" sub-areas, particularly if such sub-areas are much larger than the area where potential harmful interference is predicted.

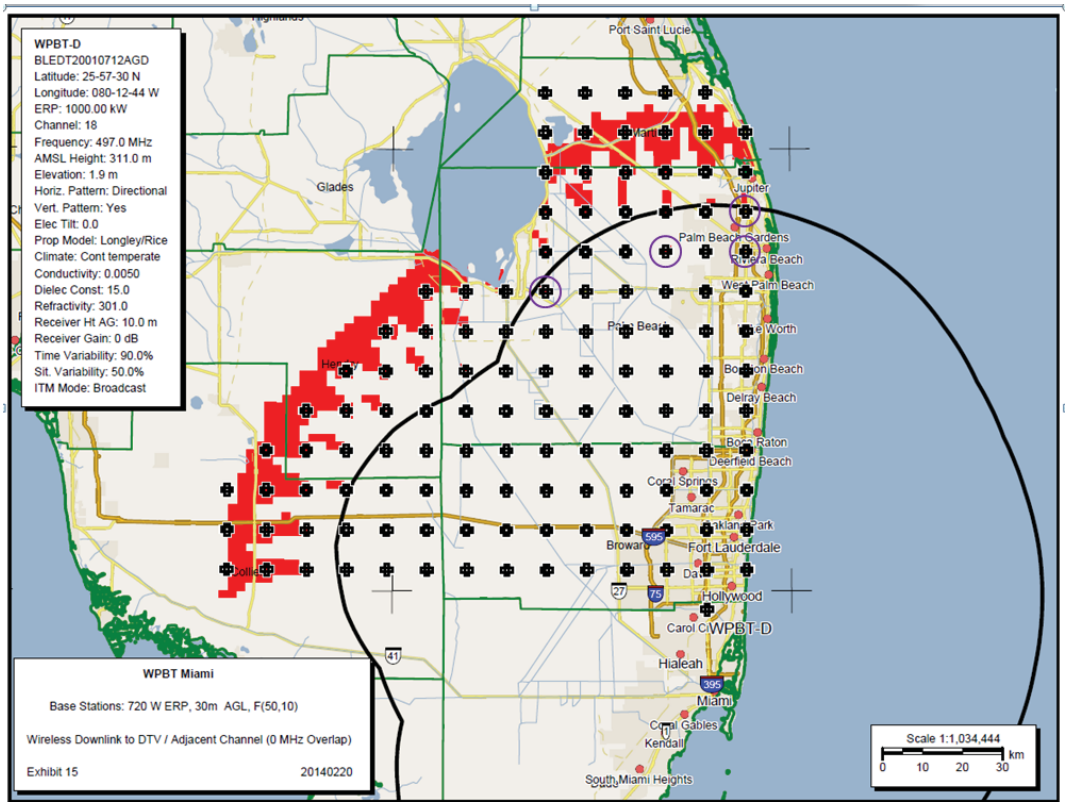

Figure 4: Predicted Excessive D/U to WPBT, Miami, FL, from Wireless Base Stations Located on Adjacent Channel (0 MHz overlap)

For instance, Figure 4 depicts a scenario in which wireless operations are directly adjacent to a television station. Red squares indicate areas in which the base stations are predicted to cause interference (*i.e.*¸ an excessive D/U ratio) to DTV reception, based on the proposed generic base station deployment. As Figure 4 illustrates, the vast majority of the analyzed wireless sites would result in an acceptable D/U ratio both within and outside the WPBT coverage contour. However, there are a few small areas near the edge of WPBT's protected service contour where the D/U ratio could be exceeded. There are several tools a wireless operator could utilize in such instances to reduce the D/U ratio at those locations to an acceptable level (including, *inter alia*, modifying base station power, height and directivity, or potentially reaching a mutually-acceptable business arrangement with the television station).

Sprint believes that the Commission should, as a preliminary matter, indicate that a *de minimis* level of predicted harmful interference (*i.e.*, interference exceeding the D/U ratio) should not require restrictions on the wireless use of that spectrum. The *Public Notice* specifically solicits comment on whether to allow a wireless licensee to reduce the coverage of a DTV station by no more than 0.1% of its served population.[11] However, current broadcast rules permit a DTV station to make changes to its facilities that could result in interference that reduces coverage of another DTV station, so long as such changes would not result in more than 0.5% new interference to the other DTV station.[12] *Sprint suggests that the Commission should adopt a similar approach with respect to potential interference from wireless operations to a DTV station's reception. Thus, if a DTV station's service area is forecast to be impacted by harmful interference from wireless operations, on a system-wide basis, constituting no more than*

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[11] *Id.* at 7.

[12] *See* 47 C.F.R. Section 73.616(e).

0.5% of the station's service population, then potential interference would be considered acceptable and the spectrum block or blocks could be auctioned without restrictions.

Consistent with the Commission's goal of maximizing the amount of repurposed 600 MHz spectrum, Sprint also suggests that the Commission permit the auction of license areas, or sub-license areas, where the *potential* for harmful interference exceeds the D/U limit, but a potential wireless licensee would have a reasonable opportunity to use those areas without causing unacceptable levels of excessive D/U in *real-world deployment conditions*. The auction of such spectrum would be considered "restricted," in that the auction winner would not be permitted to operate unless it took the necessary actions to ensure that the D/U ratio is not exceeded at wireless deployment locations containing more than 0.5% of the population served by the DTV station. By designating such wireless spectrum as restricted, and providing the basis for such restriction (*i.e.*, population, number of TV receive cell grids analyzed, and number of TV receive cell grids where the D/U is predicted to be exceeded), the Commission would provide sufficient information to ensure that a wireless licensee understands the amount of potential interference problems it could face were it to bid for and win that license. In the event that the Commission agreed to auction such restricted spectrum, Sprint recommends that it first seek additional input on a high side limit for such areas (for example, areas could be "prohibited" from auction, even on a "restricted" basis, if the D/U limit was exceeded at more than 25% of the television receiver grid points, or if the D/U limit would be exceeded at any television receiver grid point from more than 50% of the wireless base station grid points).

C. The Commission Should Adopt the Smallest Possible Geographic Definition of Restricted Sub-Areas

Finally, with respect to the OET Plan's proposal to generalize or restrict the areas or sub-areas where wireless operations could cause harmful interference (*i.e.,* excessive D/U ratios) to a DTV station, Sprint encourages the Commission to define prohibited (*i.e.*, non-auctioned) and restricted sub-areas in as granular a way as is practically feasible. Sprint considers county boundaries (used as an example in the *Public Notice*)[13] to be inapt: in many cases counties would be too large and could unnecessarily result in making fallow perfectly auctionable spectrum. For instance, as Figure 4 demonstrates, predicted D/U ratios would be exceeded in a minority of locations; use of county boundaries, however, would render all of Palm Beach County unusable because of four cell grids (each differing in the extent to which predicted D/U ratios are exceeded). Designating an entire (and possibly competitively-significant) county unusable for wireless broadband simply because of a small subset of grid areas (in which operations could simply be "restricted") would waste the potential of 600 MHz spectrum (and could conceivably depress revenues by failing to auction an area that wireless operators might well be interested in bidding on, despite minor restricted areas). Setting the sub-area size based on county boundaries would be inappropriate and inefficient, particularly if a large county were to be prohibited from auction based on interference predictions at only a few locations (potentially situated in remote or less populated areas).

Accordingly, Sprint submits that a superior alternative would be to establish the sub-areas based on the size of the wireless base station grid spacing (*i.e.,* 10 kilometers). The proposed OET Plan methodology, with modifications as discussed above, would provide greater accuracy

[13] *Id.* at 13.

and enable more 600 MHz spectrum to be repurposed and auctioned for mobile broadband than a separation distance or predefined radius protection requirement.

III. THE COMMISSION SHOULD INCORPORATE INFORMATION ON POTENTIALLY RESTRICTED SPECTRUM WITHIN ITS REPACKING ANALYSIS

The process of dynamically evaluating potential repacking contingencies involves a complex undertaking, with a wide range of variables. Sprint suggests that the Commission nonetheless incorporate information on the effects of variable band plans on coexistence between remaining broadcast operations and wireless broadband services – most notably, to what extent, based on the degree of variation between markets, wireless operations can operate on a "restricted basis" in certain areas. Sprint suggests that the Commission should set a goal within its repacking analysis during the auction to minimize the amount of "prohibited" spectrum locations (*i.e.*, those in which wireless operations would be completely barred based on predicted harmful interference), as well as a secondary goal to minimize "restricted" spectrum (*i.e.*, spectrum in areas which wireless operations would only be permitted with certain precautionary measures).

Sprint recognizes that it will be difficult if not impossible to develop a final repacking plan as the auction progresses round-by-round. Instead, the Commission has proposed to do an expedited feasibility assessment of how much spectrum can be reclaimed through repacking, and the possible frequency locations remaining broadcasters could occupy – a provisional repacking approach Sprint considers a practical requirement for the auction. At the same time, however, Sprint encourages the Commission to consider whether it can also assess the amount (and size) of prohibited areas that would occur from potential repacking outcomes under certain market variable band plans, and continue the auction based on clearing and repacking assumptions and

band plans that would minimize the areas of potential interference, thereby maximizing the amount of spectrum that can be auctioned.

IV. CONCLUSION

Sprint appreciates the opportunity to comment on the Commission's alternative methodology for predicting and modeling potential interference between broadcaster television and wireless broadband services under a market variable band plan. The OET Plan provides significant improvements in spectral efficiency and auction outcomes over predefined separation distances and technical rules. At the same time, Sprint believes that minor alterations to the OET Plan – in particular, maximizing the areas in which wireless operations could occur, even under certain impairment restrictions – could provide even greater spectral efficiency and produce additional, revenue-generating spectrum for auction.

Respectfully submitted,

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March 18, 2014

ATTACHMENT

Maps Showing Predicted Signal Levels from Wireless Base Stations
Using Longley-Rice and Hata Propagation Models

Exhibit 1: Longley-Rice F(50,50) Near WPBT, Miami, FL

Exhibit 2: Longley-Rice F(50,10) Near WPBT, Miami, FL

Exhibit 3: Hata F(50,50) Near WPBT, Miami, FL

Exhibit 4: Hata F(50,10) Near WPBT, Miami, FL

Exhibit 5: Longley-Rice F(50,50) Near KKPX-TV, San Jose, CA

Exhibit 6: Longley-Rice F(50,10) Near KKPX-TV, San Jose, CA

Exhibit 7: Hata F(50,50) Near KKPX-TV, San Jose, CA

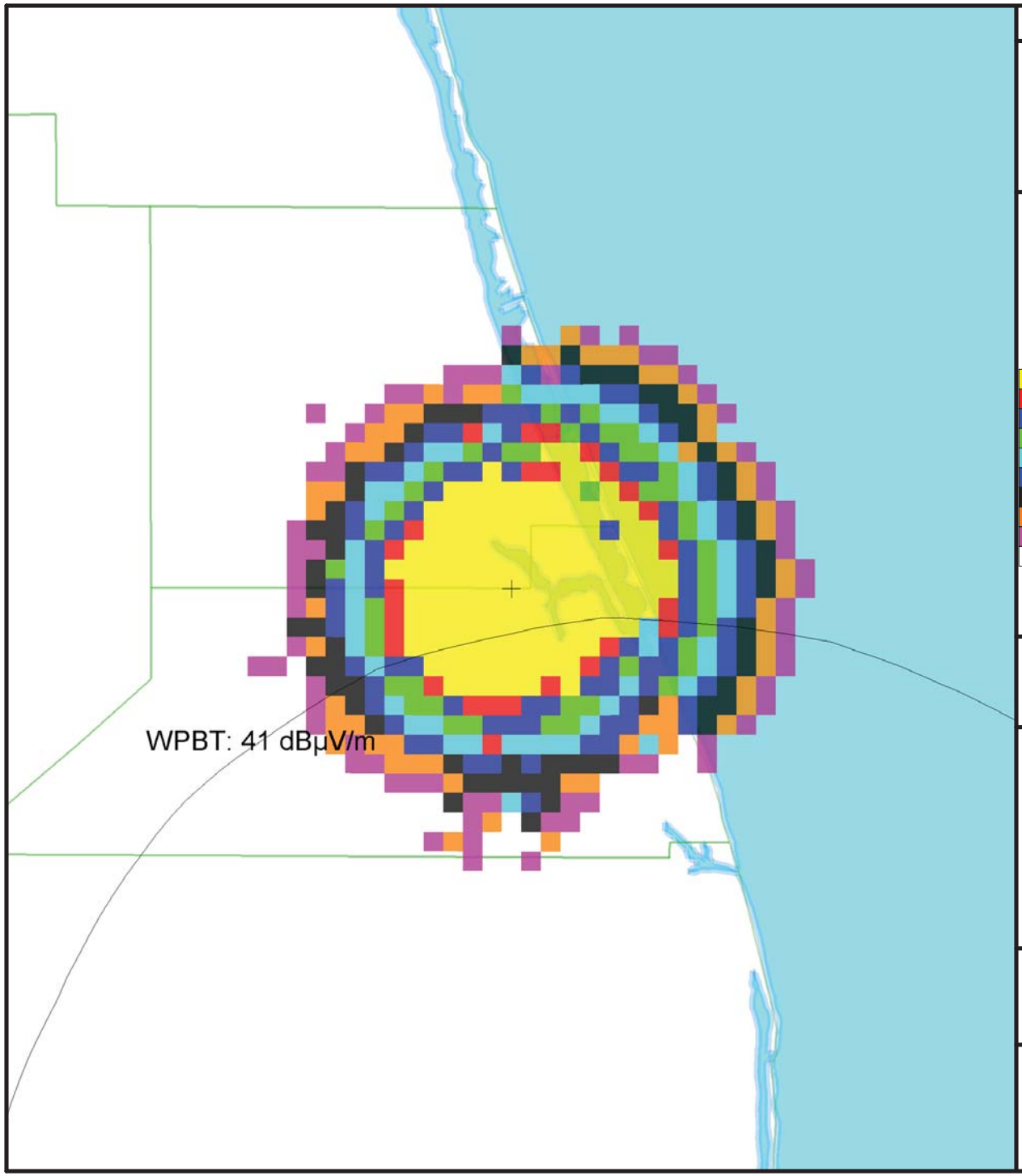
Exhibit 8: Hata F(50,10) Near KKPX-TV, San Jose, CA

Exhibit 9: Longley-Rice F(50,50) Near WCBS, New York, NY

Exhibit 10: Longley-Rice F(50,10) Near WCBS, New York, NY

Exhibit 11: Hata F(50,50) Near WCBS, New York, NY

Exhibit 12: Hata F(50,10) Near WCBS, New York, NY



EDX® SignalPro®: KGA Test 3

Prop. model 1: Longley-Rice v1.2.2
Time: 50.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: NY
N27°12'19.00" W80°18'19.00" 3.0 m
NY * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
	72.0 to 74.0 dBuV/m
	70.0 to 72.0 dBuV/m
	68.0 to 70.0 dBuV/m
	66.0 to 68.0 dBuV/m
	64.0 to 66.0 dBuV/m
	62.0 to 64.0 dBuV/m
	60.0 to 62.0 dBuV/m
	58.0 to 60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

KILOMETERS
-5 0 20

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(352) 262-0858 **Mobile**
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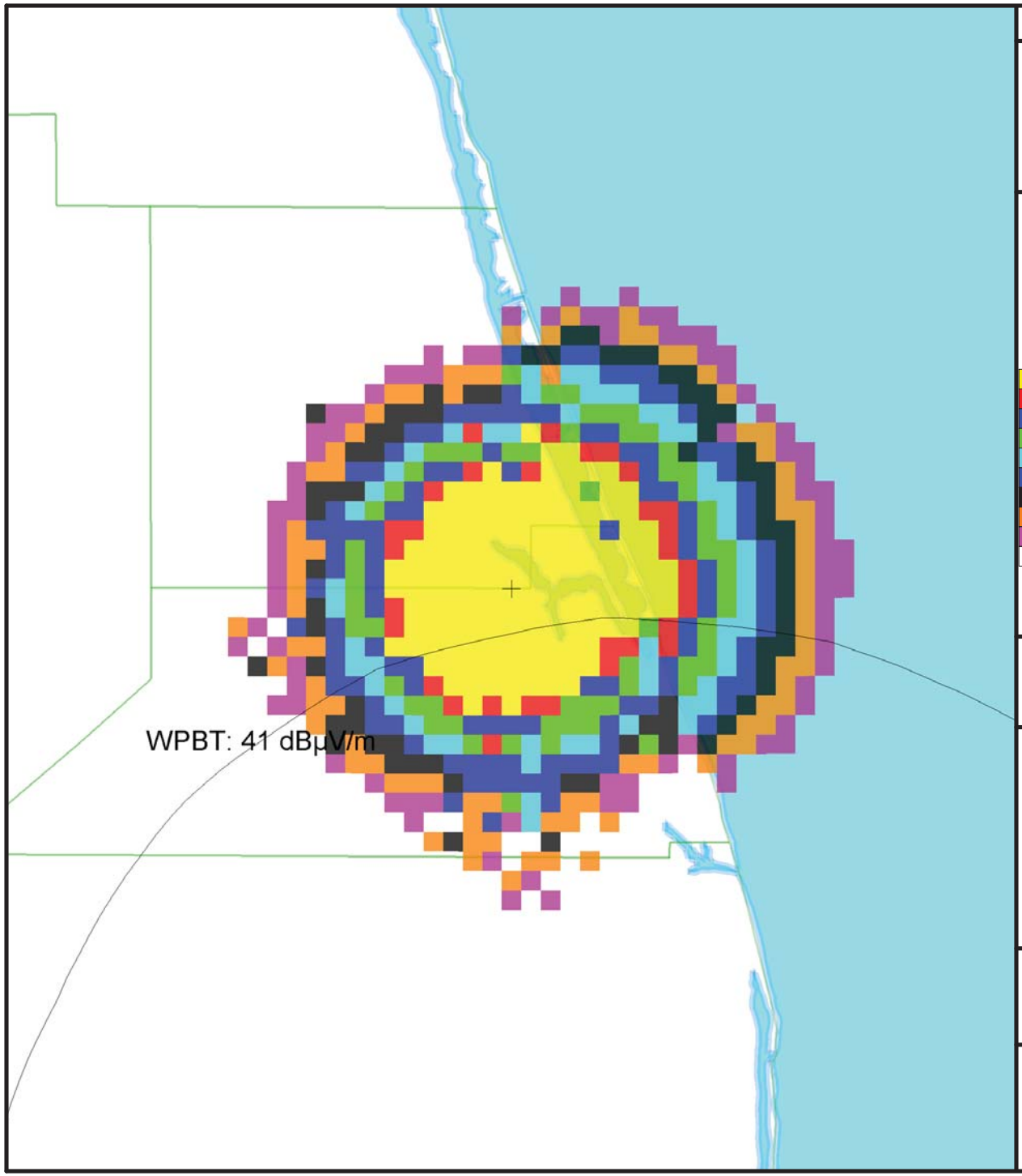
KGA Miami Test

LR vs Hata

Exhibit 1 20140226



EDX® SignalPro®: KGA Test 3

Prop. model 1: Longley-Rice v1.2.2
Time: 10.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: NY
N27°12'19.00" W80°18'19.00" 3.0 m
NY * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
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	62.0 to 64.0 dBuV/m
	60.0 to 62.0 dBuV/m
	58.0 to 60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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-5 0 20

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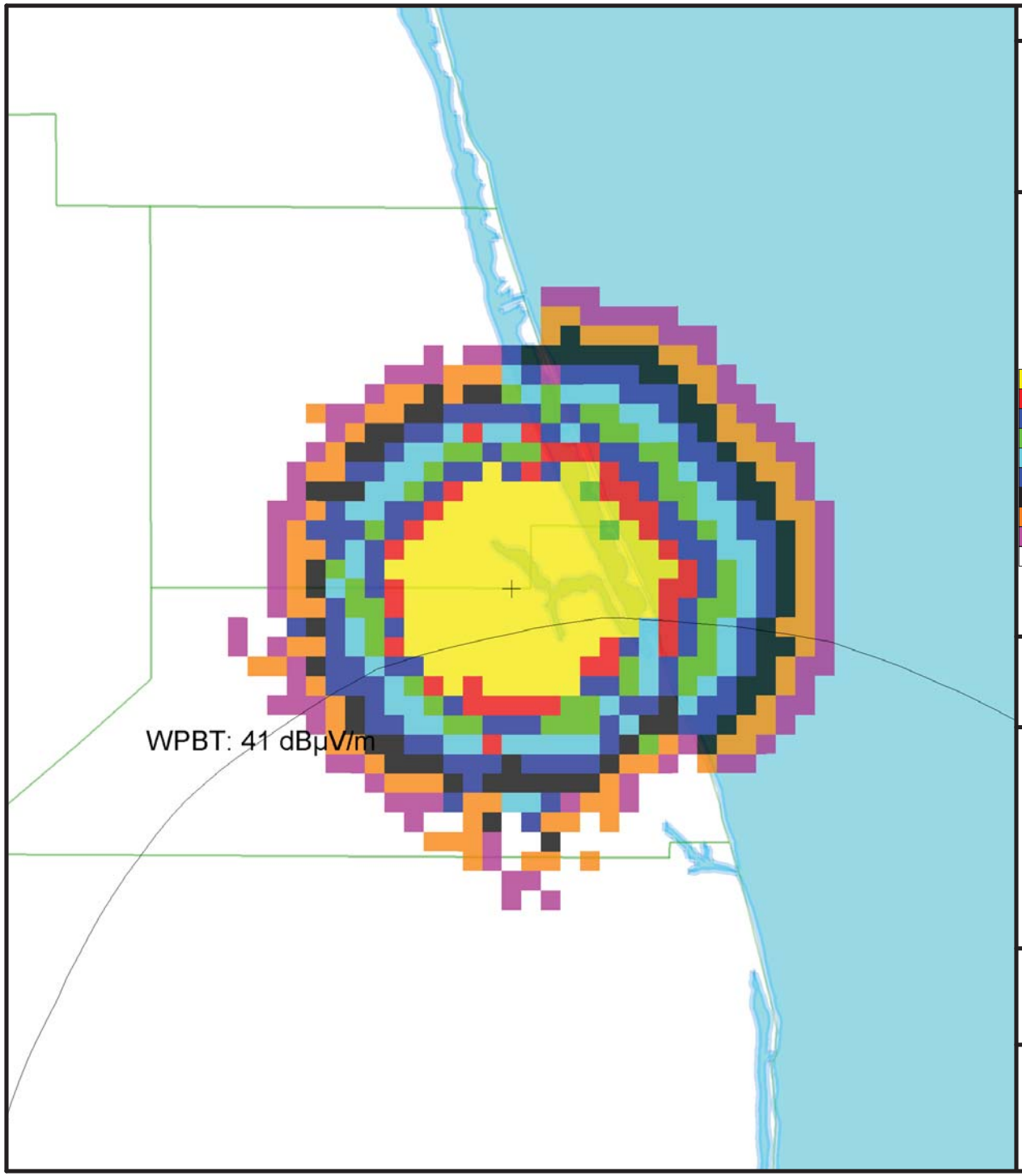
KGA Miami Test

LR vs Hata

Exhibit 2 20140226



EDX® SignalPro®: KGA Test 3

Prop. model 1: Hata-Extended/E-P diff.
Time: 50.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: NY
N27°12'19.00" W80°18'19.00" 3.0 m
NY * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
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	62.0 to 64.0 dBuV/m
	60.0 to 62.0 dBuV/m
	58.0 to 60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

KILOMETERS
-5 0 20

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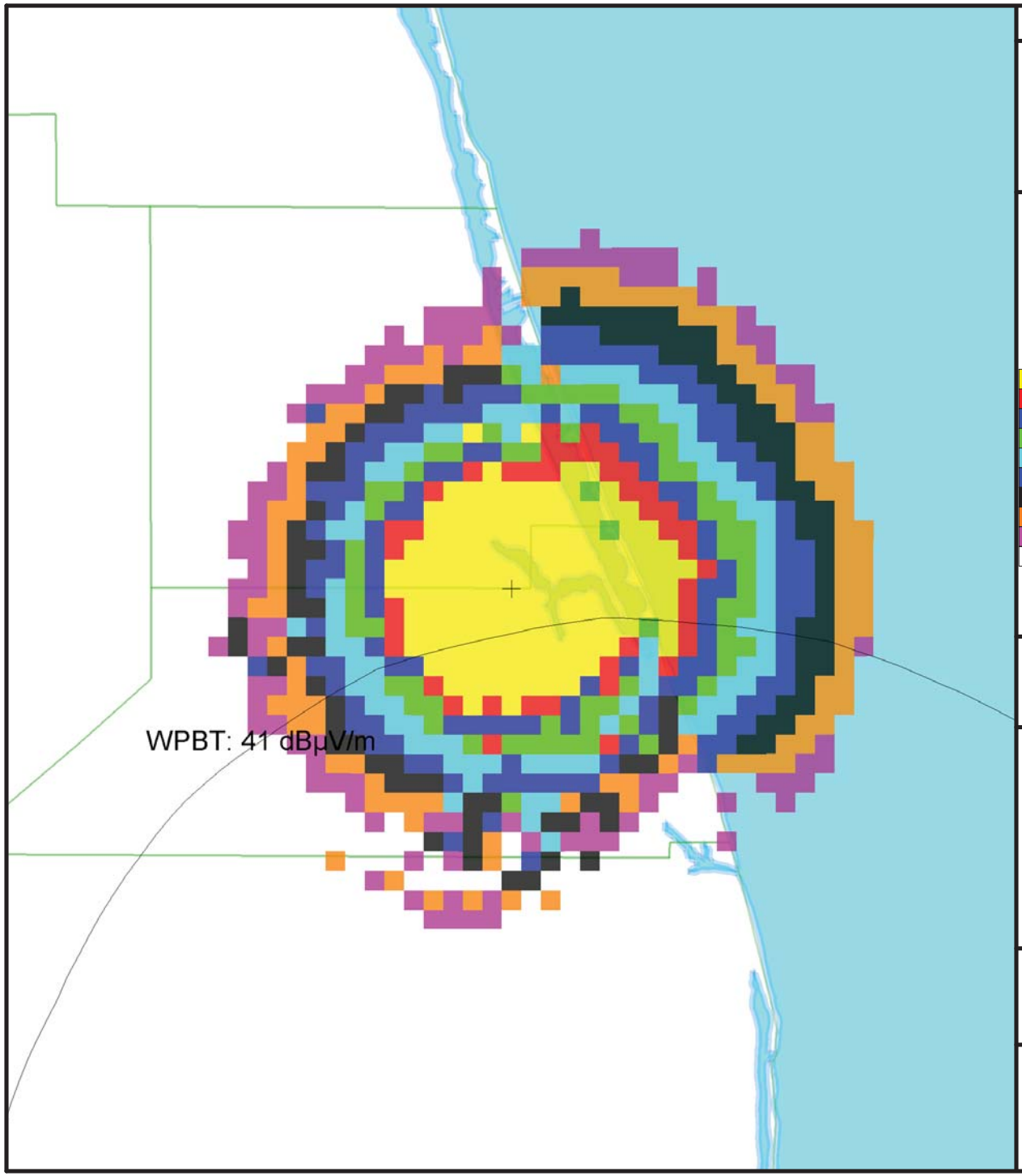
KGA Miami Test

LR vs Hata

Exhibit 3 20140226



EDX® SignalPro®: KGA Test 3

Prop. model 1: Hata-Extended/E-P diff.
Time: 10.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: NY
N27°12'19.00" W80°18'19.00" 3.0 m
NY * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
	72.0 to 74.0 dBuV/m
	70.0 to 72.0 dBuV/m
	68.0 to 70.0 dBuV/m
	66.0 to 68.0 dBuV/m
	64.0 to 66.0 dBuV/m
	62.0 to 64.0 dBuV/m
	60.0 to 62.0 dBuV/m
	58.0 to 60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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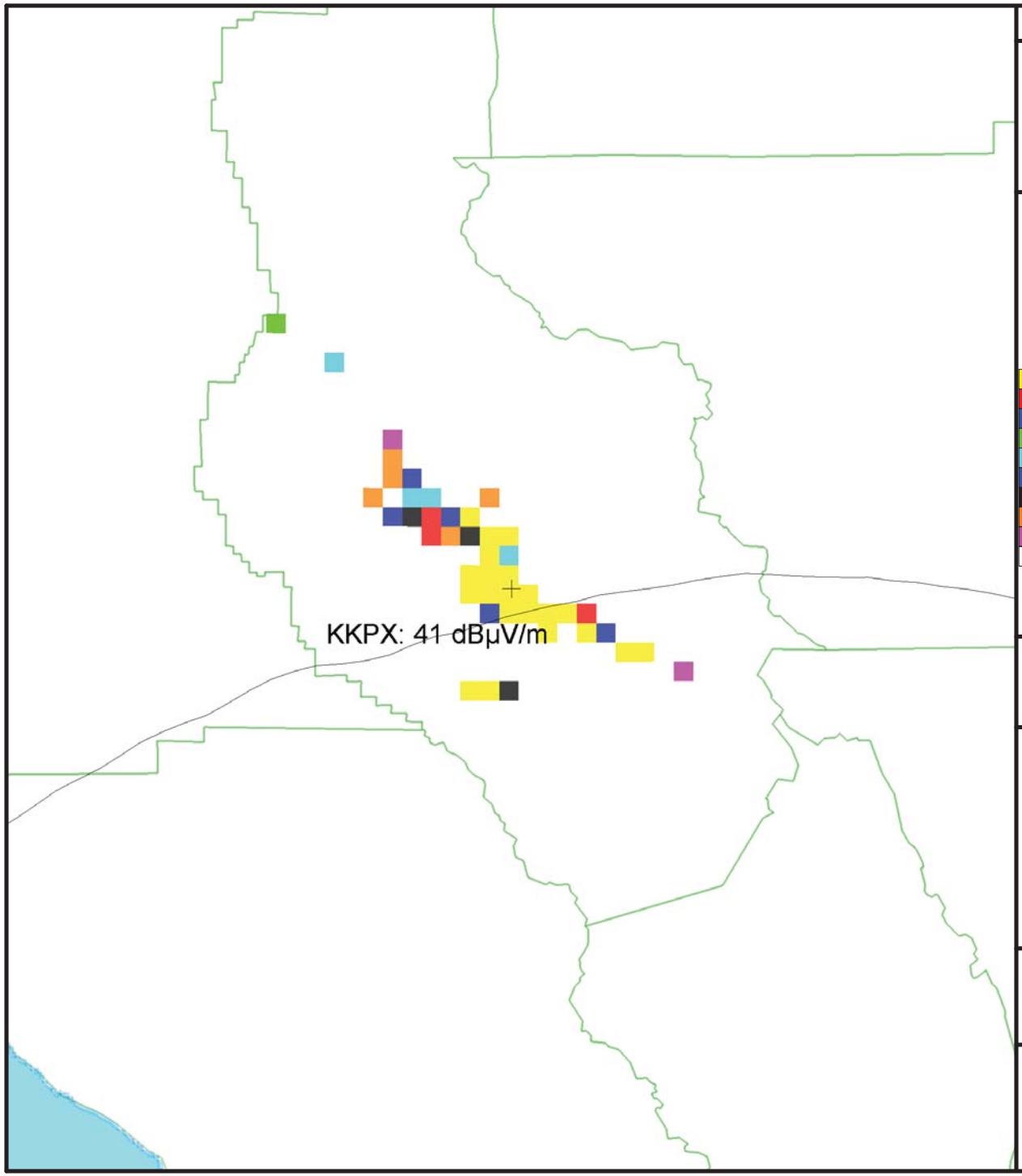
KGA Miami Test

LR vs Hata

Exhibit 4 20140226



EDX® SignalPro®: San Jose LR 5050 test 1

Prop. model 1: Longley-Rice v1.2.2
Time: 50.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: SJ
N38°58'55.17" W122°42'49.41" 405.0 m
SJ * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
	72.0 to 74.0 dBuV/m
	70.0 to 72.0 dBuV/m
	68.0 to 70.0 dBuV/m
	66.0 to 68.0 dBuV/m
	64.0 to 66.0 dBuV/m
	62.0 to 64.0 dBuV/m
	60.0 to 62.0 dBuV/m
	58.0 to 60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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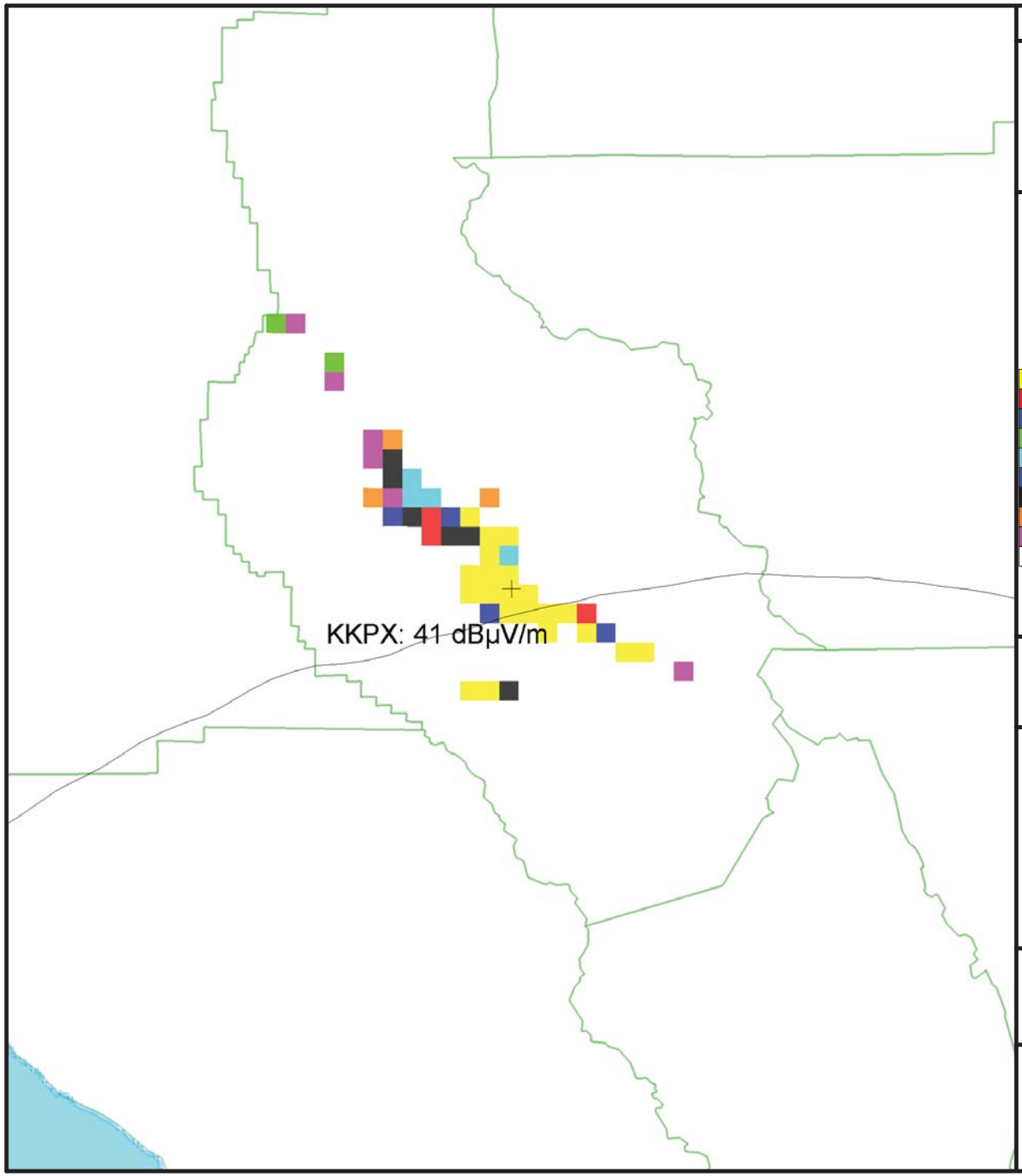
KGA San Jose Test

LR vs Hata

Exhibit 5 20140318



EDX® SignalPro®: San Jose LR 5010 test 1

Prop. model 1: Longley-Rice v1.2.2
Time: 10.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: SJ
N38°58'55.17" W122°42'49.41" 405.0 m
SJ * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
	72.0 to 74.0 dBuV/m
	70.0 to 72.0 dBuV/m
	68.0 to 70.0 dBuV/m
	66.0 to 68.0 dBuV/m
	64.0 to 66.0 dBuV/m
	62.0 to 64.0 dBuV/m
	60.0 to 62.0 dBuV/m
	58.0 to 60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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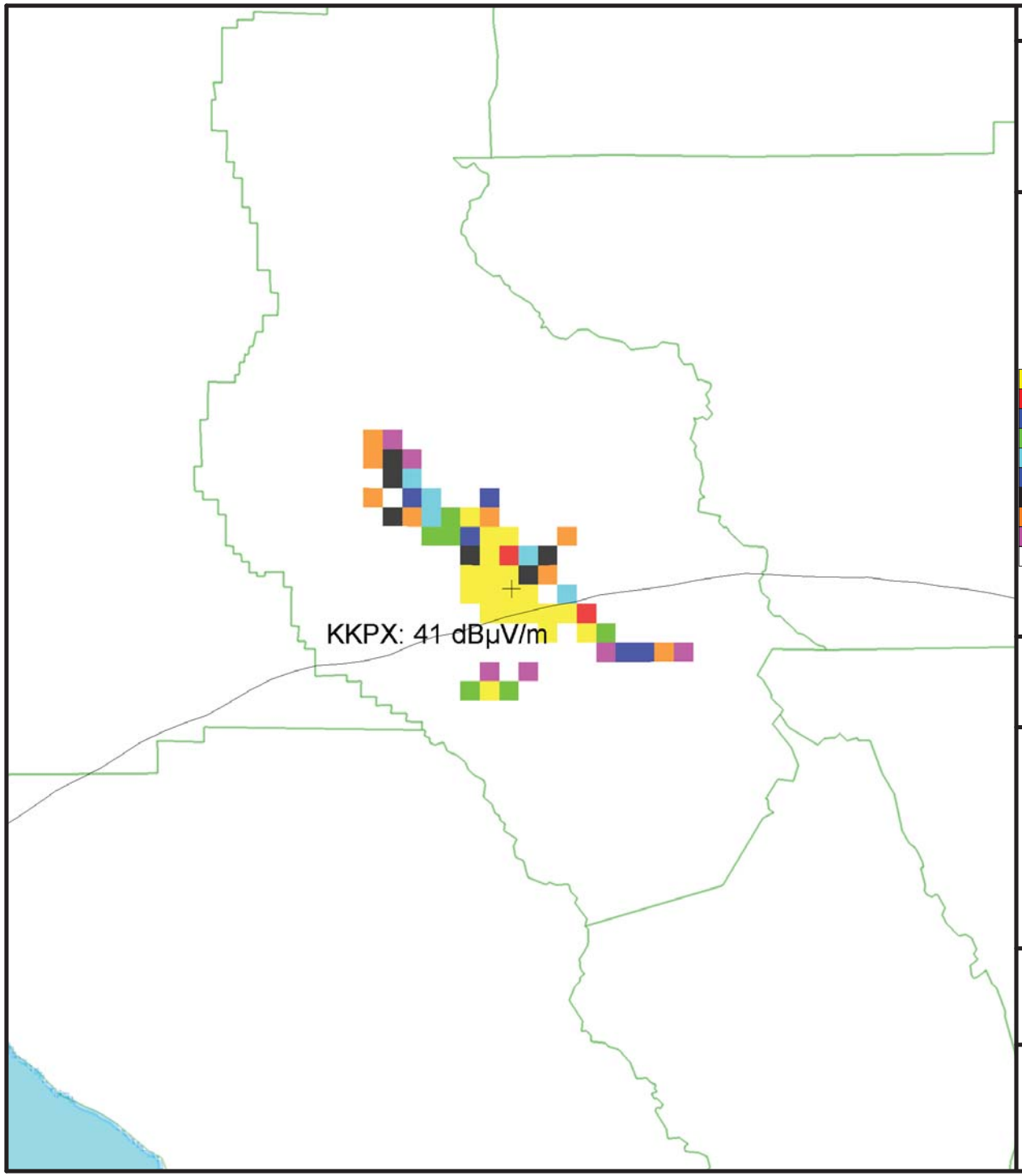
LR vs Hata

Exhibit 6 20140318



EDX® SignalPro®: San Jose Hata 5050 test 1

Prop. model 1: Hata-Extended/E-P diff.
Time: 50.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: SJ
N38°58'55.17" W122°42'49.41" 405.0 m
SJ * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
	72.0 to 74.0 dBuV/m
	70.0 to 72.0 dBuV/m
	68.0 to 70.0 dBuV/m
	66.0 to 68.0 dBuV/m
	64.0 to 66.0 dBuV/m
	62.0 to 64.0 dBuV/m
	60.0 to 62.0 dBuV/m
	58.0 to 60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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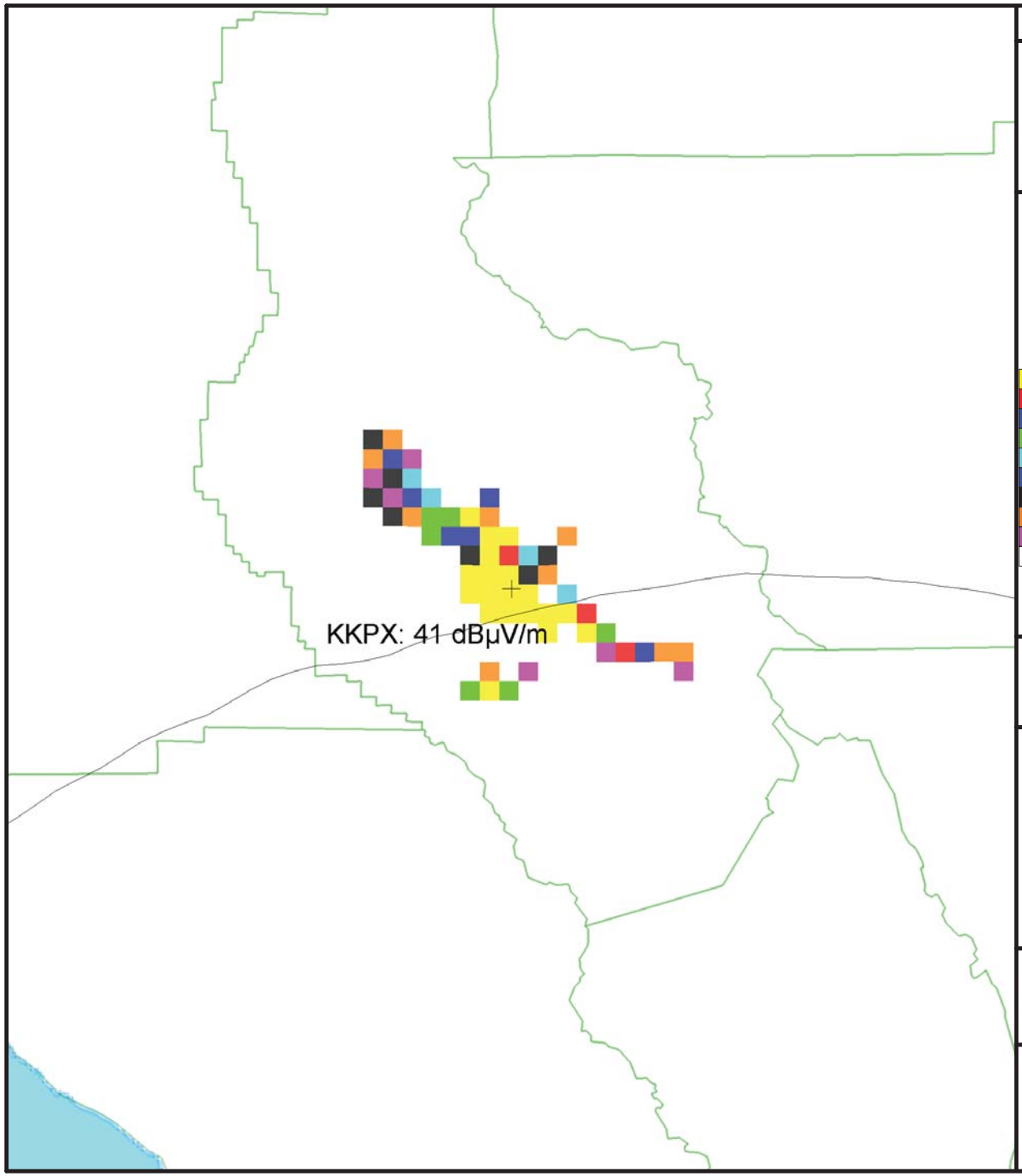
LR vs Hata

Exhibit 7 20140318



EDX® SignalPro®: San Jose Hata 5010 test 1

Prop. model 1: Hata-Extended/E-P diff.
Time: 10.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: SJ
N38°58'55.17" W122°42'49.41" 405.0 m
SJ * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
	72.0 to 74.0 dBuV/m
	70.0 to 72.0 dBuV/m
	68.0 to 70.0 dBuV/m
	66.0 to 68.0 dBuV/m
	64.0 to 66.0 dBuV/m
	62.0 to 64.0 dBuV/m
	60.0 to 62.0 dBuV/m
	58.0 to 60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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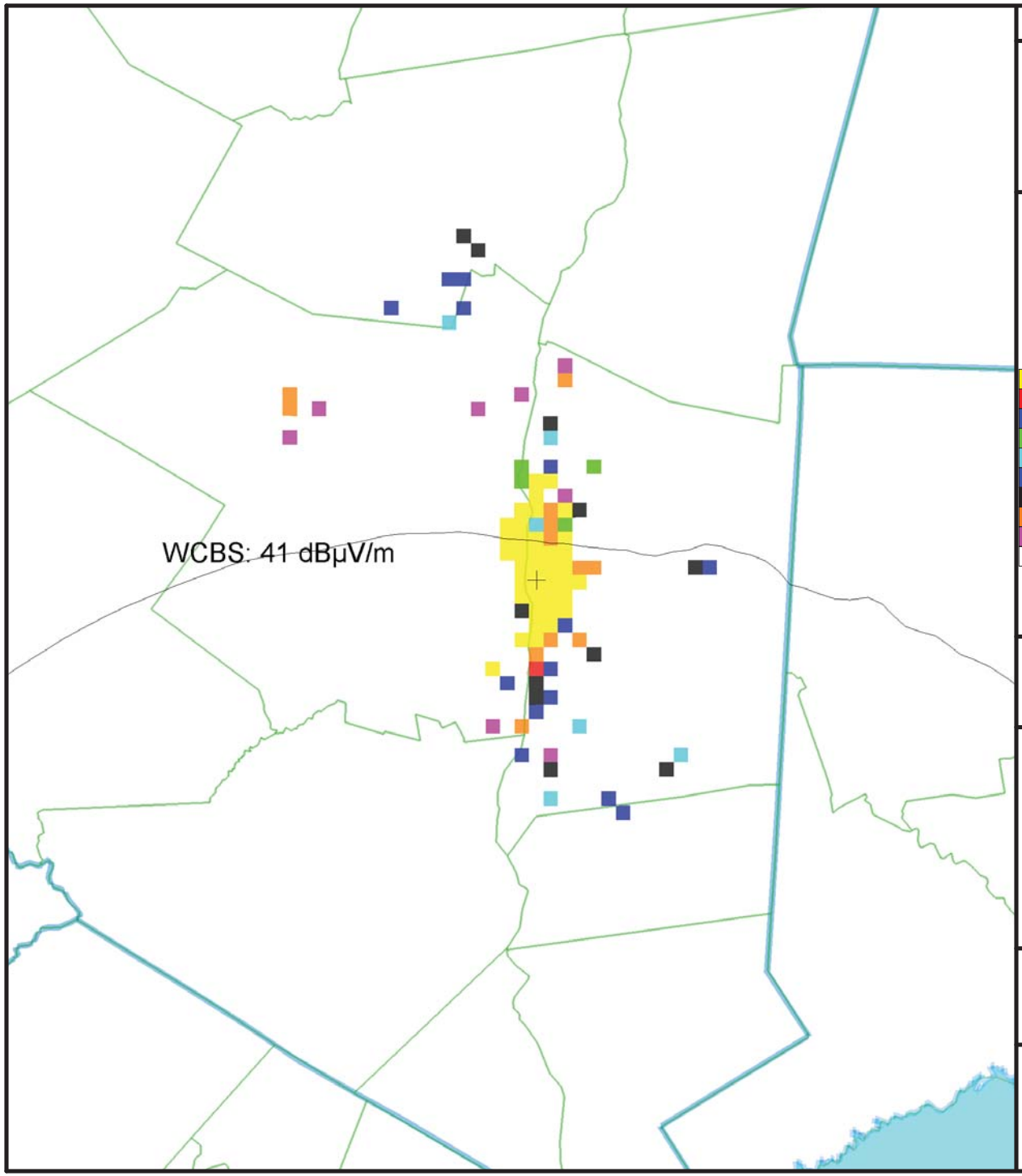

EDX® SignalPro®: New York LR 5050 test 1

Prop. model 1: Longley-Rice v1.2.2
Time: 50.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: NY
N41°47'00.00" W73°56'00.00" 57.0 m
NY * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
72.0 to	74.0 dBuV/m
70.0 to	72.0 dBuV/m
68.0 to	70.0 dBuV/m
66.0 to	68.0 dBuV/m
64.0 to	66.0 dBuV/m
62.0 to	64.0 dBuV/m
60.0 to	62.0 dBuV/m
58.0 to	60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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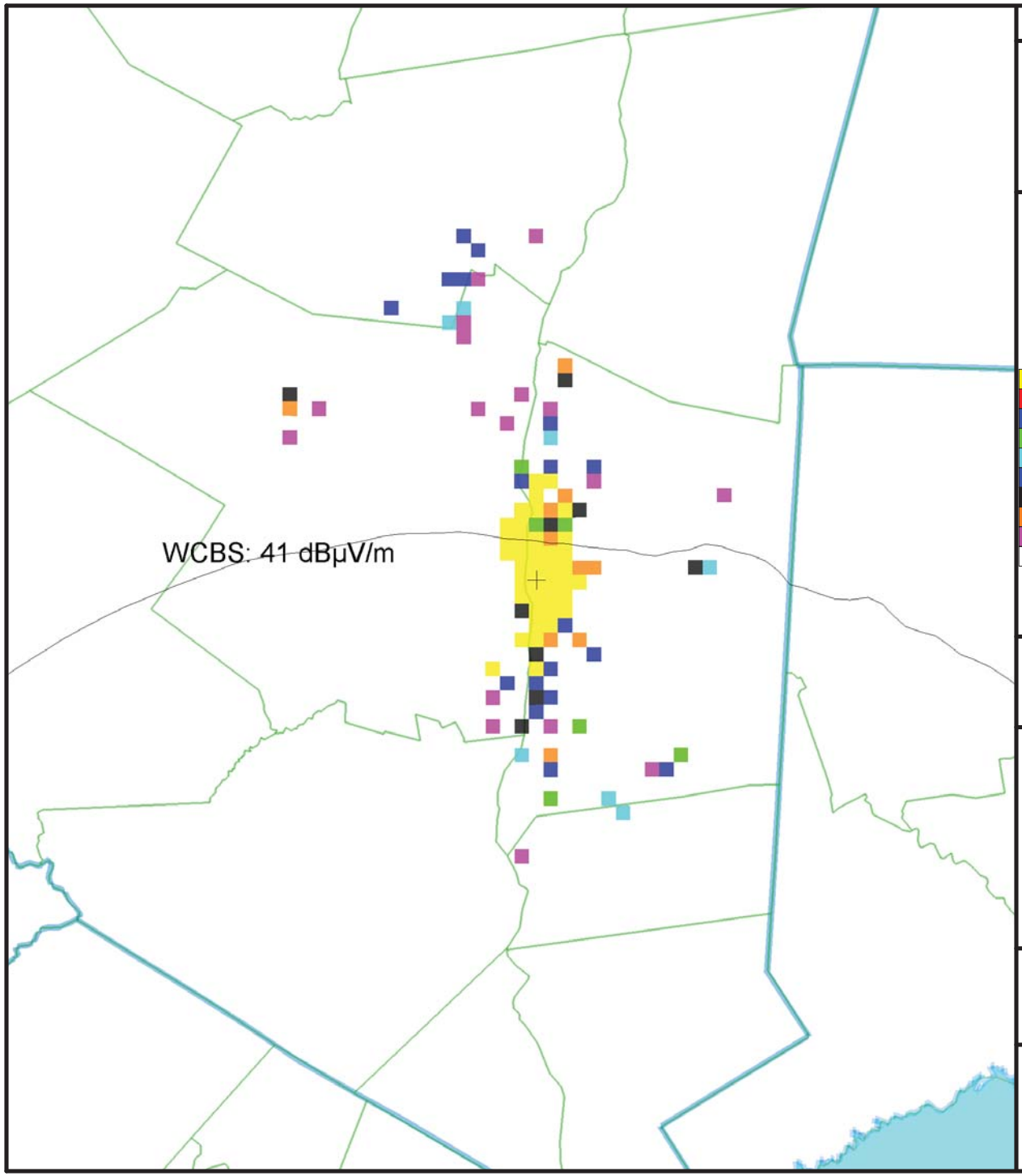

EDX® SignalPro®: New York LR 5010 test 1

Prop. model 1: Longley-Rice v1.2.2
Time: 10.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: NY
N41°47'00.00" W73°56'00.00" 57.0 m
NY * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
72.0 to	74.0 dBuV/m
70.0 to	72.0 dBuV/m
68.0 to	70.0 dBuV/m
66.0 to	68.0 dBuV/m
64.0 to	66.0 dBuV/m
62.0 to	64.0 dBuV/m
60.0 to	62.0 dBuV/m
58.0 to	60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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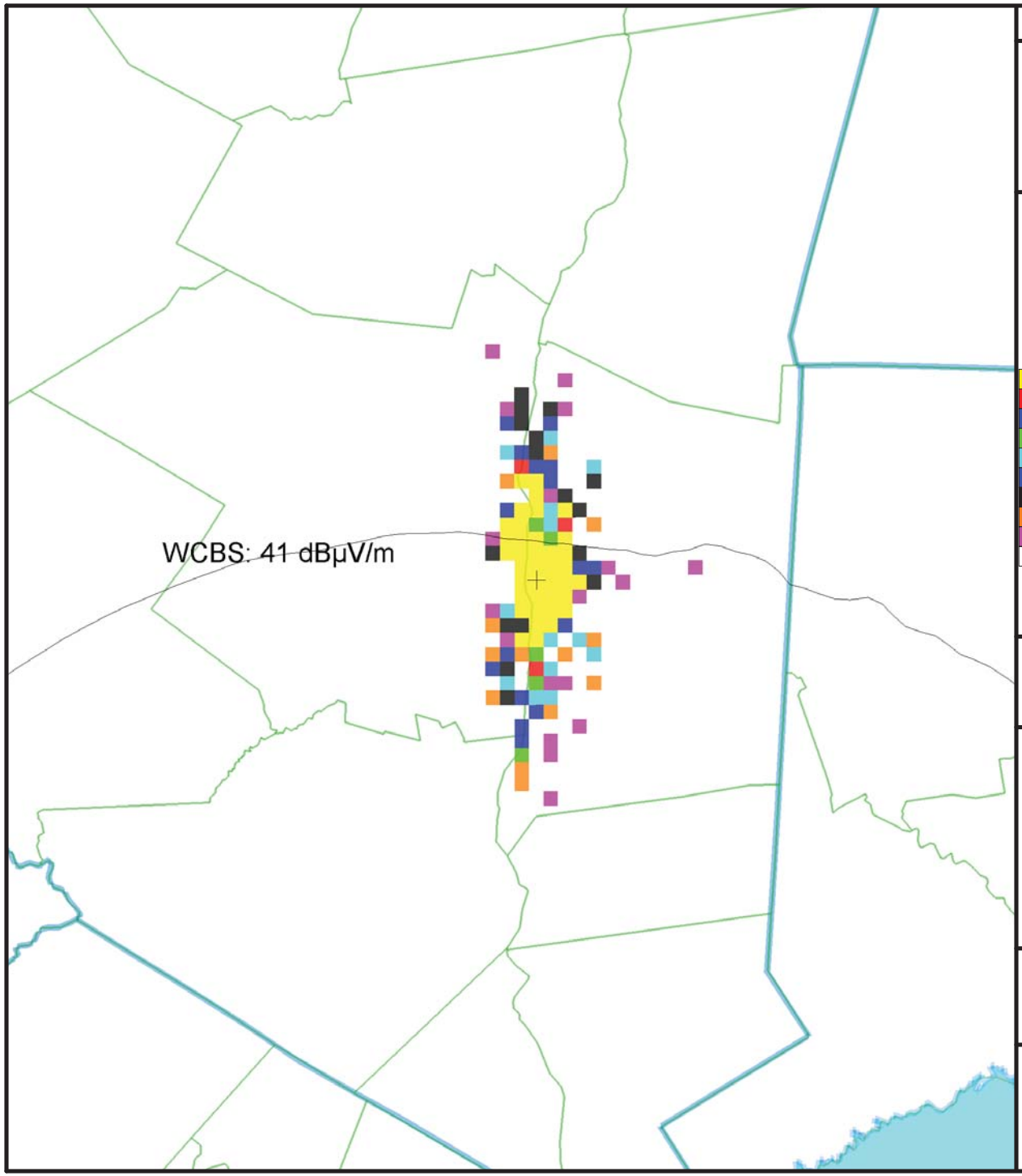

EDX® SignalPro®: New York Hata 5050 test 1

Prop. model 1: Hata-Extended/E-P diff.
Time: 50.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: NY
N41°47'00.00" W73°56'00.00" 57.0 m
NY * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
	72.0 to 74.0 dBuV/m
	70.0 to 72.0 dBuV/m
	68.0 to 70.0 dBuV/m
	66.0 to 68.0 dBuV/m
	64.0 to 66.0 dBuV/m
	62.0 to 64.0 dBuV/m
	60.0 to 62.0 dBuV/m
	58.0 to 60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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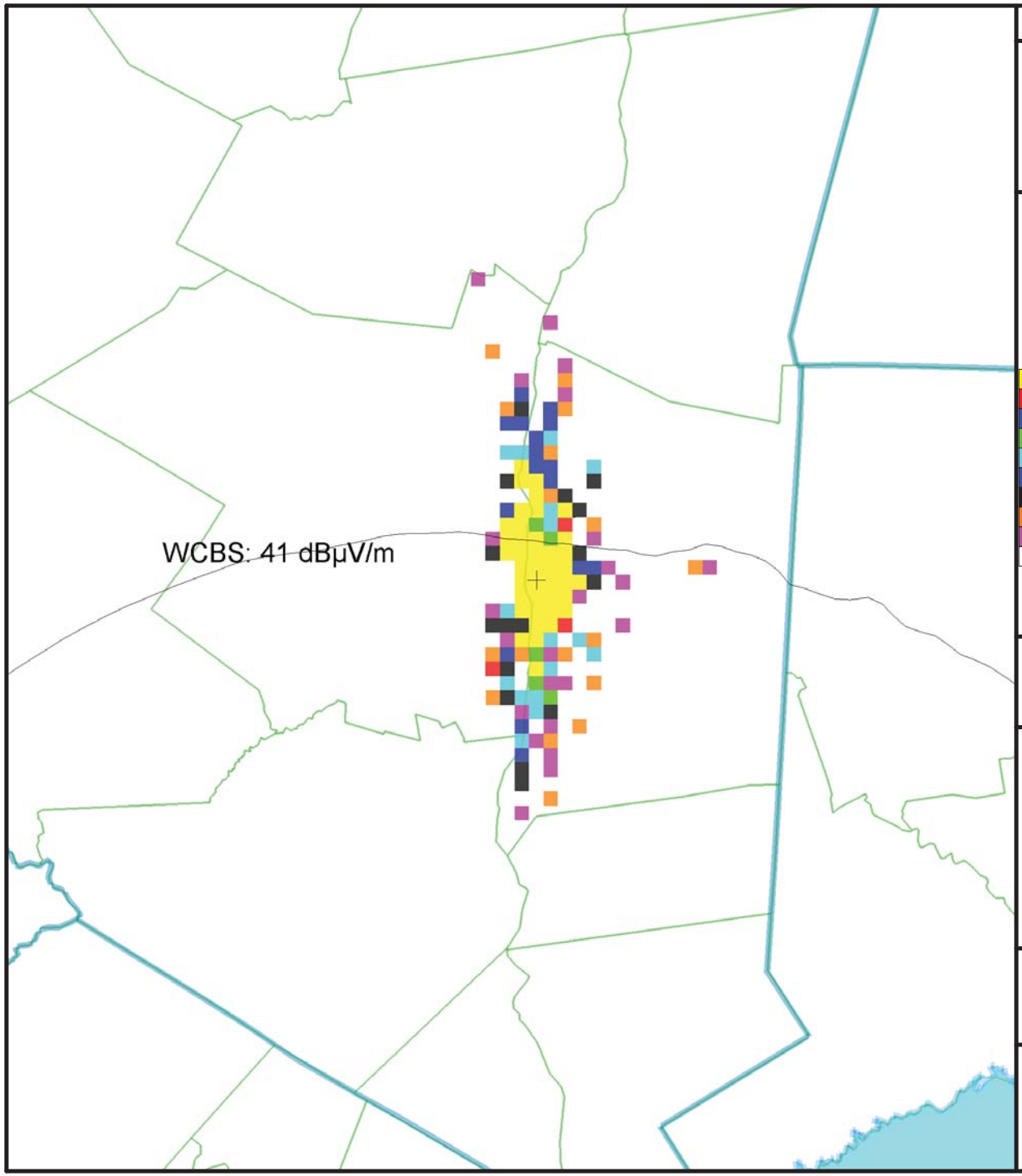
Exhibit 11 20140318



EDX® SignalPro®: New York Hata 5010 test 1

Prop. model 1: Hata-Extended/E-P diff.
Time: 10.0% Loc.: 50.0%
Prediction Confidence Margin: 0.0dB
Climate: Continental Temperate
Land use (clutter): EDX .GCV format
Atmospheric Abs.: none
K Factor: 1.333

Sites

Site: NY
N41°47'00.00" W73°56'00.00" 57.0 m
NY * Tx.Ht.AGL: 30.0 m Total ERPd: 720.00 W
Model: 1 Isotropic-horizontal/0.0° 615.0000 MHz

Field strength at remote

>=	74.0 dBuV/m
72.0 to	74.0 dBuV/m
70.0 to	72.0 dBuV/m
68.0 to	70.0 dBuV/m
66.0 to	68.0 dBuV/m
64.0 to	66.0 dBuV/m
62.0 to	64.0 dBuV/m
60.0 to	62.0 dBuV/m
58.0 to	60.0 dBuV/m
<	58.0 dBuV/m

Display threshold level: -120.0 dBmW
RX Antenna - Type: ISOTROPIC
Height: 10.0 m AGL Gain: -2.20 dBd

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