

Practical Principle and Technical Standards for DAB+ Trial Planning

Deliverable No. 2



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Notice

This document is provided in good faith and is based on the Consultants' understanding of the NBTC's Radio Frequency Plan Project requirements. We would be pleased to discuss the contents of this document with you, particularly if NBTC's requirements have in any way changed.

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Table of Contents

1.	Executive Summary	1
1.1	Scope Practical Principle and Technical Standards for DAB+ Trial Planning Report.....	2
1.2	Context of Work Assignment: 'Trial DAB+ Plan'	2
1.3	Preliminary Key Findings	3
2.	Network Design and Presentation Format	6
2.1	Planning Tool and Digital Terrain Data	6
2.2	Set up of Planning/Simulation Environment	7
2.3	Planning Methodology	8
2.3.1	Tower Selection Concept	8
2.3.2	Assessment Spectrum Availability	8
2.4	Planning Tool Settings for Analogue Television Simulations	10
2.5	Planning Tool Settings for DAB+ Interference on TV Simulations	11
2.6	Planning Tool Settings for DAB+ Coverage Simulations	12
2.6.1	Coordination Calculation between DAB+ and Television Analogue Services	14
2.6.2	Emission Mask	16
2.7	Antenna Patterns	16
2.7.1	Chon Buri Station Directional Antenna	17
2.7.2	Hua Hin Station Directional Antenna	18
2.8	DAB Channel Selection	19
3.	DAB+ Allotment Discussions	20
3.1	Scenario 1 Population Coverage Objectives	20
3.1.1	Minimum Population Coverage Objectives	22
	Appendix A - Coordination between DAB+ and Analogue Television Services	i
	Appendix B - Available DAB+ Allotments	x
	Appendix C – DAB+ Allotments Coverage	xv
	Appendix D - U/D Ratio between DAB+ Allotments and Analogue Television	xxxix
	Appendix E – Thailand VHF Analogue Television Database as provided by NBTC	xli

FIGURES

Figure 1: Screen shot CHIRplus_BC - Planning Parameters Analogue TV Service Coverage	10
Figure 2: Screen shot CHIRplus_BC - Planning Parameters DAB+ Interference to Analogue TV Services	11
Figure 3: Screen shot CHIRplus_BC - Planning Parameters DAB+ Coverage	12
Figure 4: Screen shot CHIRplus_BC – Configuration Network Simulator.....	13
Figure 5: Frequency difference between vision carrier of unwanted signal and centre frequency of T-DAB (MHz)	15
Figure 6: Power level measured in a 4 kHz bandwidth measured in a 4 KhZ bandwidth where 9 dB corresponds to the total output power.....	16
Figure 7: Antenna Pattern at Chon Buri Station	17
Figure 8: Antenna Pattern at Hua Hin Station	18
Figure 9: Coordination with ATV for DAB+ Channel 8 in Bangkok Area.....	ii
Figure 10: Coordination with ATV for DAB+ Channel 8 in Chiang Mai Area	iii
Figure 11: Coordination with ATV for DAB+ Channel 7 in Nakkon Ratchasima Area	iv
Figure 12: Coordination with ATV for DAB+ Channel 8 in Khon Kaen Area.....	v
Figure 13: Coordination with ATV for DAB+ Channel 7 in Songkhla Area.....	vi
Figure 14: Coordination with ATV for DAB+ Channel 8 in Nakkon Sri Thammarat Area.....	vii
Figure 15: Coordination with ATV for DAB+ Channel 8 in Chon Buri Area.....	viii
Figure 16: Coordination with ATV for DAB+ Channel 8 in Hua Hin Area.....	ix
Figure 17: DAB+ Allotment Coverage Bangkok - 1	xv
Figure 18 - DAB+ Allotment Coverage Bangkok – 2.....	xvi
Figure 19 - DAB+ Allotment Coverage Bangkok – 3.....	xvii
Figure 20 - DAB+ Allotment Coverage Chiang Mai – 1	xviii
Figure 21 - DAB+ Allotment Coverage Chiang Mai – 2.....	xix
Figure 22 - DAB+ Allotment Coverage Chiang Mai – 3.....	xx
Figure 23 - DAB+ Allotment Coverage Nakhon Ratchasima – 1	xxi
Figure 24 - DAB+ Allotment Coverage Nakhon Ratchasima – 2	xxii
Figure 25 - DAB+ Allotment Coverage Nakhon Ratchasima – 3	xxiii
Figure 26 - DAB+ Allotment Coverage Khon Kaen – 1	xxiv
Figure 27 - DAB+ Allotment Coverage Khon Kaen – 2.....	xxv
Figure 28 - DAB+ Allotment Coverage Khon Kaen – 3.....	xxvi
Figure 29 - DAB+ Allotment Coverage Songkhla – 1	xxvii
Figure 30 - DAB+ Allotment Coverage Songkhla – 2.....	xxviii
Figure 31 - DAB+ Allotment Coverage Songkhla – 3.....	xxix
Figure 32 - DAB+ Allotment Coverage Nakhon Sri Thammarat – 1.....	xxx
Figure 33 - DAB+ Allotment Coverage Nakhon Sri Thammarat – 2.....	xxxix
Figure 34 - DAB+ Allotment Coverage Nakhon Sri Thammarat – 3.....	xxxii
Figure 35 - DAB+ Allotment Coverage Chonburi – 1	xxxiii
Figure 36 - DAB+ Allotment Coverage Chonburi – 2	xxxiv

Figure 37 - DAB+ Allotment Coverage Chonburi – 3	xxxv
Figure 38 - DAB+ Allotment Coverage Hua Hin – 1	xxxvi
Figure 39 - DAB+ Allotment Coverage Hua Hin – 2	xxxvii
Figure 40 - DAB+ Allotment Coverage Hua Hin – 3	xxxviii

TABLES

Table 1: Summary data on each of the DAB+ multiplex	5
Table 2 - DAB Planning Parameters	13
Table 3: Coverage Reserve.....	14
Table 4: The 11 cities identified for the DAB+ Trial Plan.....	21
Table 5: Population covered for each proposed allotments	22
Table 6 - Population Objectives Analysis	23
Table 7 - Hybrid Population Objectives Analysis.....	24
Table 8: Available DAB+ Allotments.....	xii
Table 9: U/D Ratio between DAB+ Allotments and Analogue Television	xl

1. Executive Summary

The Office of the National Broadcast and Telecommunications Commission, herein in this report referred to as “NBTC”, has the mandate to implement and promote the Thai Government’s policy objectives for the broadcast and telecommunications sector in Thailand, and to establish and monitor the regulatory frameworks for the guidance of the telecommunications and broadcasting industry.

In the execution of its mandate to regulate the broadcasting sector in Thailand in line with the duties and responsibilities laid down in the Telecom Act BE2555 sections 27(1) and (5) the NBTC has embarked on a Radio Frequency Plan Project, hereinafter referred to as “RFPP”, with the main objective to develop a forward-looking radio frequency plan including related policy and implementation strategy for the introduction and management of digital radio services in Thailand based, among others, on international best practises established through a comparative assessment and benchmark study between Thailand and the benchmark countries subject to this study.

The technical terms and conditions for the use of radio frequency services to be developed within the scope of this project shall give consideration to public, local, and commercial services (including local, regional, and national levels). In addition technical standards for the sound broadcasting services shall be defined. The radio frequency plan and related technical standards shall be developed in compliance with Act on Organization to Assign Radio Frequency and to Regulate the Broadcasting and Telecommunications Services B.E 2553 (2010): article 27 (1) (5) and (10).

The main focus of the Consultancy is intended to be laid on

- the maximisation of the overall public benefit from use of the spectrum allocated for digital radio services;
- transparent and effective process for the introduction and management of digital radio services;
- assessment, evaluation and recommendation to optimise the FM radio services;
- assessment of the current AM radio services; and
- benchmarking of the different proposal with international country’s standards.

The NBTC has entrusted LS telcom Limited, hereinafter referred to as the “Consultant”, with the task to conduct this Radio Frequency Plan Project.

1.1 Scope Practical Principle and Technical Standards for DAB+ Trial Planning Report

The scope of this document is to present the proposed DAB+ Scenario 1. The Scenario 1 is defined as:

The initial DAB+ Trial Plan for 11 cities¹ in Thailand that were selected by the NBTC will be based on a compatibility approach with the existing ATV (analogue TV) infrastructure. This plan will allow for a quick deployment and for the beginning of the Digital Radio trial. This plan might also include some SFN capacity in order to test and validate the SFN approach and to extend and/or improve the initial coverage. It should be noted that until the TV Analogue Switch-Off (ASO) is completed, SFN repeaters may create local interference to analogue TV operations. This initial DAB+ Trial Plan will focus on the basic DAB+ ensemble that will become the national services (whereas some repacking might be necessary).

1.2 Context of Work Assignment: ‘Trial DAB+ Plan’

In 2013, the NBTC issued the “Term of Reference Consultancy Service for Radio Frequency Plan and Technical Standards of Sound Broadcasting Service” in the context of Thailand’s plans and strategy to migrate to digital broadcast technology for radio and TV broadcast services. The Consultant responded to the NBTC and after a successful negotiation period has been attributed the mandate to complete the AM, FM and digital radio plans for Thailand.

The NBTC selected a staged approach for the introduction of DAB+ in Thailand and 3 project involvement stages – an introductory stage, a transitional stage and a final stage.

In response to NBTC’s requirements under this mandate, the Consultant has been provided the following three (3) digital radio plan scenarios:

- DAB+ Trial plan for 11 cities specified by the NBTC (Scenario 1);
- Transitional DAB+ plan on a national level (Scenario 2); and
- Final DAB+ plan after analogue TV switch-off on a local, regional and national level according to the ITU report presented to NBTC (Scenario 3).

The present report addresses Scenario 1, or the “Trial DAB+ Plan”.

In the introductory stage of the DAB+ standard implementation in Thailand, NBTC intends to initiate a DAB+ trial in 11 cities in the Kingdom of Thailand to collect operational and performance data for the design, configuration and specification of the parameter set for the future implementation of nationwide DAB+ network services.

The Trial DAB+ Plan presented in the following sections has been established in consideration of these conditions.

¹ List of the 11 cities is given in Table 1 of this document.

1.3 Preliminary Key Findings

In the course of this work assignment the following preliminary key findings were made by the Consultant when establishing the Trial DAB+ Plan:

- The desired number of multiplex (3) could be realized for each of the 11 cities.
- For the first 4 cities which are all located in the Bangkok metropolitan area (Bangkok, Nonthaburi, Samut Prakarn and Pathumthani), only one transmission site was useable (Bangkok) in order to adequately protect the Analogue Television (ATV).
- The Chonburi and Hua Hin will not be co-sited with the adjacent ATV channels. Therefore, overloading interference can occur to the adjacent ATV channels in the vicinity of the DAB transmitter. No solution was found to avoid the interference on ATV and provide usable allotments in Chonburi and Hua Hin. Therefore, implementation of DAB+ allotments in Chonburi and Hua Hin wasn't possible in Scenario 1.
- Optionally, the Consultant has determined that if Chonburi and Hua Hin sites are implemented, they can be configured in SFN configuration with the Bangkok sites.
- All selected DAB channels are either on VHF III band channel 7 or on channel 8. This configuration will allow for an easy migration to one single channel (possibly channel 8) when deriving the national SFN plan in Scenario 3.
- The Nakhon Ratchasima site, if implemented, will have to use channel 7, but will be modified to channel 8 in Scenario 3 to be part of the National Multiplex.
- The Songkhla site will also use channel 7 but will stay on channel 7 in scenario 3 to allow for the coordination with Malaysia.
- Table 1 below gives summary data on each of the DAB+ multiplex (detailed data can be found in Appendix B).

The table below represents a summary of data for each of the identified DAB+ multiplex.

Allotment	Channel	Frequency	Tower	Lat	Lon	Antenna Radiation Center (AGL)	MAX DAB+ ERP (dBW)	MAX DAB+ ERP (W)
Bangkok-1	8B	197.648	Bangkok (Sapan Daeng)	13.79051 4	100.5253 5	185	40	10000
Bangkok-2	8C	199.36	Bangkok (Sapan Daeng)	13.79051 4	100.5253 5	185	45	31622
Bangkok-3	8D	201.072	Bangkok (Sapan Daeng)	13.79051 4	100.5253 5	185	50	100000
Chiang Mai-1	8B	197.648	Chiang Mai CH7	18.79778	98.94277 8	63	30.97	1250
Chiang Mai-2	8C	199.36	Chiang Mai CH7	18.79778	98.94277 8	63	35.97	3953
Chiang Mai-3	8D	201.072	Chiang Mai CH7	18.79778	98.94277 8	63	40.97	12502
Nakhon Ratchasima (Korat) – 1	7B	190.64	Nakhon Ratchasima MCOT	14.94777 9	102.0037 4	153	36.99	5000
Nakhon Ratchasima (Korat) – 2	7C	192.352	Nakhon Ratchasima MCOT	14.94777 9	102.0037 4	153	41.99	15812
Nakhon Ratchasima (Korat) – 3	7D	194.064	Nakhon Ratchasima MCOT	14.94777 9	102.0037 4	153	46.99	50003
Khon Kaen - 1	8B	197.648	Khon Kaen MCOT	16.45337 8	102.9501 6	136	43	19952
Khon Kaen - 2	8C	199.36	Khon Kaen MCOT	16.45337 8	102.9501 6	136	48	63095
Khon Kaen - 3	8D	201.072	Khon Kaen MCOT	16.45337 8	102.9501 6	136	53	199526
Songkhla – 1	7B	190.64	Song Khla CH5	7.037696	100.5186 4	80	27	501
Songkhla – 2	7C	192.352	Song Khla CH5	7.037696	100.5186 4	80	32	1584
Songkhla – 3	7D	194.064	Song Khla CH5	7.037696	100.5186 4	80	37	5011
Nakhon Sri Thammarat - 1	8B	197.648	Nakhon PRD	8.366633 3	99.97735 6	123	31	1258
Nakhon Sri Thammarat - 2	8C	199.36	Nakhon PRD	8.366633 3	99.97735 6	123	36	3981
Nakhon Sri Thammarat - 3	8D	201.072	Nakhon PRD	8.366633 3	99.97735 6	123	41	12589
Chonburi – 1	8B	211.648	Chonburi MCOT	13.18982 2	100.9505 6	43	30	1000
Chonburi – 2	8C	213.36	Chonburi MCOT	13.18982 2	100.9505 6	43	35	3162

Allotment	Channel	Frequency	Tower	Lat	Lon	Antenna Radiation Center (AGL)	MAX DAB+ ERP (dBW)	MAX DAB+ ERP (W)
Chonburi – 3	8D	215.072	Chonburi MCOT	13.18982 2	100.9505 6	43	40	10000
Hua Hin – 1	8B	211.648	Hua Hin CH 7	12.56514 2	99.93517 6	55	43.01	19998
Hua Hin – 2	8C	213.36	Hua Hin CH 7	12.56514 2	99.93517 6	55	48.01	63241
Hua Hin – 3	8D	215.072	Hua Hin CH 7	12.56514 2	99.93517 6	55	53.01	199986

Table 1: Summary data on each of the DAB+ multiplex

Note that for transmitter sites where the maximum permissible ERP was above 50 kW (values in gray), the Consultant has considered that the maximum implementation ERP values should be 50 kW. For this reason the coverage results have been evaluated at 50 kW.

It should be noted that for COFDM based services such as DAB+, the overall coverage gains are much greater by the addition of transmitters instead of increasing the maximum power. Consequently, the Consultant does not recommend considering the implementation of transmitter station with an EIRP higher than 50 kW. Additional transmitter stations or gap fillers should be considered instead.

In conclusion, upon discussion with the NBTC during the week of July 14, 2014 in Bangkok, it has been decided not to implement the Nakhon Ratchasima, Chon Buri and Hua Hin sites (orange shadowed sites in table 1 above) since these sites were not meeting the objectives set for Scenario 1. These sites were not fully protecting the existing analogue television service and being compatible with future Scenario 3. Information related to these sites is provided in the report as reference material only.

2. Network Design and Presentation Format

In the following section the Consultant describes the simulation software, input parameter and methodology applied for deriving the Trial DAB+ Plan.

Based on NBTC inputs (actual usage of the analogue television (ATV) channels in Thailand), the Consultant was tasked to identify at least 3 multiplexes available in each city (if possible). In order to minimise the interference with the ATV service, the DAB+ multiplexes will share the same transmitter towers as the ATV stations, wherever feasible.

The potential interference can be of a co-channel or adjacent channel type. For Adjacent channels, a certain Desired/Undesired ratio needs to be respected. This ratio can be calculated at the analogue TV site that will be subject to coordination, since it is known to the Consultant that the ratio will stay constant if DAB+ and Analog Television signal are broadcasting from the same site or near co-sited within one (1) km of distance. If the DAB+ transmitter is located in a distance of a 1 km radius surrounding the TV station, it will create a “punch-hole” in the TV coverage around the DAB+ transmitter station. Depending on the distance between the DAB+ transmitter and the analogue TV transmitter station, this punch-hole can range from a couple of hundred meters (if nearby the TV transmitter - the TV signal is high), to multiple kilometers (if far from the TV transmitter station). Each case has to be analysed individually. For co-channel protection, the Consultant has evaluated the protection contours of the ATV stations and the interfering contours of the proposed DAB+ as per the methodology explained in section 2.3.2 below.

In cases where it was not possible to meet the DAB+ service coverage objectives, additional potential SFN repeater sites (gap fillers) will have to be identified. It should be noted that these SFN repeater sites may have a negative impact on the ATV service in the area surrounding the DAB+ SFN repeater stations. The potential interference on ATV stations will be limited to about a 5 km radius surrounding individual SFN repeater sites. All transmitter locations and proposed antenna heights will be based on tower information provided by NBTC.

Optionally in this plan, the Chonburi and Hua Hin transmitter sites, if implemented, could be used in SFN. But, the Chonburi and Hua Hin sites could not be co-located with the adjacent ATV stations as they would create some interference to adjacent TV channels in the vicinity of the transmitters. If upon analysis the protection of ATV adjacent channels is mandatory, there are no other solutions for providing a DAB+ service to Chonburi and Hua Hin.

2.1 Planning Tool and Digital Terrain Data

For conducting the technical coverage analysis for the Trial DAB+ Plan based on the DAB+ standard, the Consultant utilized of its own developed and market leading broadcast network planning solution **CHIRplus_BC**, which is also in operation at the NBTC. **CHIRplus_BC** is currently used by more than 50 clients (regulators and operators) worldwide, including ACMA, Ofcom, Industry Canada and MCMC.

The software solution CHIRplus_BC respective licenses used in this project are and will remain the property of the LS telcom unless otherwise described. The user rights will not be transferred within the course of this project.

The analysis is based on the DTM (200 m resolution) and population layers provided by the NBTC.

Please note that the quality and the resolution of the digital terrain database as well as the quality of the other required input parameters have a significant impact on the quality of the analysis results.

In addition to the digital mapping data, NBTC made the following information available to the Consultant:

- Site information for main FM and Television transmitter stations including information such as, but not limited to:
 - Coordinates, elevation height of site, elevation height of the transmitting antenna for some of the sites, EIRP (W) for some of the sites, channel information, name of the site
- Population/demographic data.

Please note for sites for which the Consultant has not received all of the required information, the Consultant made assumptions and applied default values as described in this report.

2.2 Set up of Planning/Simulation Environment

The Consultant did carry out the following principle preparation and tool configuration work to conduct and deliver this coverage study:

- Setup planning tool CHIRplus_BC.
 - Import digital terrain data provide by the NBTC
 - Import population data provided by the NBTC
- Import main analogue TV and FM transmitter stations currently deployed and in operation in Thailand as provided by the NBTC.
 - Name
 - Coordinates
 - Frequency
 - Antenna pattern (for the purpose of this study, all antenna patterns are considered as non-directional)
 - EIRP (for analogue TV sites, many EIRP values were not available and a value of 50 dBW was considered as a default value)
 - Antenna elevation height above sea level
 - Terrain elevation height above sea level (this value was derived using the NBTC 200m resolution database)

The coverage analyse calculations for analogue television services have been based on the applicable ITU recommendations (ITU-R BS.412-9 for FM stations coordination, ITU-R 1546 for the DAB+ coordination simulations, 370-7 for the FM and TV protection calculation and ITU-R SM.851-1 for ATV station coordination).

The coverage analysis for the analogue transmitter stations have been based on the transmitter data provided by the NBTC. Please note, the quality of the calculation results depends on the accuracy of the provided data and information.

The purpose of this study is to establish the Trial Plan for DAB+ service coverage for portable indoor and mobile reception based on a SFN configuration in Thailand.

2.3 Planning Methodology

In order to derive the Scenario 1 plan, the Consultant has developed and applied the following methodology:

- Define the spectrum availability by analyzing the frequency assignments of the existing analog television stations;
- Evaluate the maximum permissible power that can be broadcasted for providing DAB+ services while protecting the television coverage of the related co-, lower first and upper first analog television adjacent channels.
- Evaluate the limitation factors derived from the existing television analog signals; and
- Determine the resulting DAB+ coverage.

2.3.1 Tower Selection Concept

For Scenario 1, protection to the Analogue Television Service (ATV) was required. Therefore, the Consultant selected the broadcasting tower sites based on the maximum protection to ATV. As determined in the section 2.6 of the report, coordination with the lower adjacent TV channel is more stringent than with the upper TV channel due to the sensitivity of the television audio carrier (smaller bandwidth than the luminance carrier). For this reason, co-siting with the television lower-adjacent channel was considered as a high priority throughout the site selection process.

2.3.2 Assessment Spectrum Availability

The amount of available spectrum is a key input parameter for the planning and introduction of new radio services such as DAB+. To define the spectrum availability, the Consultant has proceeded with the following activities:

- 1) Enter all VHF Band III analog television stations from the Excel sheet provided by NBTC (File name: VHF-Database v11 260514.xls), which is annexed to this report as Appendix E for reference purpose. It should be noted that most analog TV sites listed in the NBTC database do not have any information regarding the installed ERP. The Consultant used the information provided in the TV_plan_BE2539.pdf document in order to being in a position of adding the missing ERP information.
- 2) As per the ITU recommendation ITU-R SM.851-1 "Sharing between the broadcasting service and the fixed and/or mobile services in the VHF and UHF bands", the minimum desired field strength for analog television (PAL-B) in Band III is 55 dB μ V/m. The Consultant followed the ITU recommendation.
- 3) The Consultant has calculated and plotted all TV services coverage areas using the propagation model ITU-R 370-7 (for further information please see Appendix A – Coordination with Analog Television Service) and transmitters at statistics of 50% Time and 50% Locations. It should be noted that the coordination for each block (A to D) within the same frequency channel has been the same, since the Consultant was matching the maximum permissible ERP of the DAB+ transmitter to meet the maximum analogue television coordination requirement (as per ITU-R SM.85101 minimum protection requirement). This means that the same methodology has been applied for the coordination of each block (A to D) and therefore only one simulation is provided in Appendix A that shows the coordination with the co-channel analogue TV service. Of course, the D/U ratio are not the same for each block, but lowering the proposed ERP value of a specific block by 'X dB' and increasing at the same time the protection ratio by the same 'X dB' value will

result in the exact same simulation result. The table in Appendix 2 shows the different values for each of the blocks.

- 4) The Consultant has evaluated the co-channels' and, lower and upper adjacent channels' desired/undesired ratio (D/U) between DAB+ stations and analog TV stations applying the values for Tropospheric Protection provided in Table A7-1 of the EBU (European Broadcasting Union) document TR 021².
 - a. Note that to evaluate the co-channel interference, the Consultant has considered that the analog TV service will be received using a directional antenna with a front-to-back ratio of 14 dB, thus providing 14 dB of additional power margin that can be coordinated for the benefit of the DAB+ service.
 - b. Additionally, the document ITU-R SM.851-1 specifies in section 4.1.1 that "Interference from stations of the fixed service or base stations of the land mobile service which are orthogonally polarized with respect to a station of the television service. In this case, the adjustment factor is equal to the antenna discrimination which has a value of -16 dB for 50% of locations and -10 dB for 90% of locations." Consequently, the Consultant considered an additional 10 dB of protection to the TV service for co-channel coordination (this could not be applied to adjacent channels since they will be co-sited with the DAB+ transmitter and will be received in a zone where VHF dual-dipoles - commonly called rabbit-ears - type antenna will be used).
- 5) The Consultant has selected suitable sites for the location of the DAB+ antennas, based on the document "*Transmitter sites for DAB+ scenario A 1 Trial 10+1 v 2 170457.xls*", received from the NBTC on April 17, 2014. When no suitable site in this file provided by the NBTC could be identified, the Consultant has used other existing TV sites as alternative DAB+ sites and defined the potential DAB+ radiation center as the total height of the identified alternate tower site minus 50 meters.
- 6) The protection ratio is different for each block of on DAB+ multiplex. For each of the 11 cities, the Consultant analysed each potential channel that could meet the calculated protection ratio based on channel relationships of co-, lower or upper adjacent channels. This exercise allowed the Consultant to identify for each city the best channel to use for the DAB+ multiplex as well the permissible ERP of each of its blocks. With this approach the lowest permissible ERP of each of the blocks becomes the highest permissible ERP for the corresponding DAB+ multiplex. The table in Appendix B summarizes all available DAB+ channel blocks that were identified by the Consultant, with their associated maximum ERP level and other relevant technical data linked to each of them.
- 7) In addition to the results detailed below, the report on Scenario 1 provides a realistic simulation, highlighting the service areas and the covered population for each of the best candidate channels for each of the 11 cities (where the first 4 cities are covered by the Bangkok transmitter site), as per the definition provided in section 5.2.5 of the Inception Report (see Appendix C).
- 8) In cases where the evaluated maximum permissible ERP was above 50 kW, the value was limited to 50 kW for reasons explained in the preceding sections. The Consultant considers that the implementation of ERPs above 50 kW is not practical.

² European Broadcasting Union, *Technical Bases for T-DAB Services Network, Planning and Compatibility with Existing Broadcasting Services - TR 021*, Geneva, October 2013. Table A7-1.

2.4 Planning Tool Settings for Analogue Television Simulations

The Consultant defined the following data, parameter set and analysis models to simulate the existing analogue television service coverage.

- **CHIRplusBC Version 5.8.0 r1**
- Wave propagation model: ITU-R 370-7 Terrain Mode Model
 - Statistics: 50% time, 50% location
- Receiving antenna height for fixed reception: 10 m
- Usage of DTM-data (digital terrain model) – resolution 200m
- Usage of Clutter-data (land use data) – resolution 200m
- Wanted summation procedure: T-Log-Normal
- Interfering summation procedure: Power Sum [No interference simulations have been undertaken at this stage]

The following CHIRplus_BC screen shots demonstrate the parameter setup for the analogue television protected contour simulations:

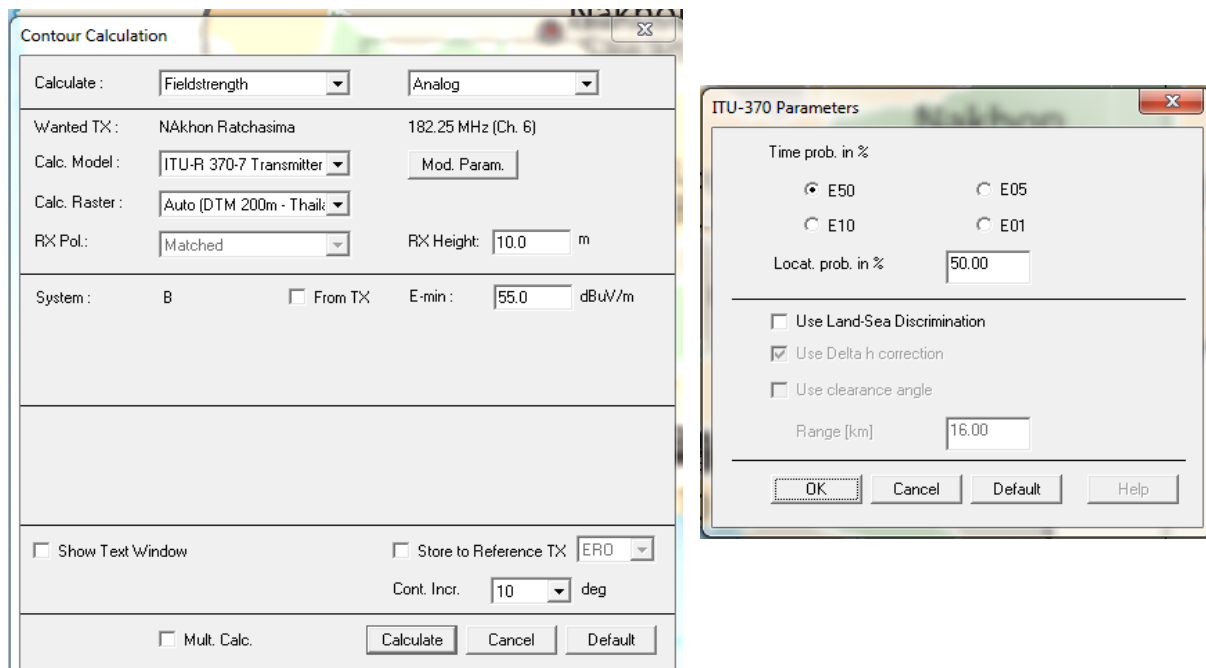


Figure 1: Screen shot CHIRplus_BC - Planning Parameters Analogue TV Service Coverage

2.5 Planning Tool Settings for DAB+ Interference on TV Simulations

The Consultant defined the following data, parameter set and analysis models to simulate the interference level from the planned DAB+ services to the existing analogue television service coverage.

- **CHIRplusBC Version 5.8.0 r1**
- Wave propagation model: ITU-R 1546 Terrain Mode Model
 - Statistics: 10% time, 50% location
- Receiving antenna height for fixed reception: 10 m (considering the interference to TV)
- Usage of DTM-data (digital terrain model) – resolution 200m
- Usage of Clutter-data (land use data) – resolution 200m
- Wanted summation procedure: T-Log-Normal
- Interfering summation procedure: Power Sum [No interference simulations have been undertaken at this stage]

It should be noted that the DAB+ maximum interference on the TV protected contour has been determined by evaluating visually on each simulation map the resulting interference zone inside the TV protected service contour (see Appendix A). In some instances, the DAB+ signal can cause interference to the TV service over water. For transmitters located in mountainous areas, some interference on the TV service can occur on mountain peaks.

The following CHIRplus_BC screen shots demonstrate the parameter setup for DAB+ interference to analogue television simulations:

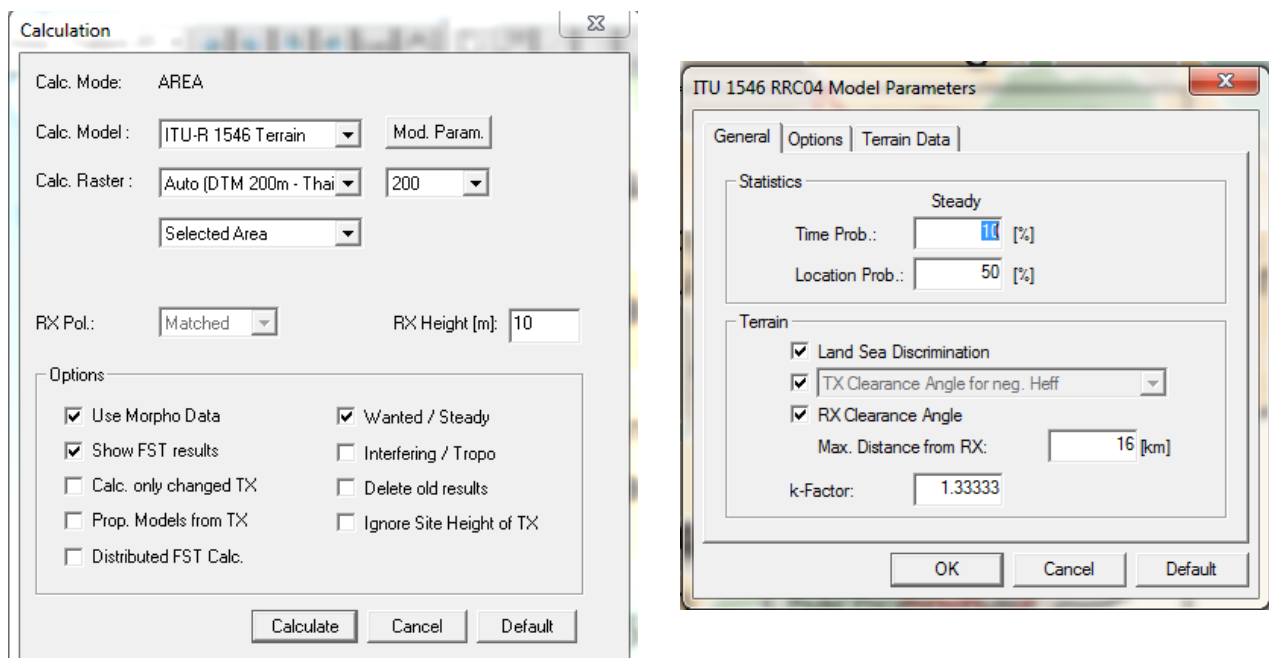


Figure 2: Screen shot CHIRplus_BC - Planning Parameters DAB+ Interference to Analogue TV Services

2.6 Planning Tool Settings for DAB+ Coverage Simulations

The Consultant defined the following data, parameter set and analysis models to simulate the planned DAB+ service coverage.

- **CHIRplusBC Version 5.8.0 r1**
- Wave propagation model: CRC-Predict
 - Statistics: 50% time, 50% location
- Receiving antenna height for fixed reception: 1.5 m
- Usage of DTM-data (digital terrain model) – resolution 200m
- Usage of Clutter-data (land use data) – resolution 200m
- Wanted summation procedure: T-Log-Normal
- Interfering summation procedure: T-Log-Normal [No interference simulations between DAB services have been undertaken at this stage]

The following CHIRplus_BC screen shots demonstrate the parameter setup for DAB+ coverage simulations:

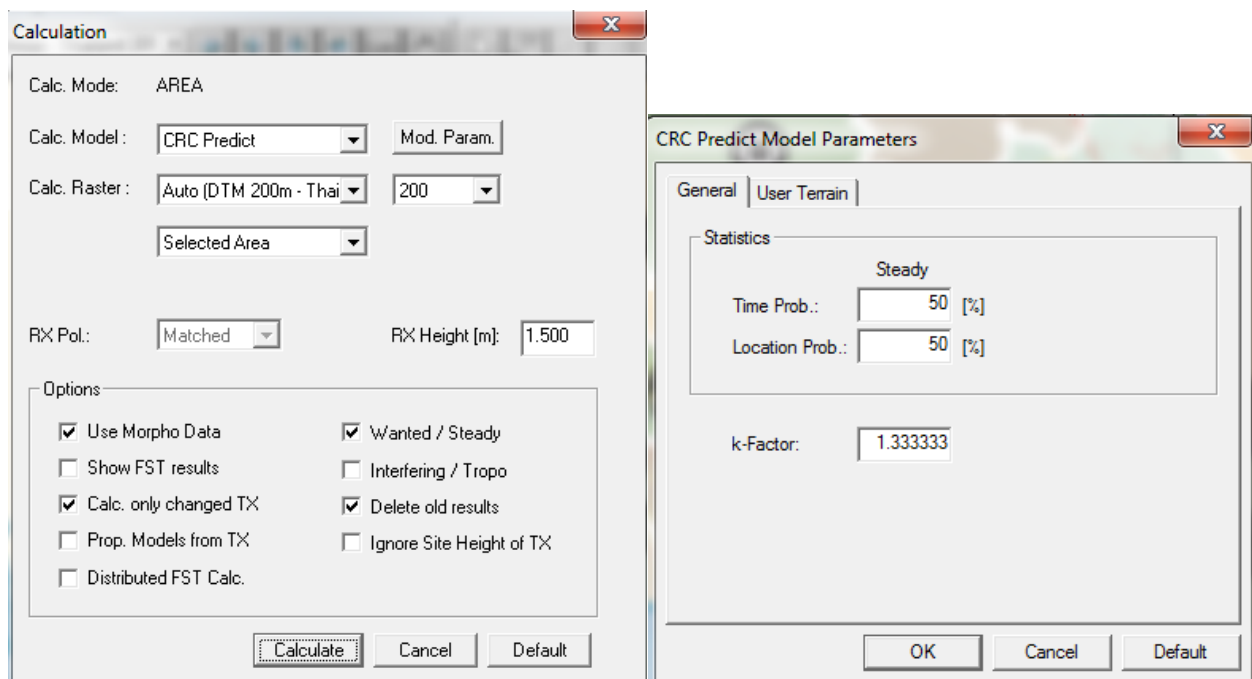
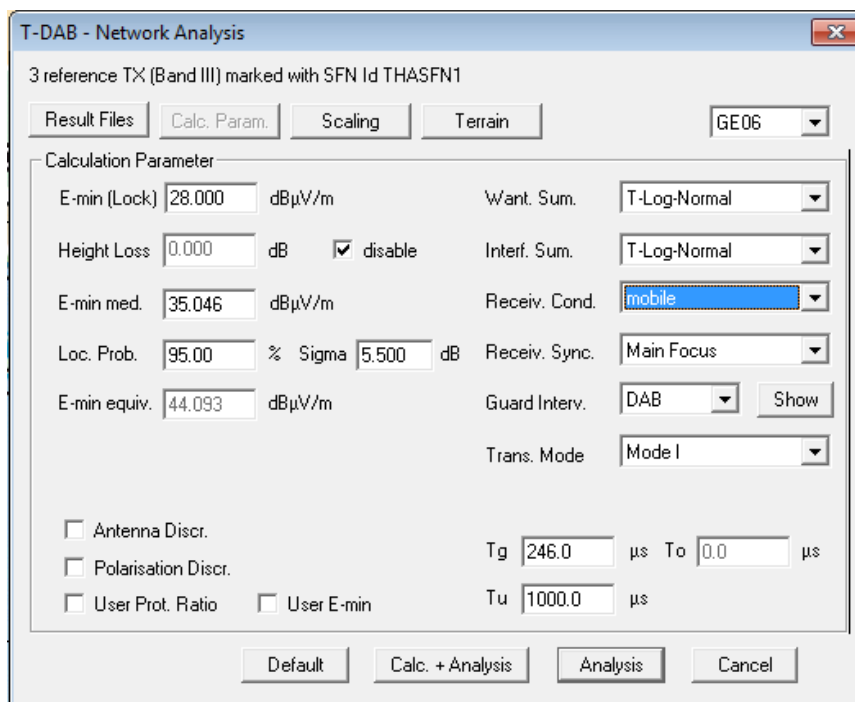


Figure 3: Screen shot CHIRplus_BC - Planning Parameters DAB+ Coverage

In addition the following configuration of the CHIRplus_BC network simulator was used for the DAB+ service coverage simulations:



T-DAB - Network Analysis

3 reference TX (Band III) marked with SFN Id THASFN1

Result Files Calc. Param. Scaling Terrain GE06

Calculation Parameter

E-min (Lock) 28.000 dBμV/m Want. Sum. T-Log-Normal

Height Loss 0.000 dB ☒ disable Interf. Sum. T-Log-Normal

E-min med. 35.046 dBμV/m Receiv. Cond. mobile

Loc. Prob. 95.00 % Sigma 5.500 dB Receiv. Sync. Main Focus

E-min equiv. 44.093 dBμV/m Guard Interv. DAB Show

Trans. Mode Mode I

☐ Antenna Discr. Tg 246.0 μs To 0.0 μs

☐ Polarisation Discr. Tu 1000.0 μs

☐ User Prot. Ratio ☐ User E-min

Default Calc. + Analysis Analysis Cancel

Figure 4: Screen shot CHIRplus_BC – Configuration Network Simulator

The parameters used for the simulations are those accepted in the ITU GE06 Agreement for Digital Broadcasting. The selected values correspond to the following DAB+ planning parameters:

Parameter	Value
Planning Tool	LS telcom CHIRplus_BC
Propagation model	CRC Predict
Terrain and clutter Database	NBTC Thailand Database
Population Database	Provided by NBTC
Equivalent Median Reception Level	44.093 dBμV/m
Receiving Antenna height above ground level	1.5 m
Coverage Area Simulation Size	200 X 200
Coverage Area Target Service Availability	95%; Sigma: 5.5 dB
DAB Transmission mode	Mode I
DAB+ Emission Mask Considered for Coordination	Critical Mask (see 2.6.2)

Table 2 - DAB Planning Parameters

Appendix C to this document shows for each of the 11 cities locations a service coverage for 95% of location probability, displaying the additional service margin in dB (coverage reserve) as per the following scale:

Coverage Reserve	Service Quality
0.1-3 dB	Marginal Operation
3-10 dB	Outside Aerial Operation
10 - 20 dB	Good Mobile Operation / Basic Indoor Operation
20 dB+	Good Indoor Operation

Table 3: Coverage Reserve

The *coverage reserve* values proposed in Table 2 are based on *Mobile Receiver Condition*. The simulator considers a more stringent reception C/N+I criteria than for fixed reception. It should be noted that the document TR025 from the EBU³ has evaluated the C/N for DAB+ fixed reception at 5.7 dB while 11.8 dB is required for mobile. Also, the Consultant's simulation was based on DAB+ demodulation at 15 dB of C/N. Consequently, our coverage reserve has an "additional reserve" of 9.3 dB relative to fixed DAB+ reception.

Although The Consultant understands that the coverage objective in downtown Bangkok requires a strong signal density, it is the Consultant's opinion that the 10-20 dB range should provide adequate representation of the coverage objective for all fixed indoor situations where a window is accessible in the room where the receiver is located. For basements and central building rooms, even the 20 dB+ range might not be sufficient to cover these areas and only an SFN approach might produce sufficient power density to allow for the adequate reception of the signal.

2.6.1 Coordination Calculation between DAB+ and Television Analogue Services

The Consultant has considered the protection of the analogue television services transmitted on co-channels, upper first and lower first adjacent channels from the DAB+ multiplex channel.

To evaluate the desired to undesired ration (D/U), the Consultant has considered the values for Tropospheric Protection provided in Figure A7-1 of the EBU (European Broadcasting Union) document TR 021 (please refer to figure 5 below).

³ European Broadcasting Union, *Report on Frequency and Network Planning Parameters Related to DAB+ TR 025*, Geneva, October 2013. Table 3.

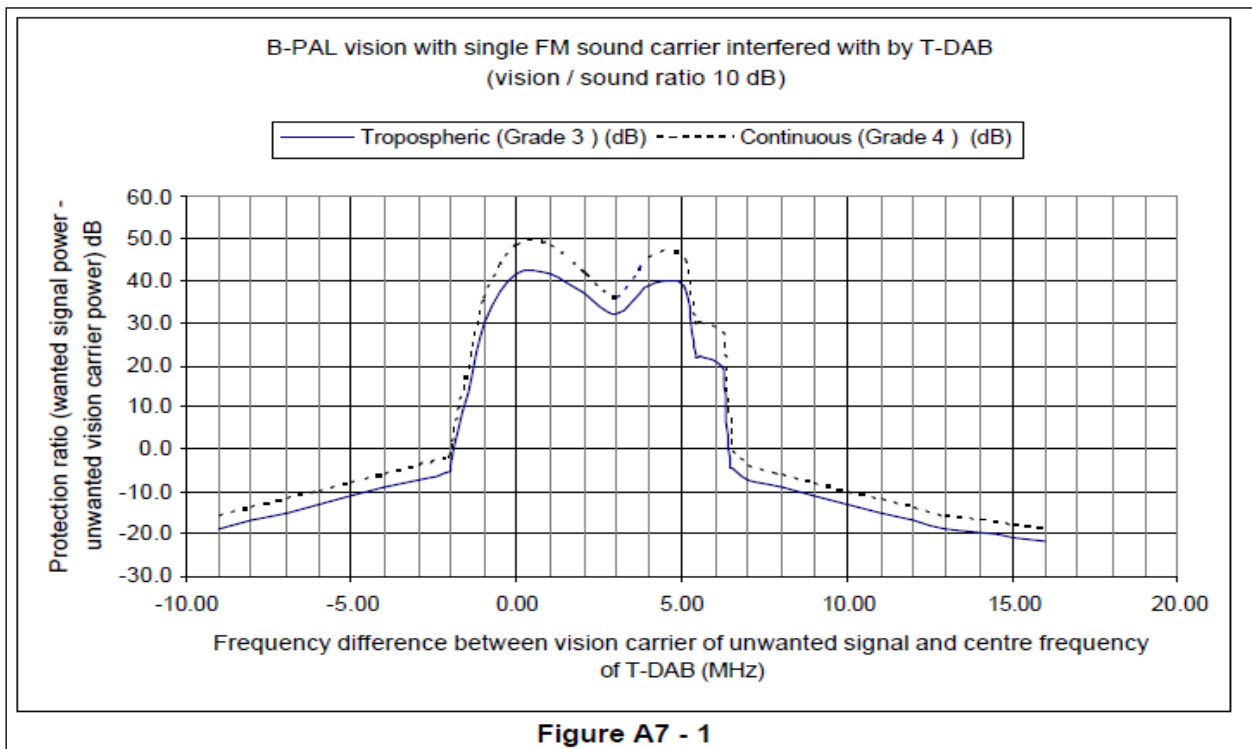


Figure 5: Frequency difference between vision carrier of unwanted signal and centre frequency of T-DAB (MHz) ⁴

NOTE: It has been identified that the values in EBU TR21 Table A7-1 were not consistent with the Figure A7-1. After a clarification request received from the EBU, the EBU has confirmed that the Figure A7-1 was to be used, but did not offer a corrected Table A7-1. Therefore, the Consultant has digitised the values from the Figure A7-1 in order to provide the reference. This process may have resulted in digitalisation errors due to the poor scale definition of the original Figure A7-1. The values are provided in Appendix D to the report. After the digitisation was completed at approximately every 0.5 MHz (half of the lowest scale on the graph), only the coordination value for the block B remained the same as what was used when using the tabled values from the EBU TR21 report. Therefore, the protection of the analogue TV station for channel B is still valid and other values have been calculated from this ratio. Appendix B shows the new values for the allotments.

From the diagram above, the Consultant has derived the U/D ratio for each DAB+ channel relation with analogue television (see Appendix D).

Furthermore, as explained in section 2.3.2.4, the Consultant has considered an additional 14 dB of front-to-back ratio for ATV receiving antenna as well as a 10 dB for cross-polarization discrimination which results in a total of a 24 dB protection ratio. This additional protection was only used for the calculation of the co-channel interference, since the DAB+ transmitters that are supposed to be co-located with adjacent ATV channels and receivers located in close proximity of the ATV transmitters might be using dual dipole (rabbit-ears) type antenna.

⁴ European Broadcasting Union, *Technical Bases for T-DAB Services Network, Planning and Compatibility with Existing Broadcasting Services - TR 021*, Geneva, October 2013. Table A7-1.

2.6.2 Emission Mask

The protection ratios presented in section 2.6.1 above include the use of the “Critical” RF Emission mask as per the following specification:

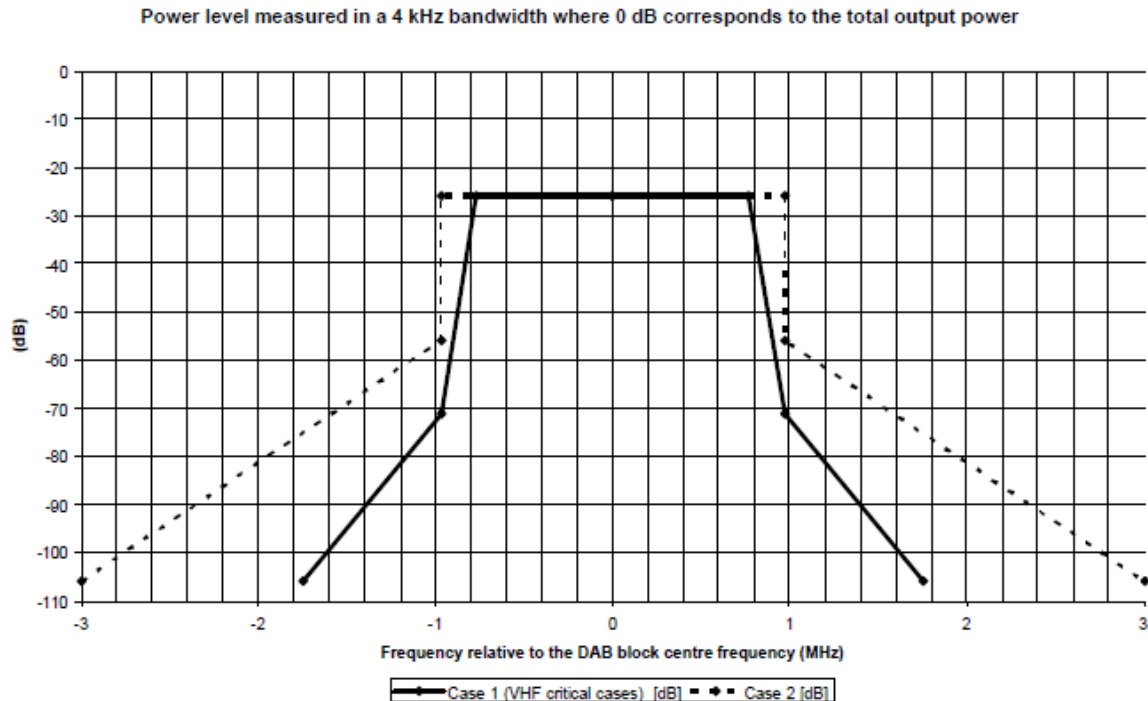


Figure 6: Power level measured in a 4 kHz bandwidth measured in a 4 KhZ bandwidth where 9 dB corresponds to the total output power

The emission mask as defined by the solid line shall apply to VHF transmitters in critical areas for adjacent channel interference from other DAB+ frequency blocks or from the television service. The dotted line emission mask applies to VHF DAB+ transmitters in other circumstances (generally for gap filler usage).

2.7 Antenna Patterns

Unless specified, all DAB+ allotments are using omni directional antennas as decided by the NBTC.

The only 2 groups of allotments that are using directional antennas are in Chon Buri and Hua Hin. For those allotments, the following directional antenna patterns have been considered for the simulations.

2.7.1 Chon Buri Station Directional Antenna

The following directional antenna pattern has been considered for Chon Buri. This antenna pattern can be created by using one 90 degree side panel antenna.

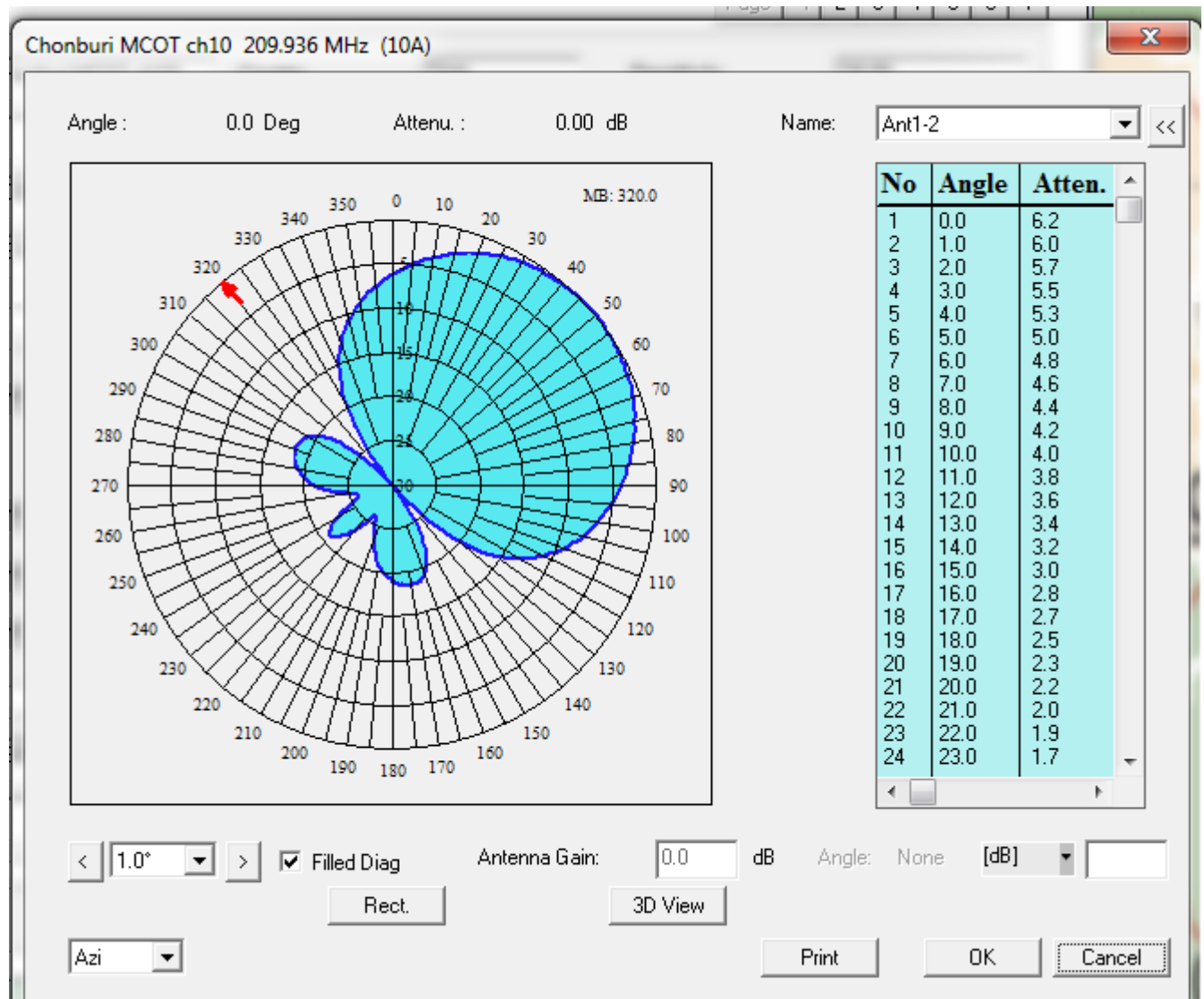


Figure 7: Antenna Pattern at Chon Buri Station

2.7.2 Hua Hin Station Directional Antenna

The following directional antenna pattern has been considered for Hua Hin. This antenna pattern can be created by using two 90 degree side panel antennas to create a 180 degrees pattern.

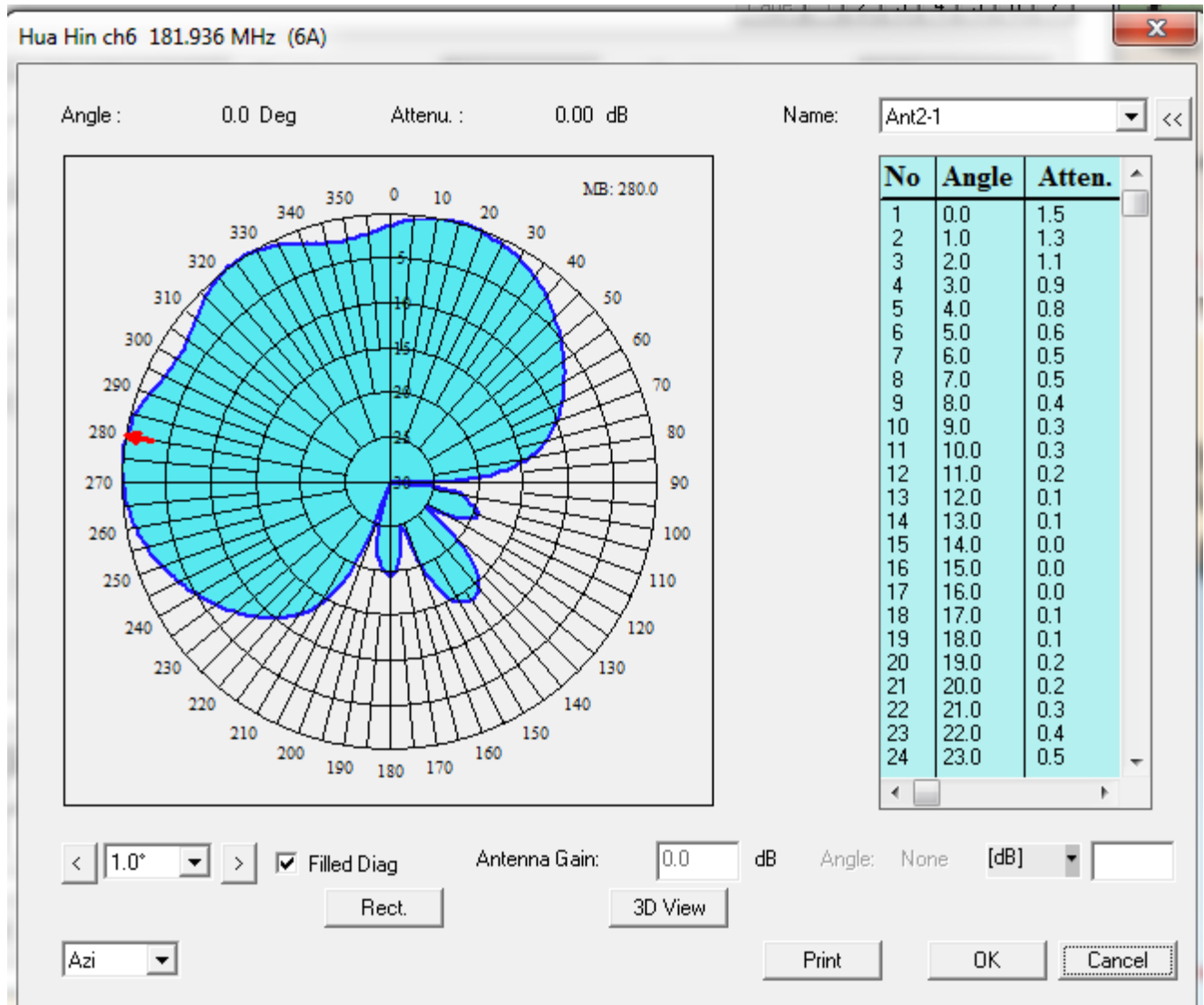


Figure 8: Antenna Pattern at Hua Hin Station

2.8 DAB Channel Selection

Whenever it was possible, the Consultant has selected the ATV channel 8 as the main core for the DAB+ Plan. This channel is usable in most of the area with the exception of Nakkon Ratchasima and Songkhla where only odd number channels were usable. For this reason, the Consultant has been proposing the use of channel 7 in Nakkon Ratchasima and Songkhla. Since the final objective in Scenario 3 is to provide 4 national multiplexes, the Consultant's objective is to plan the allotments for the National SFN based on channels 8 to the best possible extent. If MFN operation is required in some area, channel 7 will be considered as the primary alternate. At this time, the blocks B, C and D have been considered for the 3 multiplexes since they allow for a better protection of the ATV lower adjacent channel. For the final plan, block A will be added to create a 4 block DAB+ ensemble.

3. DAB+ Allotment Discussions

Of the general objective of the project is to define the allotment plan for the roll-out of DAB+ services in Thailand. For Scenario 1 an allotment plan has been defined by the Consultant as suggested and summarized in the following section:

- The first 3 allotment blocks (on channel 8) are in the Bangkok area:
 - Bangkok, Nonthaburi, Samut Prakam and Pathumthani will be covered from their main transmitter site in Bangkok.
- The Consultant avoided any usage of the channel 12, as requested by the NBTC.
- If used in MFN, the Chonburi and Hua Hin allotments will have to be coordinated with the Bangkok allotments. As previously discussed, Chonburi and Hua Hin will not be implemented in the course of the Scenario 1 trial project.
- Due to the configuration of the analogue television channels in Thailand (usually alternating between odd and even channel numbers per province) and due to the protection configuration ratios for co- lower and upper adjacent channels, it has been found that the channel D is usually the most permissible ERP channel of each group, i.e. it allows for the highest ERP values.

3.1 Scenario 1 Population Coverage Objectives

The population coverage objective for Scenario 1 was to provide the best possible DAB+ service coverage for the population in each of the 11 cities that were defined by the NBTC for Scenario 1, the Trial DAB+ Plan.

For this report and easier reference the following table lists all the 11 cities, its relating province and population based on population information database provided by the NBTC.

Please note, for executing the population coverage analysis the 2012 population census data as provided by NBTC to the Consultant on May 26, 2014 were used.

In order to evaluate if the proposed population coverage is meeting the general objectives of the plan, the population in the ranges 10-20 dB and 20 dB+ DAB+ signal coverage areas should be considered (see the discussion at section 2.6).

City	Province	Population ⁵ Per Province
Bangkok	Bangkok	5,673,560
Nonthaburi City	Nonthaburi	1,141,673
Samut Prakarn	Samut Prakarn	1,223,302
Pathumthani	Pathum Thani	1,033,837
Chiang Mai	Chiang Mai	1,655,642
Nakorn Ratchasima (Korat)	Nakorn Ratchasima	2,601,167
Khon Kaen	Khon Kaen	1,774,816
Songkhla	Songkhla	1,378,574
Nakhon Si Thammarat	Nakhon Si Thammarat	1,534,887
Chon Buri	Chon Buri	1,364,002
Hua Hin ⁶	Prachuap Khiri Khan	517,050

Table 4: The 11 cities identified for the DAB+ Trial Plan

The following table highlights the population covered for each proposed allotments:

Allotment	Channel	Population Objectives (Province)	Population 20+ dB	Population 10-20 dB	Population 3-10 dB	Population 0.1-3 dB	Total Population
Bangkok-1	8B	9 072 372	3 903 867	3 384 685	1 651 443	550 085	9 490 080
Bangkok-2	8C	1 141 673	5 536 046	2 984 231	1 304 032	394 075	10 218 384
Bangkok-3	8D	1 141 673	6 238 939	2 703 144	1 160 348	392 920	10 495 351
Chiang Mai-1	8B	1 655 642	192 247	262 199	205 042	53 388	712 876
Chiang Mai-2	8C	1 655 642	301 564	311 791	131 337	41 446	786 138
Chiang Mai-3	8D	1 655 642	455 282	259 641	94 653	28 967	838 543
Nakhon Ratchasima (Korat) – 1	7B	2 601 167	254 730	239 778	196 436	108 856	799 800

⁵ Population data taken from 2012 Census, as provided by NBTC to the Consultant on May 26, 2014.

⁶ Population of the sub-district of Hua Hin only is 42,660.

Allotment	Channel	Population Objectives (Province)	Population 20+ dB	Population 10-20 dB	Population 3-10 dB	Population 0.1-3 dB	Total Population
Nakhon Ratchasima (Korat) – 2	7C	2 601 167	369 081	260 143	266 566	145 716	1 041 506
Nakhon Ratchasima (Korat) – 3	7D	2 601 167	496 303	309 828	344 239	182 402	1 332 772
Khon Kaen - 1	8B	1 774 816	291 650	294 122	300 741	164 912	1 051 425
Khon Kaen - 2	8C	1 774 816	396 305	345 245	372 110	194 743	1 308 403
Khon Kaen - 3	8D	1 774 816	396 305	345 245	372 110	194 743	1 308 403
Songkhla – 1	7B	1 378 574	325 079	174 357	160 630	86 742	746 808
Songkhla – 2	7C	1 378 574	405 556	208 903	194 769	81 504	890 732
Songkhla – 3	7D	1 378 574	499 561	249 246	201 483	75 514	1 025 804
Nakhon Sri Thammarat - 1	8B	1 534 887	118 836	173 894	127 697	58 598	479 025
Nakhon Sri Thammarat - 2	8C	1 534 887	206 330	177 991	148 191	74 564	607 076
Nakhon Sri Thammarat - 3	8D	1 534 887	292 383	190 240	173 597	68 466	724 686
Chonburi – 1	8B	1 364 002	49 183	129 033	151 866	56 468	386 550
Chonburi – 2	8C	1 364 002	88 808	207 950	124 937	70 878	492 573
Chonburi – 3	8D	1 364 002	178 984	210 785	214 488	141 108	745 365
Hua Hin – 1	8B	517 050	98 790	66 255	59 632	40 198	264 875
Hua Hin – 2	8C	517 050	120 915	74 499	87 926	52 396	335 736
Hua Hin – 3	8D	517 050	120 915	74 499	87 926	52 396	335 736

Table 5: Population covered for each proposed allotments

3.1.1 Minimum Population Coverage Objectives

The original ITU roadmap for the introduction of DAB in Thailand plan was proposing that Scenario 1 should provide coverage to 40% of the population of Thailand. The total number Thai citizens residing in the 11 provinces where the selected 11 cities are located in, is 19,898,515. Compared to the 64,456,695 total population of Thailand this represents a percentage of 31% of the total population. It has therefore not been possible to meet the 40% coverage objective when considering only the population residing in the 11 provinces as defined in the project scope.

Please note, when considering that each of the 3 multiplexes must have the same or a similar coverage, it is required to evaluate the population based on the lowest permissible ERP. When only 2 multiplexes are considered, then the lowest 2 permissible ERP can be used; when only 1 multiplex is considered, then the maximum ERP can be used.

The values in the table below have been calculated for the sites that are considered for implementation in Scenario 1 (5 sites that are not in grey from table 6). The Consultant has also calculated the population coverage considering that all transmitter sites would be in operation (including Nakhon Ratchasima, Chonburi and Hua Hin). The following table highlights these results:

Number of Multiplex	Population 20 dB+	Percentage of Total Thai Pop	Population 10 dB+	Percentage of Total Thai Pop
1 for all TX	8,678,672	13%	13,021,300	20%
2 for all TX	7,424,605	12%	11,995,358	19%
3 for all TX	5,234,382	8%	9,958,705	15%
1 for Sc. 1 (5 Cities)	7,882,470	12%	11,629,986	18%
2 for Sc. 1 (5 Cities)	6,845,801	11%	10,873,962	17%
3 for Sc. 1 (5 Cities)	4,831,679	7%	9,120,936	14%

Table 6 - Population Objectives Analysis

It should be noted that the population figures provided in the column “Population 10 dB+” includes the population as defined in the 20 dB+ range. It should also be noted that the values in the column “Percentage of Total Thai Pop” cannot be summed together as each row is representing an individual scenario standing for its own including the relating calculated coverage result.

The table demonstrates that if only 1 transmitter is used (for 5 cities), the most powerful channel block can be used, covering 18% of the total population. If 2 transmitters are considered, then each of both stations will be broadcasting at the minimal permissible ERP of each of the 2 stations. This results in a population coverage that covers less population than the approach with one transmitter (17% instead of 18%).

The ITU has also proposed a hybrid approach where a minimum of 20 dB+ of coverage reserve for Bangkok and 10 dB+ for the other cities should be considered. It is assumed that this approach provides a better representation of the effect of the denser clutter area of metropolitan Bangkok.

The following table highlights these results:

Number of Multiplex	Hybrid (Bangkok 20 dB+; rest at 10 dB+)	Percentage of Total Thai Pop
1 for all TX	10,318,156	16%
2 for all TX	9,011,127	14%
3 for all TX	6,574,020	10%
1 for Sc. 1 (5 TX)	8,926,842	14%
2 for Sc. 1 (5 TX)	7,889,731	12%
3 for Sc. 1 (5 TX)	5,736,251	9%

Table 7 - Hybrid Population Objectives Analysis

Appendix A - Coordination between DAB+ and Analogue Television Services

1. Bangkok, Nonthaburi, Samut Prakarn and Pathumthani – Channel 8

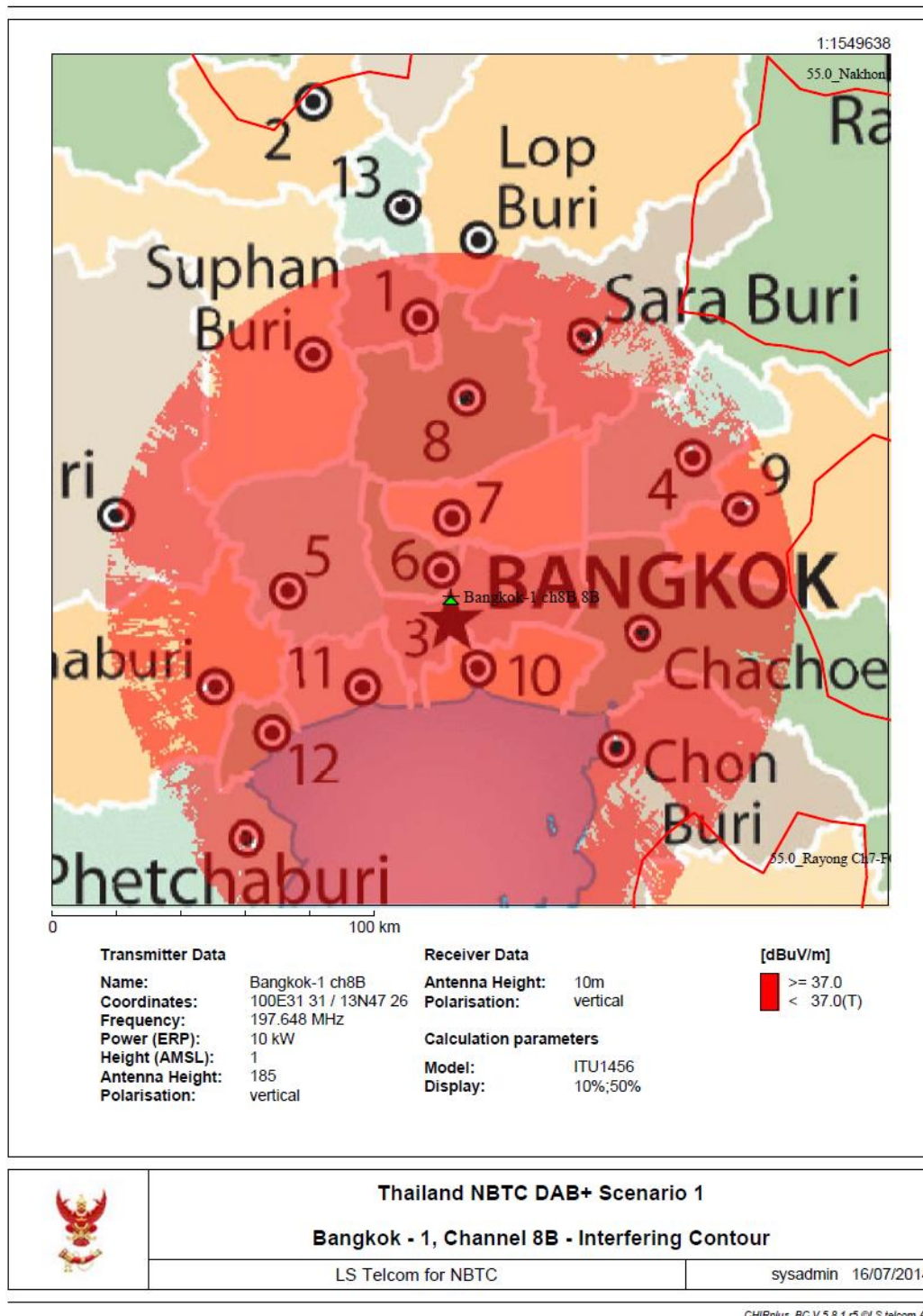


Figure 9: Coordination with ATV for DAB+ Channel 8 in Bangkok Area

2. Chiang Mai – Channel 8

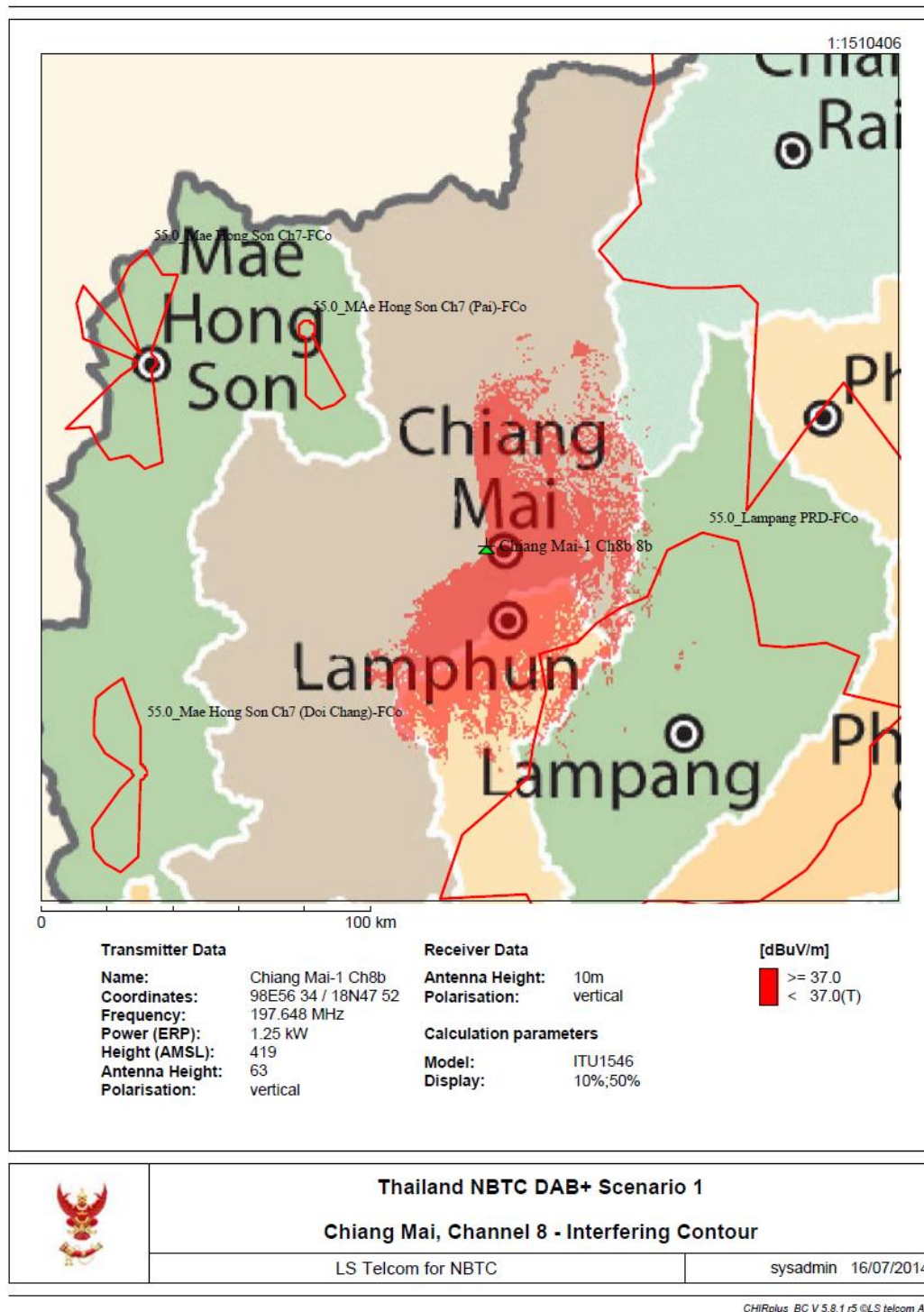


Figure 10: Coordination with ATV for DAB+ Channel 8 in Chiang Mai Area

3. Nakkon Ratchasima – Channel 7

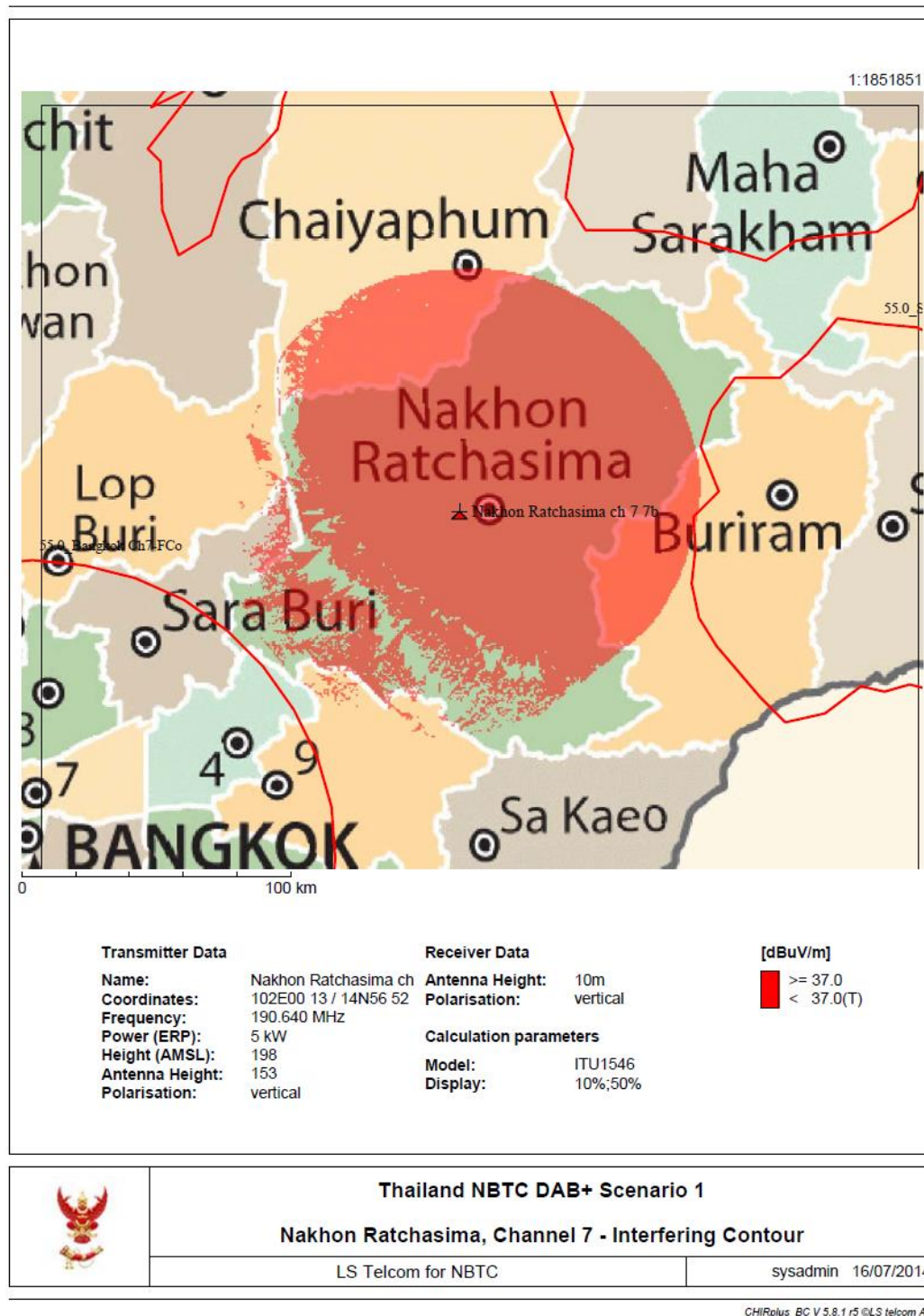


Figure 11: Coordination with ATV for DAB+ Channel 7 in Nakkon Ratchasima Area

4. Khon Kaen – Channel 8

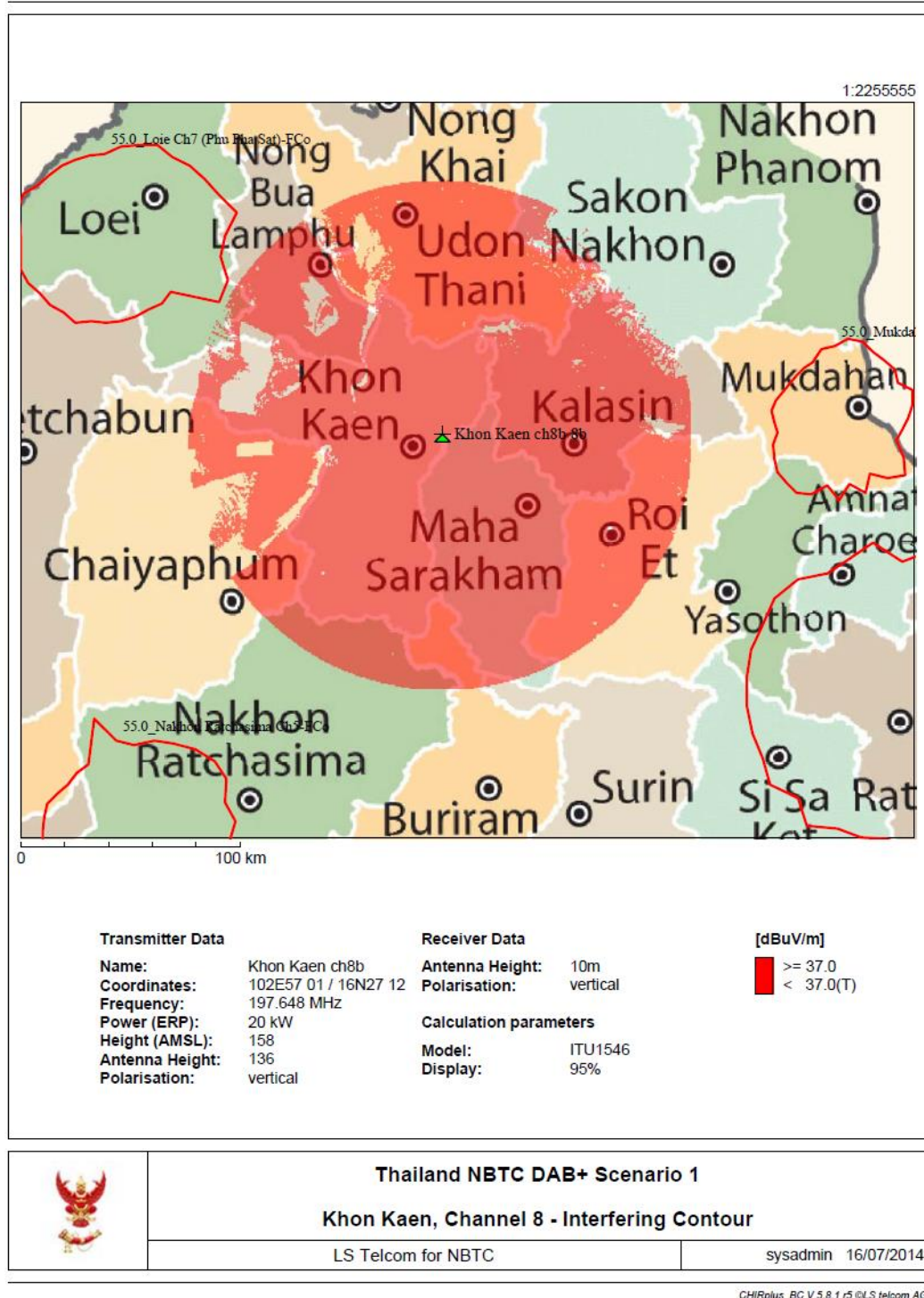


Figure 12: Coordination with ATV for DAB+ Channel 8 in Khon Kaen Area

5. Songkhla – Channel 7

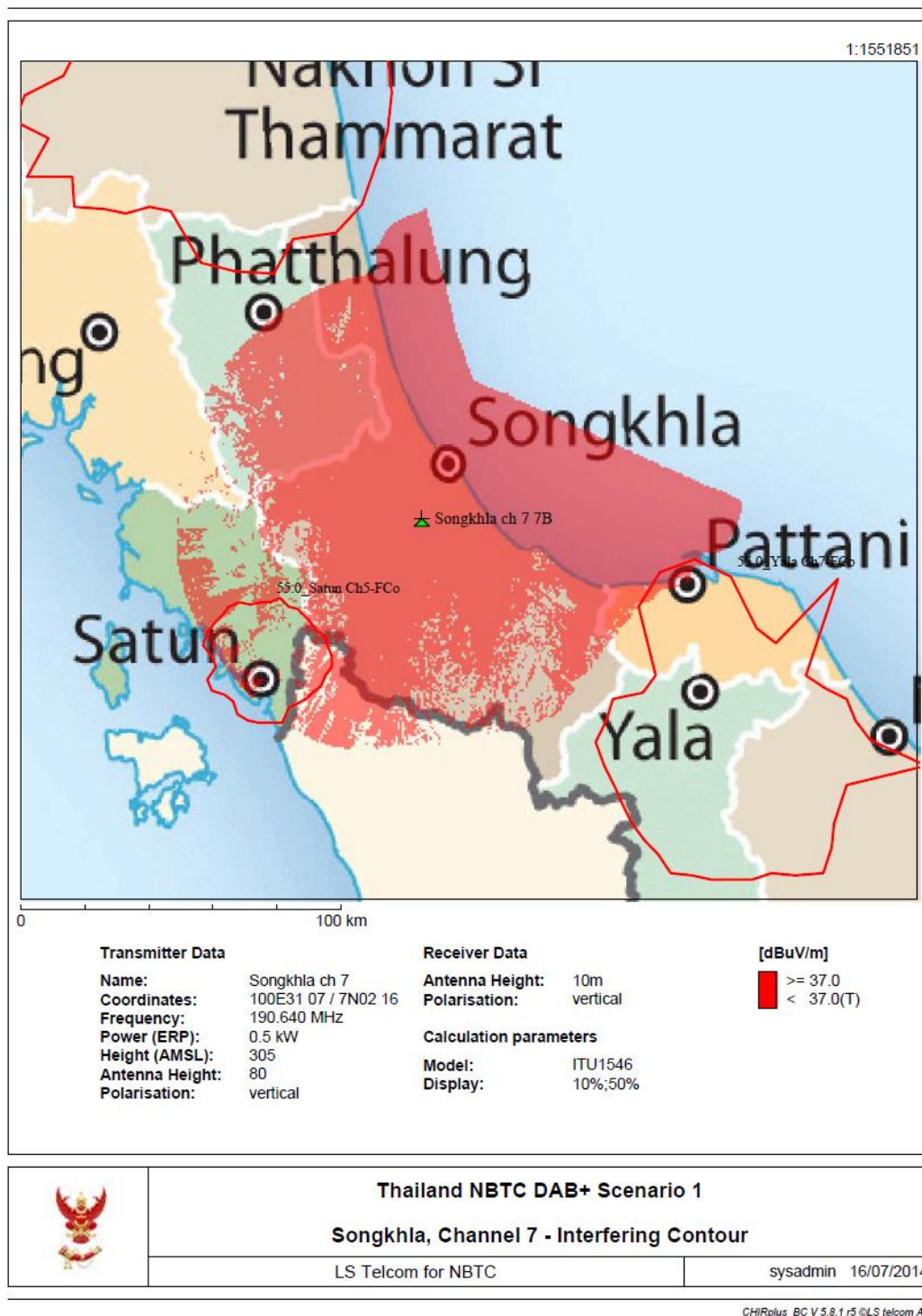


Figure 13: Coordination with ATV for DAB+ Channel 7 in Songkhla Area

6. Nakkon Sri Thammarat – Channel 8

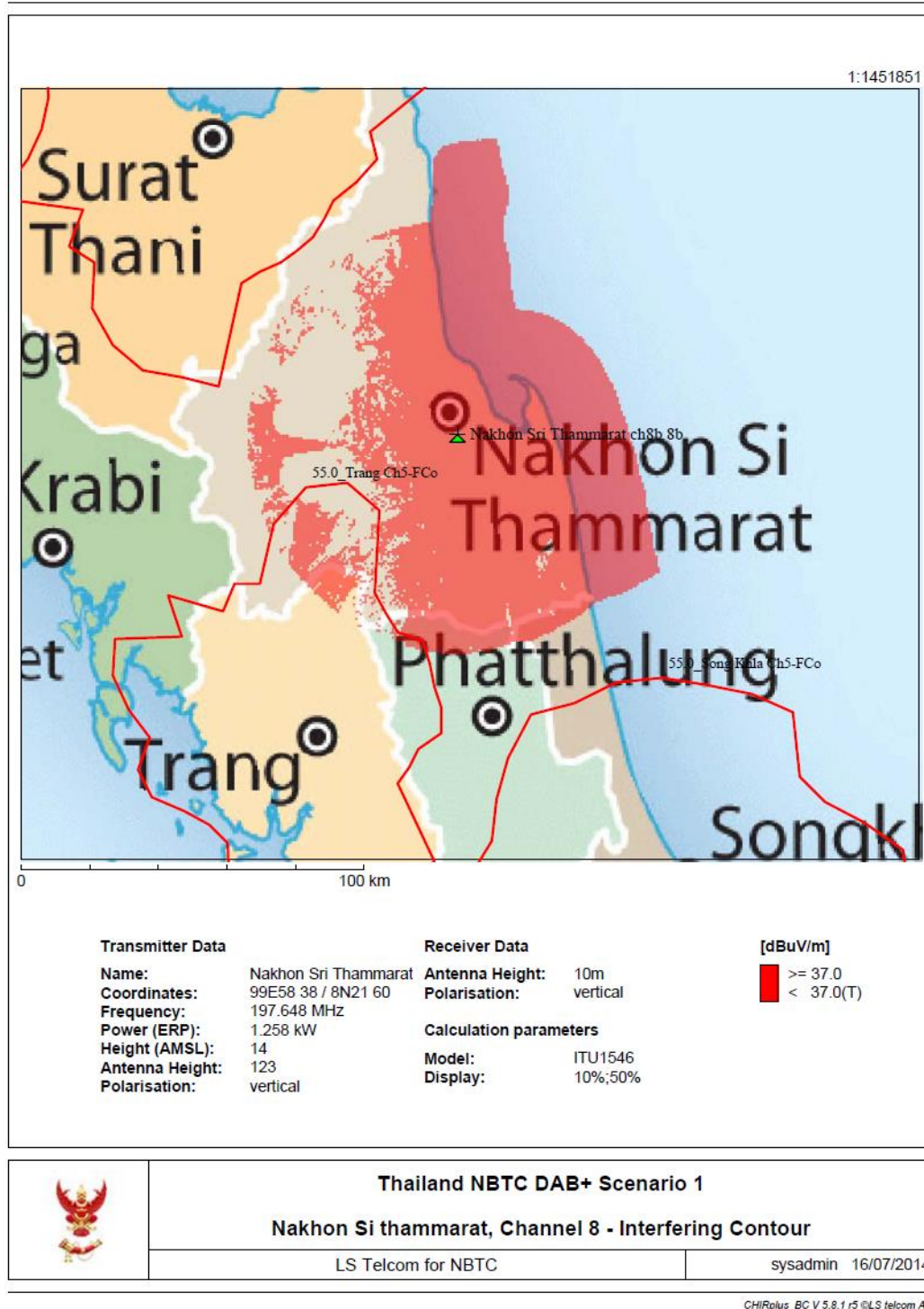


Figure 14: Coordination with ATV for DAB+ Channel 8 in Nakkon Sri Thammarat Area

7. Chon Buri – Channel 8

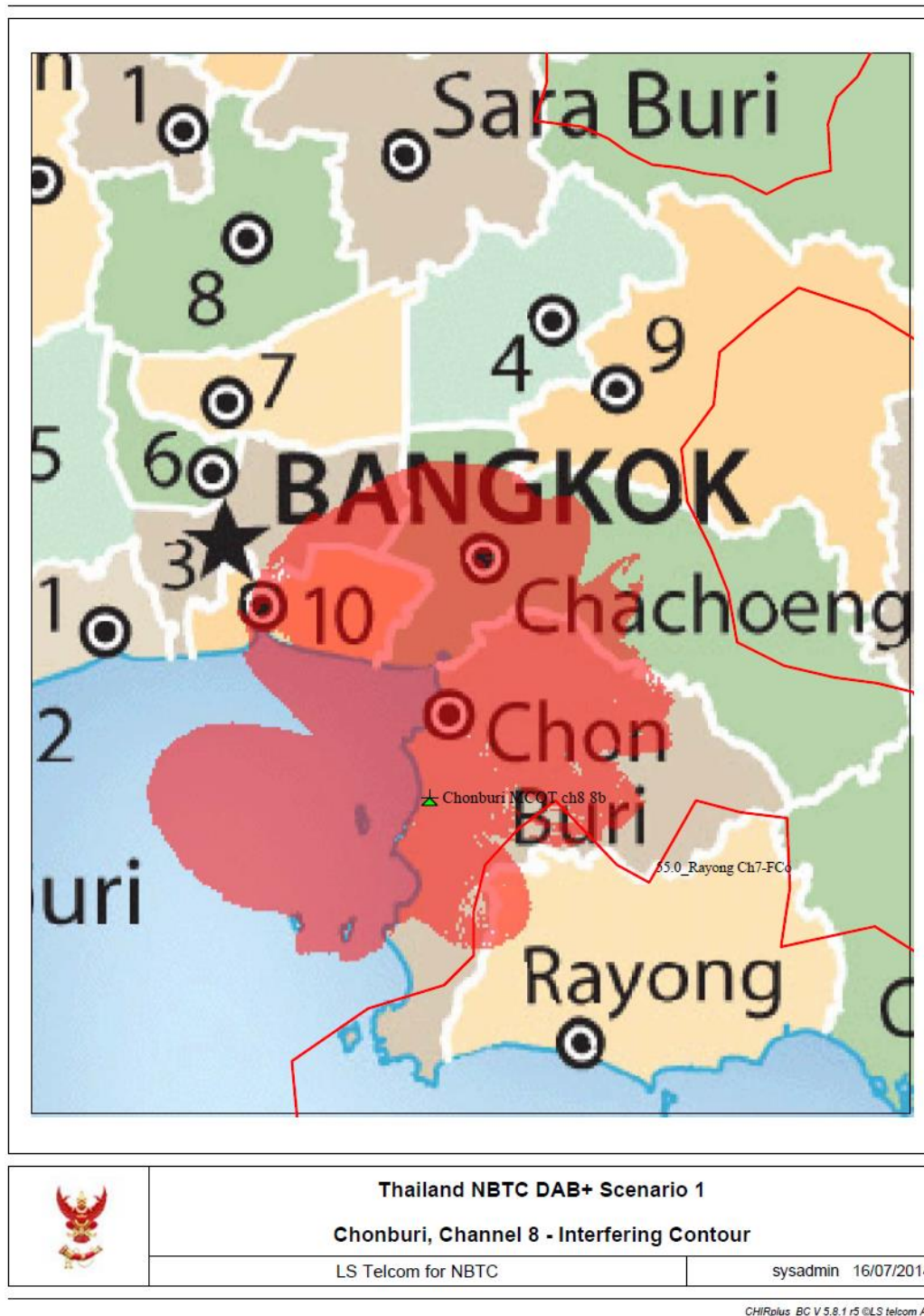


Figure 15: Coordination with ATV for DAB+ Channel 8 in Chon Buri Area

8. Hua Hin – Channel 8

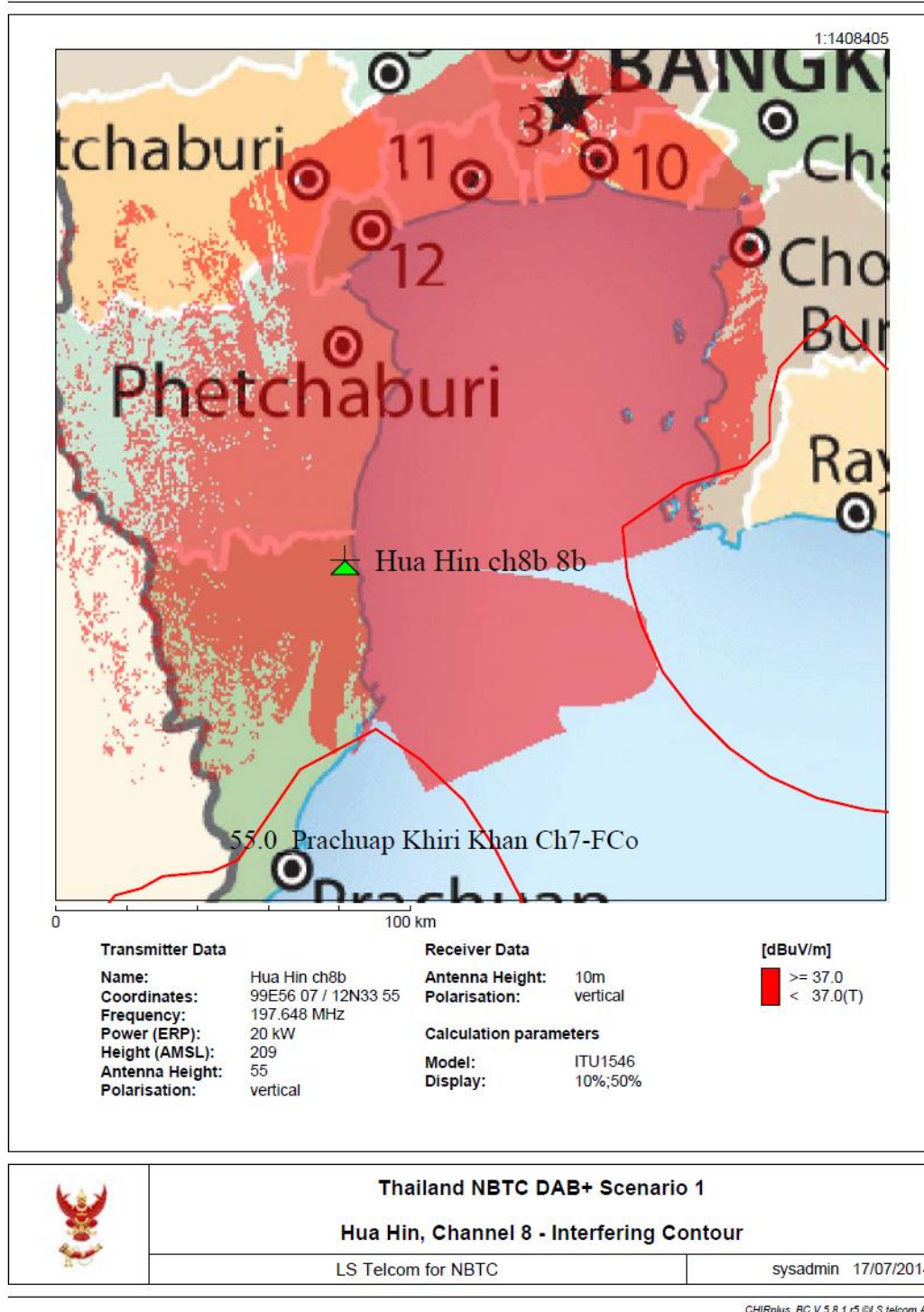


Figure 16: Coordination with ATV for DAB+ Channel 8 in Hua Hin Area

Appendix B - Available DAB+ Allotments

Tower	Lat	Lon	Antenna Rad Center	TV Protection lower ch (dB)	Lower ATV ERP (dBW)	Max ERP lower Ch (dBW)	Tv Protection CO (dB)	TV Protection Ratio (dBuV/m)	Max ERP CO Ch (dBW)	TV Protetion upper ch	Upper ATV ERP (dBW)	Max ERP UP Ch (dBW)	MAX DAB+ ERP (dBW)	MAX DAB+ ERP (W)
Bangkok (Sapan Daeng)	13.790514	100.52535	185	-9.2	55.76	64.96	42	37	40	-7	56	63	40	10000
Bangkok (Sapan Daeng)	13.790514	100.52535	185	-13	55.76	68.76	37	42	45	-9	56	65	45	31622
Bangkok (Sapan Daeng)	13.790514	100.52535	185	-15	55.76	70.76	32	47	50	-6	56	62	50	100000
Chiang May CH7	18.809055	98.912472	63	-9.2	54.7	63.9	42	37	30.97	-7	50	57	30.97	1250
Chiang May CH7	18.809055	98.912472	63	-13	54.7	67.7	37	42	35.97	-9	50	59	35.97	3953
Chiang May CH7	18.809055	98.912472	63	-15	54.7	69.7	32	47	40.97	-6	50	56	40.97	12502
Nakhon Ratchasima MCOT	14.947779	102.00374	153	-9.2	50	59.2	42	37	36.99	-7	50	57	36.99	5000

Tower	Lat	Lon	Antenna Rad Center	TV Protection lower ch (dB)	Lower ATV ERP (dBW)	Max ERP lower Ch (dBW)	Tv Protection CO (dB)	TV Protection Ratio (dBuV/m)	Max ERP CO Ch (dBW)	TV Protetion upper ch	Upper ATV ERP (dBW)	Max ERP UP Ch (dBW)	MAX DAB+ ERP (dBW)	MAX DAB+ ERP (W)
Nakhon Ratchasima MCOT	14.947779	102.00374	153	-13	50	63	37	42	41.99	-9	50	59	41.99	15812
Nakhon Ratchasima MCOT	14.947779	102.00374	153	-15	50	65	32	47	46.99	-6	50	56	46.99	50003
Khon Kaen MCOT	16.453378	102.95016	136	-9.2	52.88	62.08	42	37	43	-7	50	57	43	19952
Khon Kaen MCOT	16.453378	102.95016	136	-13	52.88	65.88	37	42	48	-9	50	59	48	63095
Khon Kaen MCOT	16.453378	102.95016	136	-15	52.88	67.88	32	47	53	-6	50	56	53	199526
Song Khla CH5	7.037696	100.51864	80	-9.2	53.9	63.1	42	37	27	-7	45.8	52.8	27	501
Song Khla CH5	7.037696	100.51864	80	-13	53.9	66.9	37	42	32	-9	45.8	54.8	32	1584
Song Khla CH5	7.037696	100.51864	80	-15	53.9	68.9	32	47	37	-6	45.8	51.8	37	5011
Nakhon PRD	8.3666333	99.977356	123	-9.2	53	62.2	42	37	31	-7	45.56	52.56	31	1258
Nakhon PRD	8.3666333	99.977356	123	-13	53	66	37	42	36	-9	45.56	54.56	36	3981
Nakhon PRD	8.3666333	99.977356	123	-15	53	68	32	47	41	-6	45.56	51.56	41	12589

Tower	Lat	Lon	Antenna Rad Center	TV Protection lower ch (dB)	Lower ATV ERP (dBW)	Max ERP lower Ch (dBW)	Tv Protection CO (dB)	TV Protection Ratio (dBuV/m)	Max ERP CO Ch (dBW)	TV Protetion upper ch	Upper ATV ERP (dBW)	Max ERP UP Ch (dBW)	MAX DAB+ ERP (dBW)	MAX DAB+ ERP (W)
Chonburi MCOT	13.189822	100.35056	43	-9.2	60	69.2	42	37	30	-7	60	67	30	1000
Chonburi MCOT	13.189822	100.35056	43	-13	60	73	37	42	35	-9	60	69	35	3162
Chonburi MCOT	13.189822	100.35056	43	-15	60	75	32	47	40	-6	60	66	40	10000
Hua Hin CH 7	12.565142	99.935176	55	-9.2	60	69.2	42	37	43.01	-7	60	67	43.01	19998
Hua Hin CH 7	12.565142	99.935176	55	-13	60	73	37	42	48.01	-9	60	69	48.01	63241
Hua Hin CH 7	12.565142	99.935176	55	-15	60	75	32	47	53.01	-6	60	66	53.01	199986

Table 8: Available DAB+ Allotments

Values in grey represent ERP that are above 50 kW and have been limited to 50 kW for the coverage simulations.

Only the first 3 highest ERP has been considered in the study (generally blocs A, C and D).

Values in red highlights the fact that the Hua Hun and Chonburi allotments were not co-sited with their respective adjacent ATV channels and will therefore create interference to the adjacent ATV service.

The following consists of the definition of the different column used in this table:

<i>Allotment:</i>	<i>Name of the proposed allotment</i>
<i>Channel:</i>	<i>Channel number of the allotment, according to the DAB+ channel raster table</i>
<i>Frequency:</i>	<i>Corresponding center frequency for the channel number, in MHz.</i>

- Tower:* Name of the tower that was used for the plan, as per document: "Antenna Check Trial 10 + 1 v.4 280457" on 28th May, not file " Transmitter sites for DAB+ scenario A 1 Trial 10+1 v2 170457.xls".
- Lat:* Latitude, in degrees North.
- Lon:* Longitude, in degrees East
- Antenna Rad Center:* Center of radiation of the proposed DAB+ antenna at the location calculated above ground level, in meters.
- TV Protection lower ch (dB):* This is the value of the protection level, in dB, that the DAB+ signal must provide to the analog TV service transmitted on the adjacent lower channel, according to the table A7-1 frequency relations (discrete values are calculated at Appendix D). As an example, a value of 31 dB indicate that the DAB+ signal needs to be 31 dB lower than the analogue TV service in order to protect it. A value of -9 indicates that the DAB+ signal can be 9 dB above the analog TV service.
- Max ERP lower ch (dBW):* Based on the value in the "TV protection lower ch" column, this is the result of the calculation of the maximal ERP for the DAB+ transmitting system in relation with the lower adjacent channel. As an example, if the protection is 31 dB and the lower TV channel is 50 dBW (based on information in Appendix E), then the maximum DAB+ ERP is 19 dBW.
- TV Protection CO (dB):* This is the value of the protection level, in dB, that the DAB+ signal must provide to the analog TV service transmitted on the co-channel, according to the table A7-1 frequency relations (discrete values are calculated at Appendix D).
- TV Protection Ratio (dBuV/m):* This value represent the nominal analogue TV service basic reception value of 55 dBu – the TV protection CO channel (example, 30 dB) + 14 dB for antenna front-to-back ratio of additional protection = 39 dBuV/m (in our example). This value is then used in Appendix A as the shadowed area coming from the DAB+ tower, protecting the 55 dBu of the surrounding TV operations. We then maximised the DAB+ ERP in order to ensure the maximum coverage of DAB+ while protecting the analogue TV.
- Max ERP Co Ch (dBW):* Based on the value in the "TV Protection CO" column, this is the result of a calculation of the maximal ERP for the DAB+ transmitting system in relation with the co-channel. Based on previous calculations and Appendix A.

TV protection upper ch: This is the value of the protection level, in dB, that the DAB+ signal must provide to the analogue TV service transmitted on the adjacent upper channel, according to the table A7-1 frequency relations (discrete values are calculated at Appendix D) - same process as for lower channel).

Max ERP UP Ch (dBW): Based on the value in the "TV protection upper ch" column, this is the result a calculation of the maximal ERP for the DAB+ transmitting system in relation with the upper adjacent channel - same process as for lower channel.

MAX DAB+ ERP (dBW): This is the minimal value between MAX ERP lower CH, Max ERP CO Ch and Max ERP Up ch. This value provides the maximum DAB+ coverage while ensuring a full protection to the analogue TV services, on lower adjacent, upper adjacent and co-channel. Units in dBW.

MAX DAB+ ERP (W): This is the minimal value between MAX ERP lower CH, Max ERP CO Ch and Max ERP Up ch. This value provides the maximum DAB+ coverage while ensuring a full protection to the analogue TV services, on lower adjacent, upper adjacent and co-channel. Units in watts (same as previous column but in W instead of dBW).

Appendix C – DAB+ Allotments Coverage

C.1 Bangkok 1 – ch8B – DAB+ Coverage

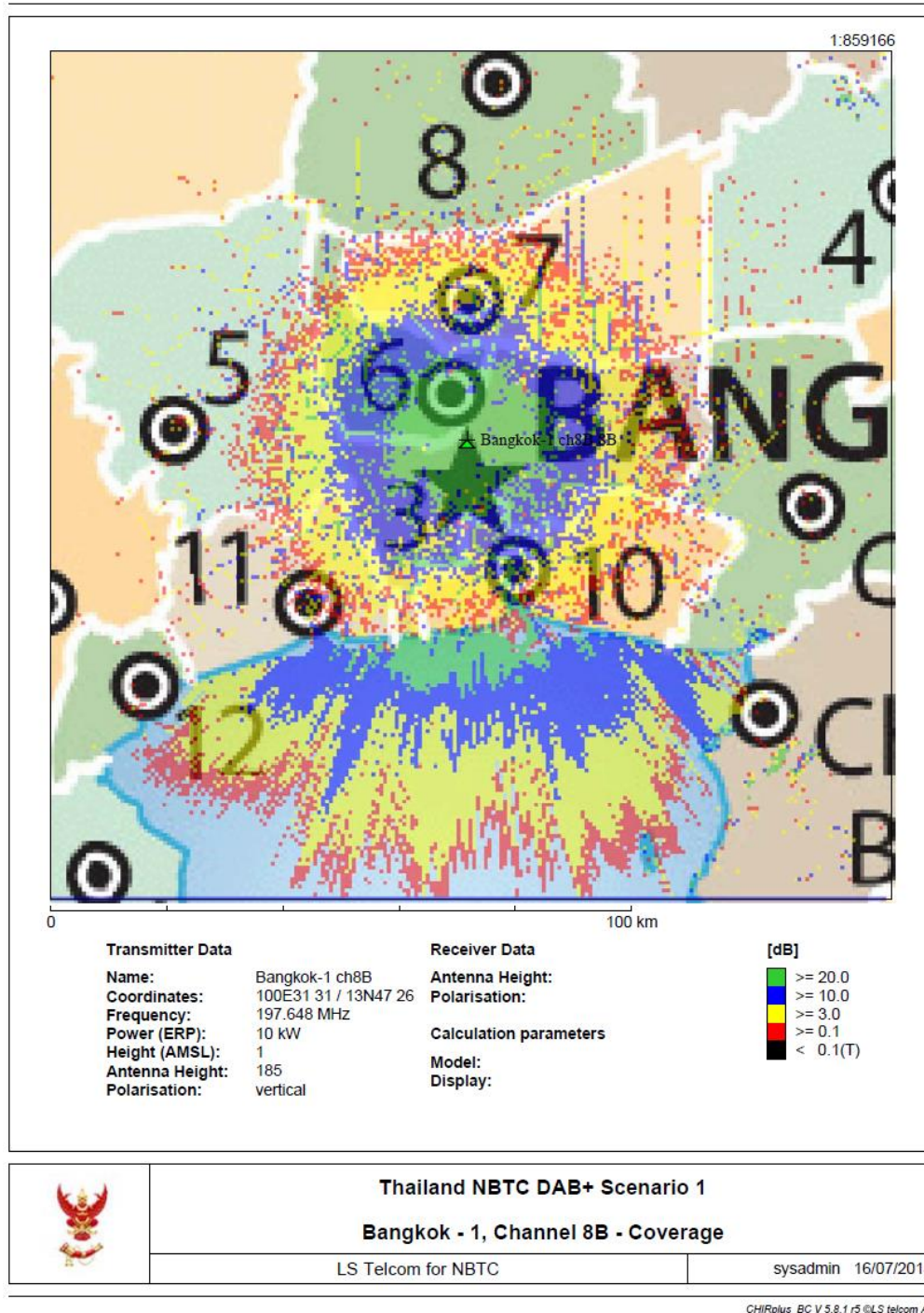


Figure 17: DAB+ Allotment Coverage Bangkok - 1

C.2 Bangkok 2 – ch8C – DAB+ Coverage

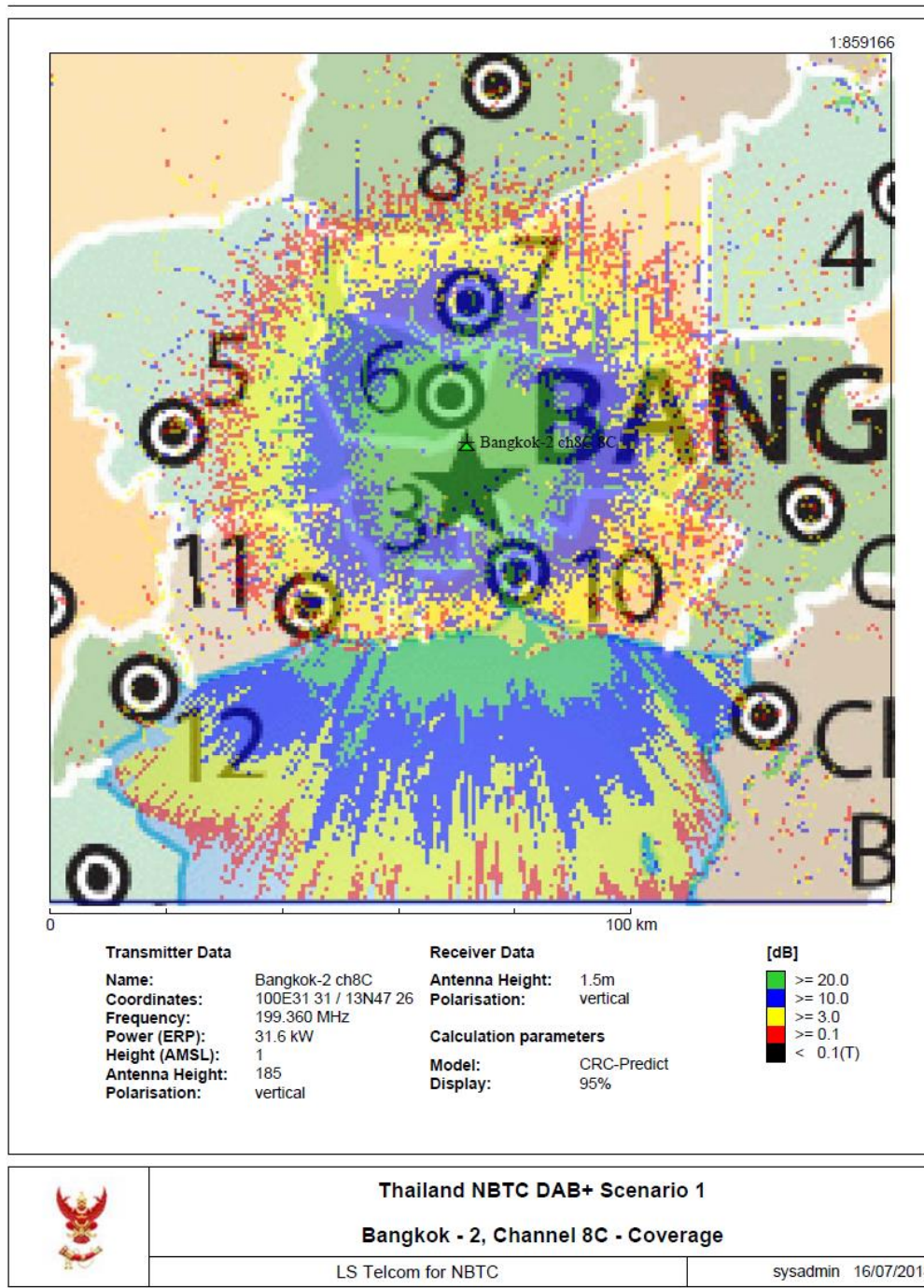


Figure 18 - DAB+ Allotment Coverage Bangkok – 2

C.3 Bangkok 3 – ch8D – DAB+ Coverage

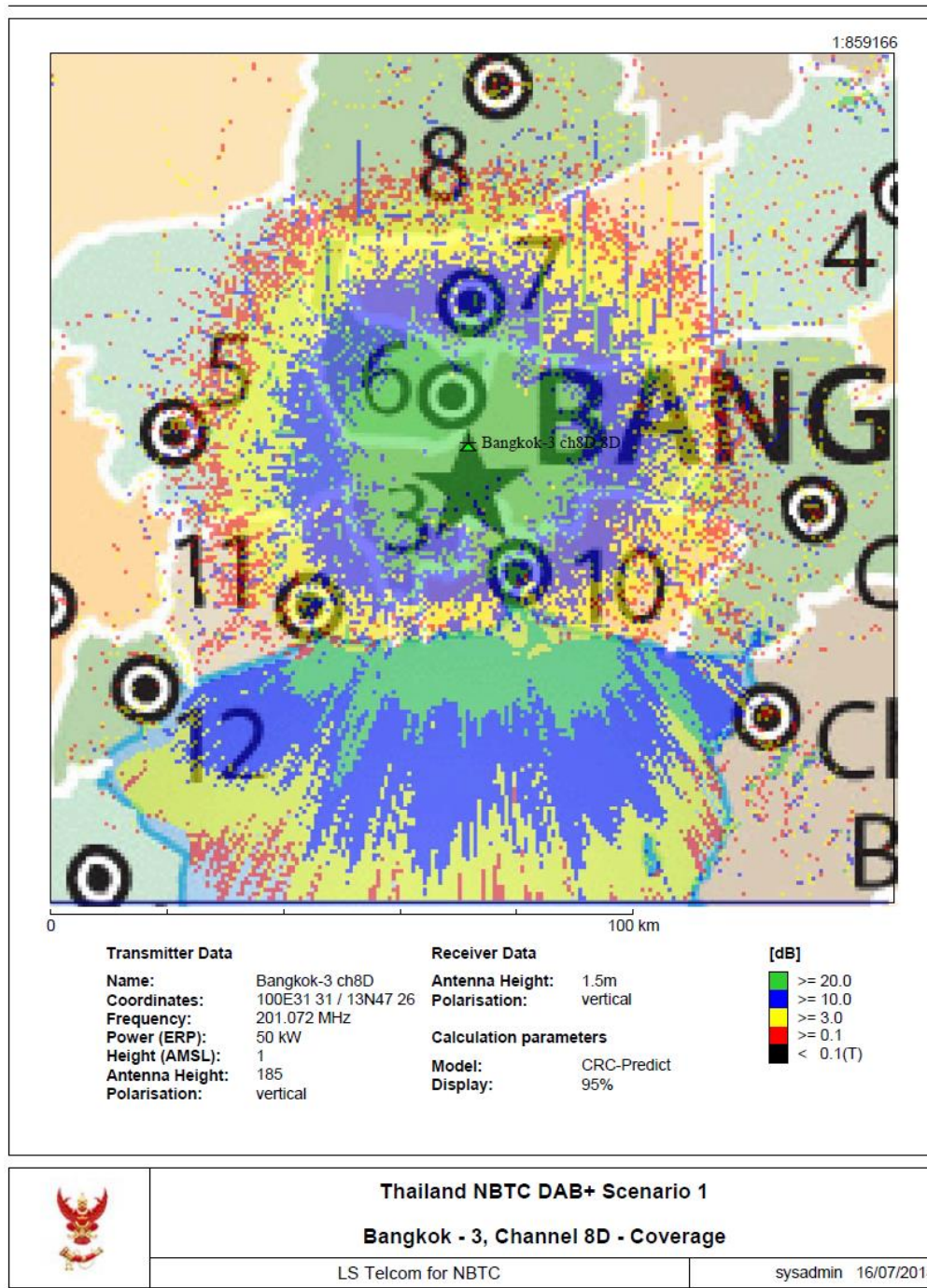


Figure 19 - DAB+ Allotment Coverage Bangkok – 3

C.4 Chiang Mai 1 – ch8B – DAB+ Coverage

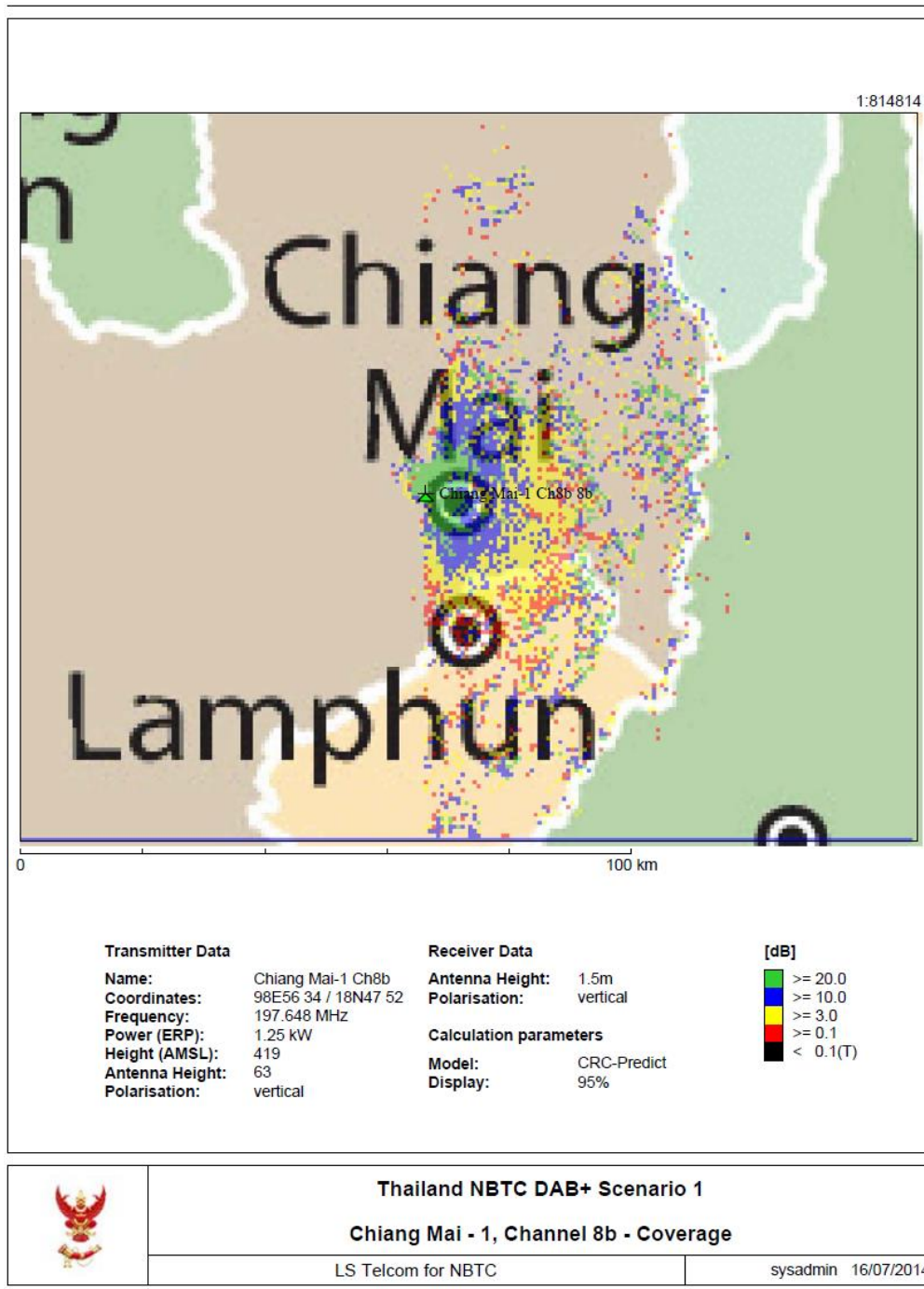


Figure 20 - DAB+ Allotment Coverage Chiang Mai – 1

C.5 Chiang Mai 2 – ch8C – DAB+ Coverage

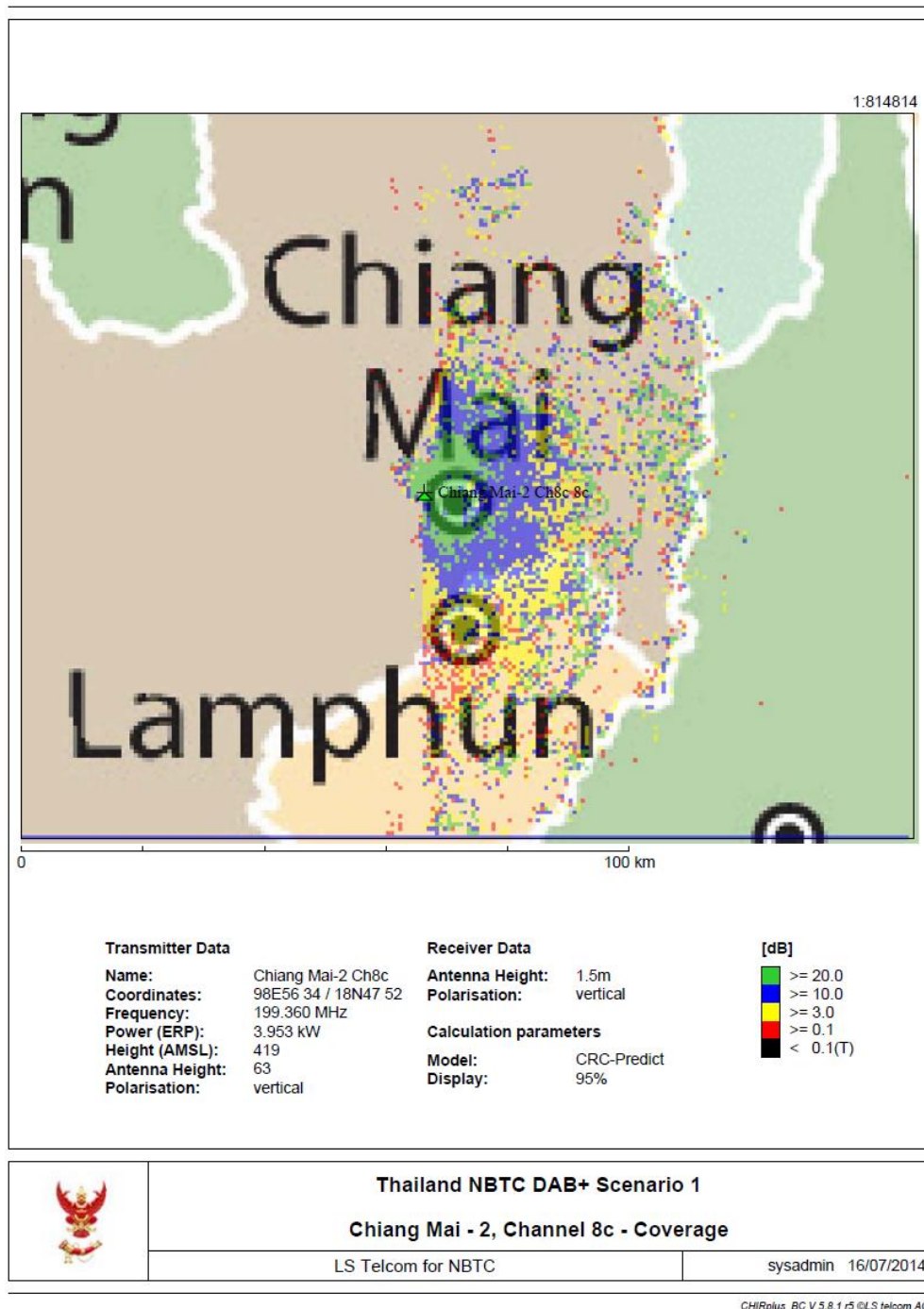


Figure 21 - DAB+ Allotment Coverage Chiang Mai – 2

C.6 Chiang Mai 3 – ch8D – DAB+ Coverage

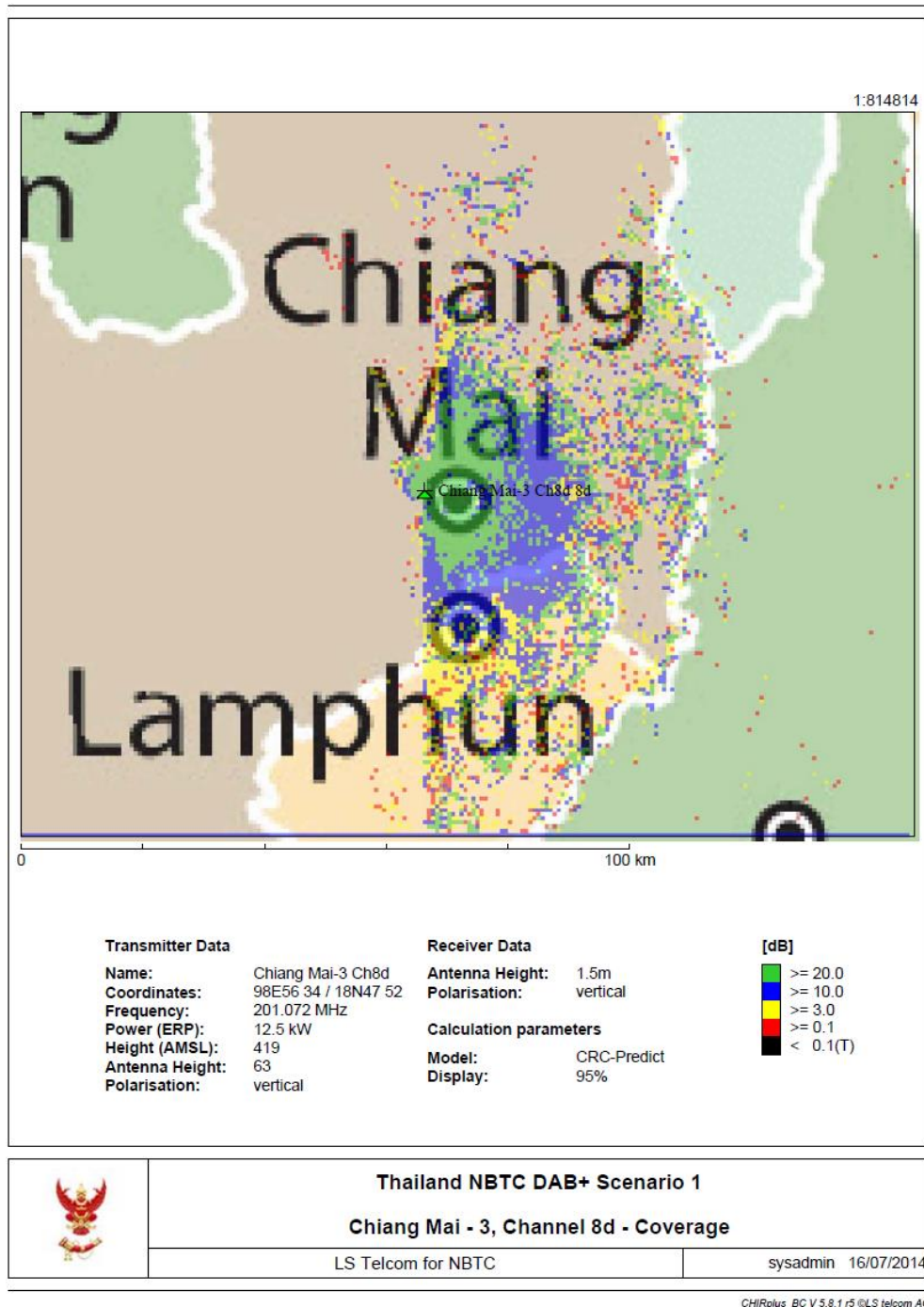


Figure 22 - DAB+ Allotment Coverage Chiang Mai – 3

C.7 Nakhon Ratchasima 1 – ch7B – DAB+ Coverage

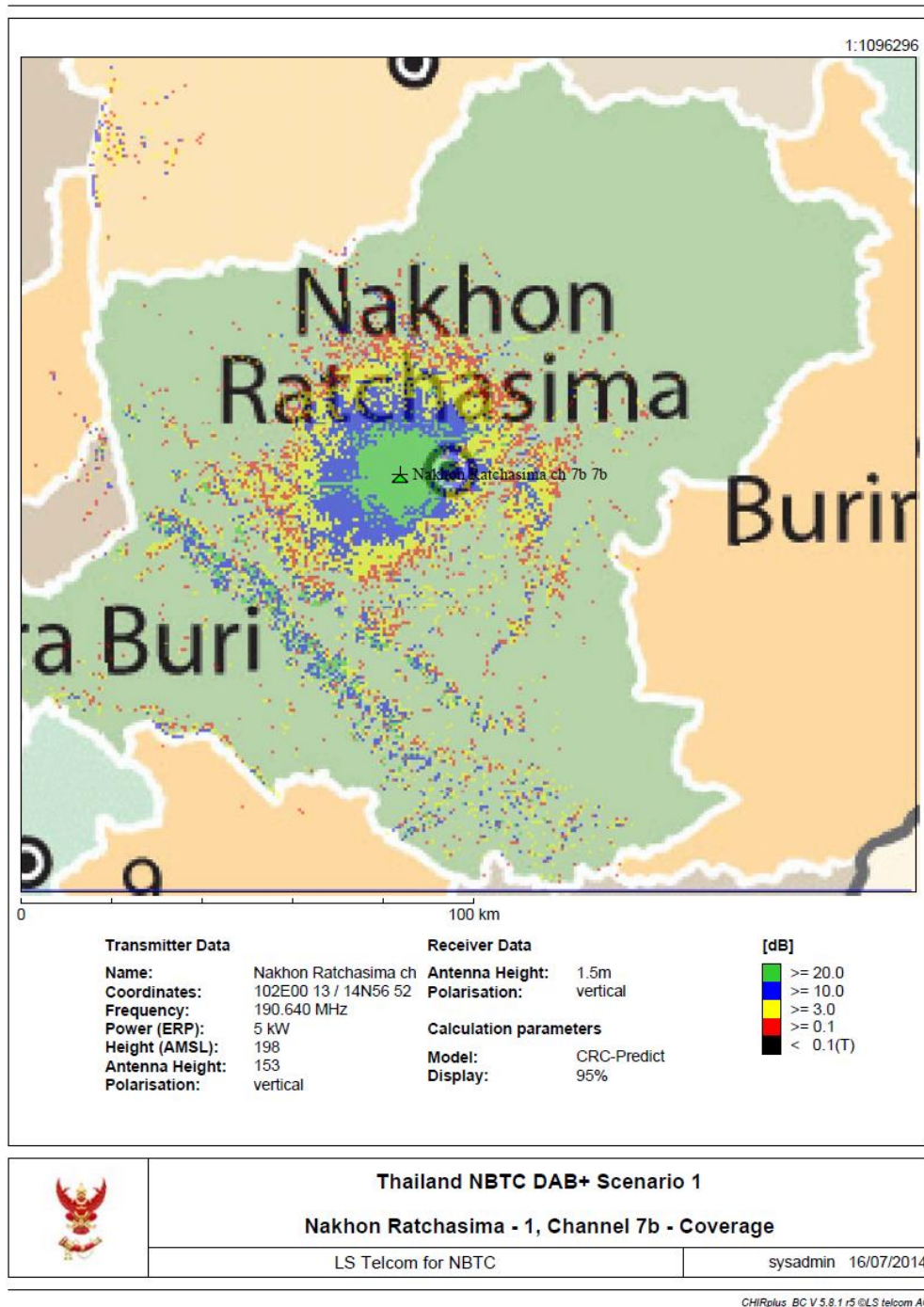


Figure 23 - DAB+ Allotment Coverage Nakhon Ratchasima – 1

C.8 Nakhon Ratchasima 2 – ch7C – DAB+ Coverage

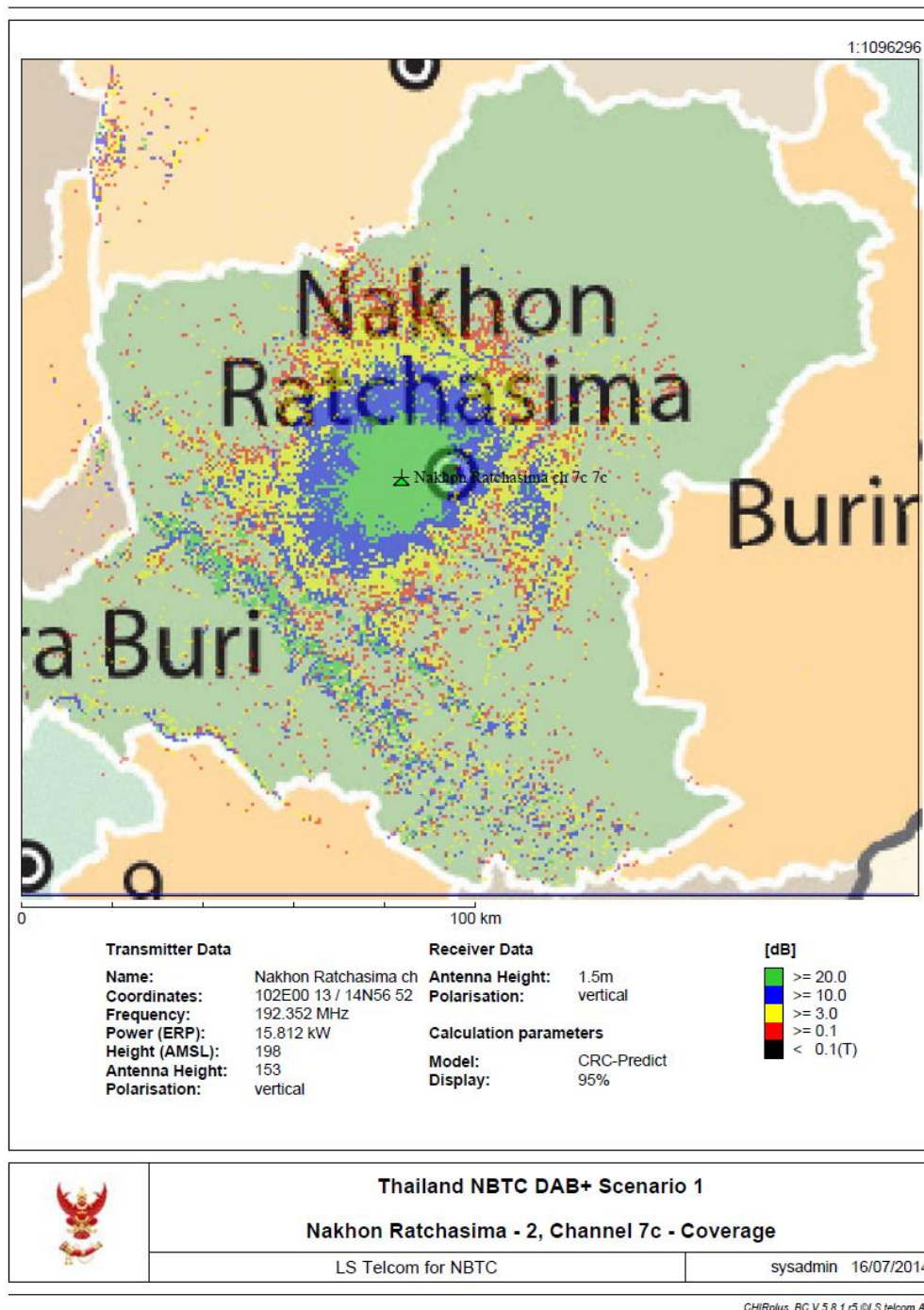


Figure 24 - DAB+ Allotment Coverage Nakhon Ratchasima – 2

C.9 Nakhon Ratchasima 3 – ch7D – DAB+ Coverage

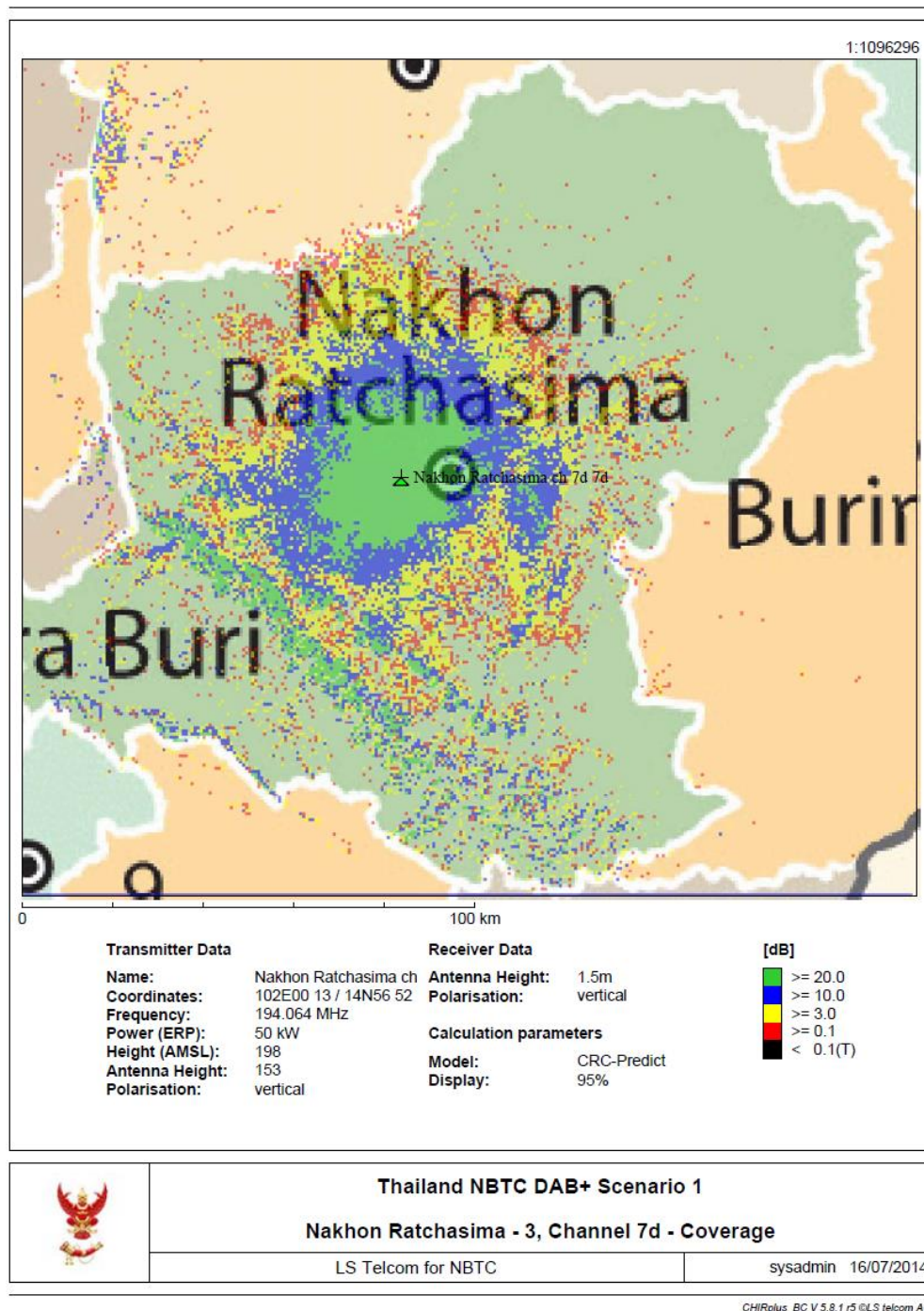


Figure 25 - DAB+ Allotment Coverage Nakhon Ratchasima – 3

C.10 Khon Kaen 1 – ch8B – DAB+ Coverage

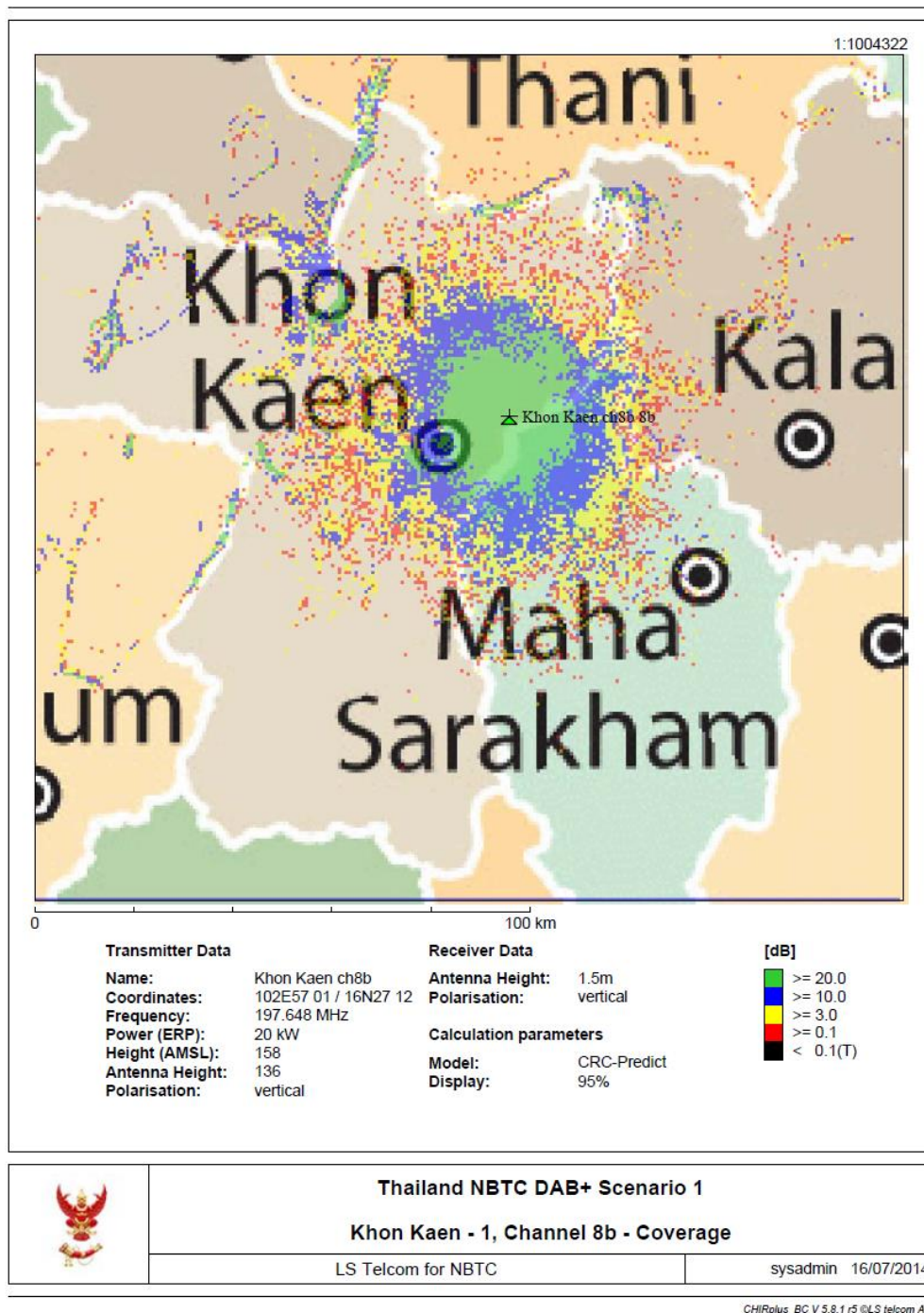


Figure 26 - DAB+ Allotment Coverage Khon Kaen – 1

C.11 Khon Kaen 2 – ch8C – DAB+ Coverage

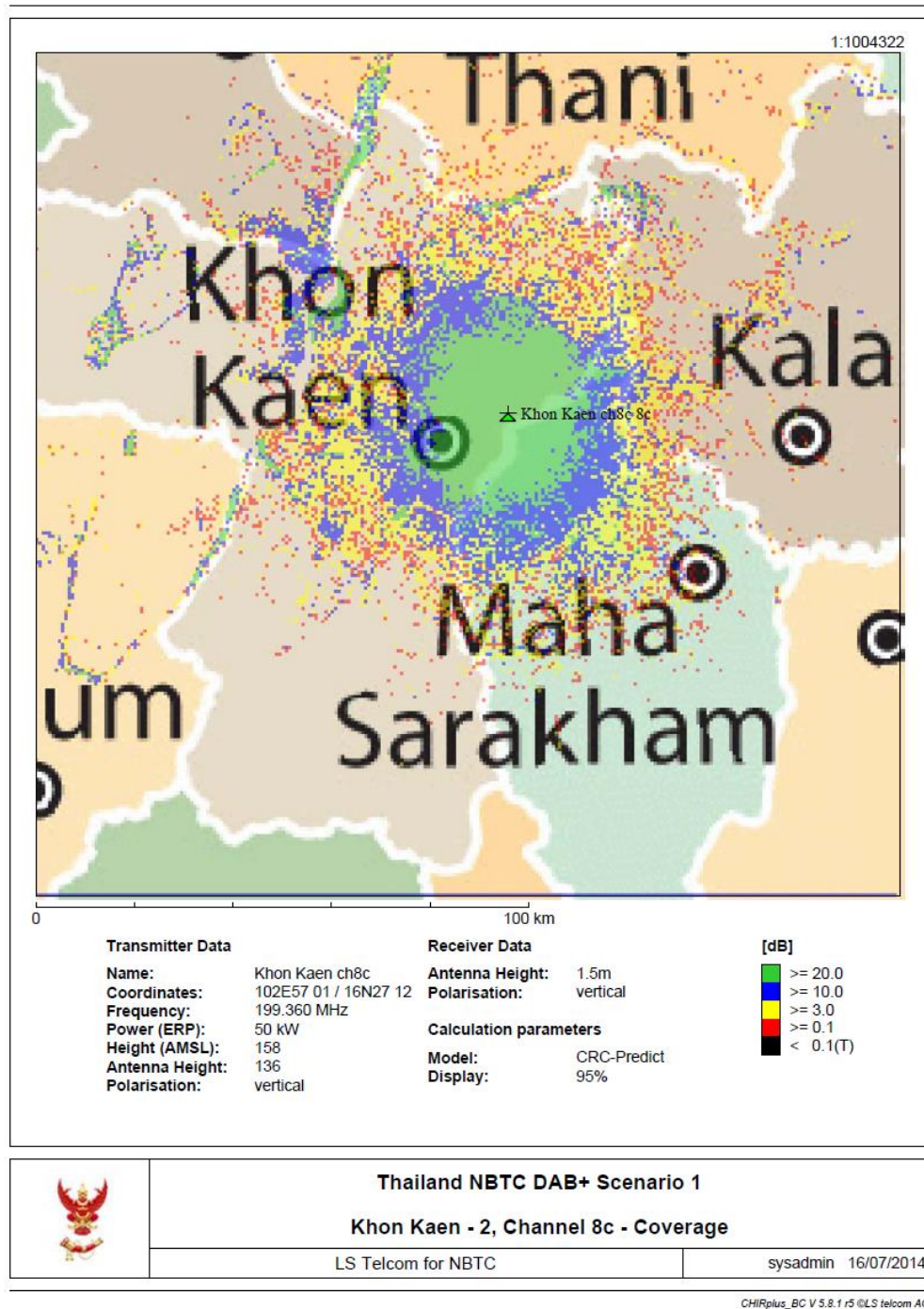


Figure 27 - DAB+ Allotment Coverage Khon Kaen – 2

C.12 Khon Kaen 3 – ch6D – DAB+ Coverage

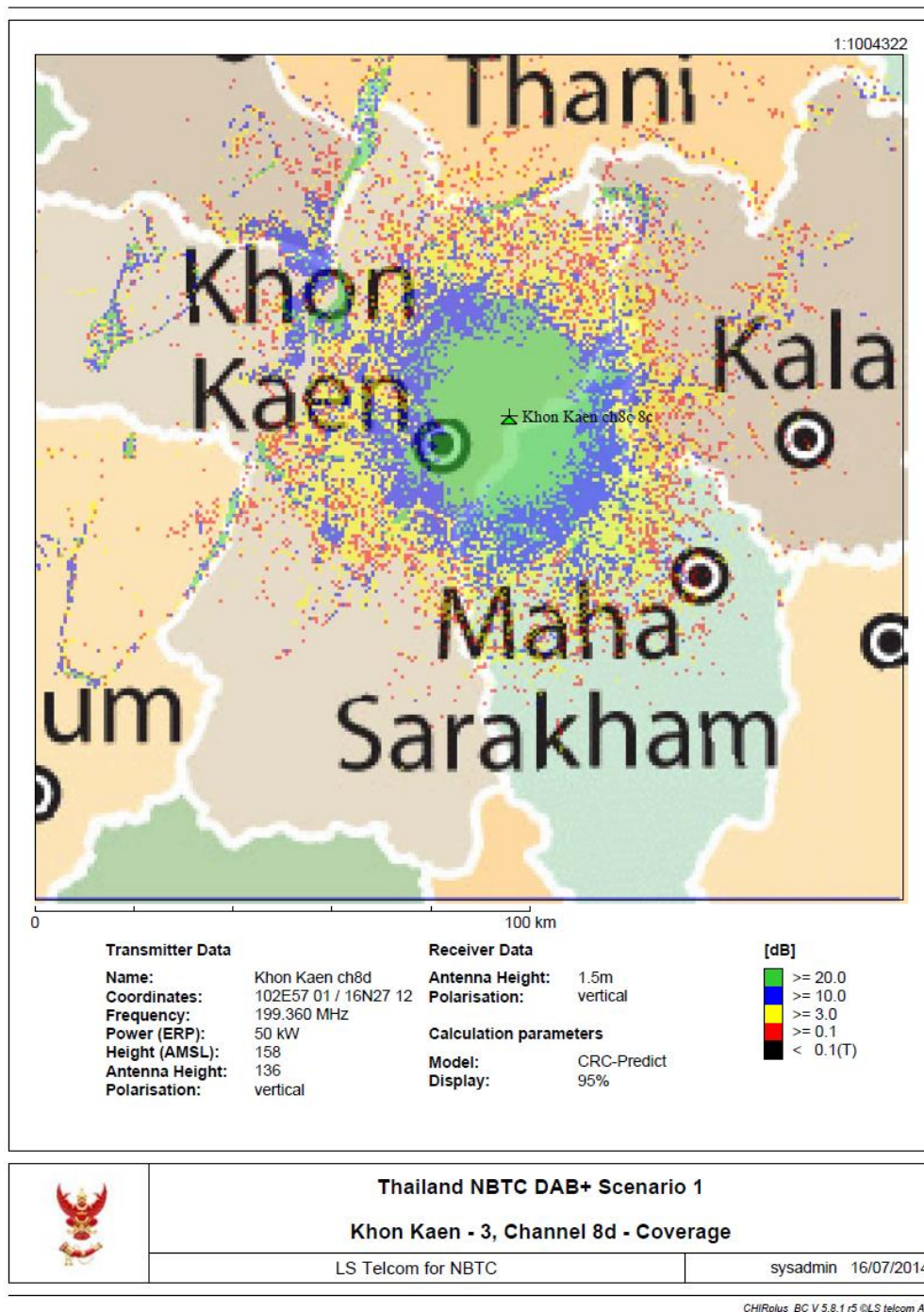


Figure 28 - DAB+ Allotment Coverage Khon Kaen – 3

C.13 Songkhla 1 – ch7B – DAB+ Coverage

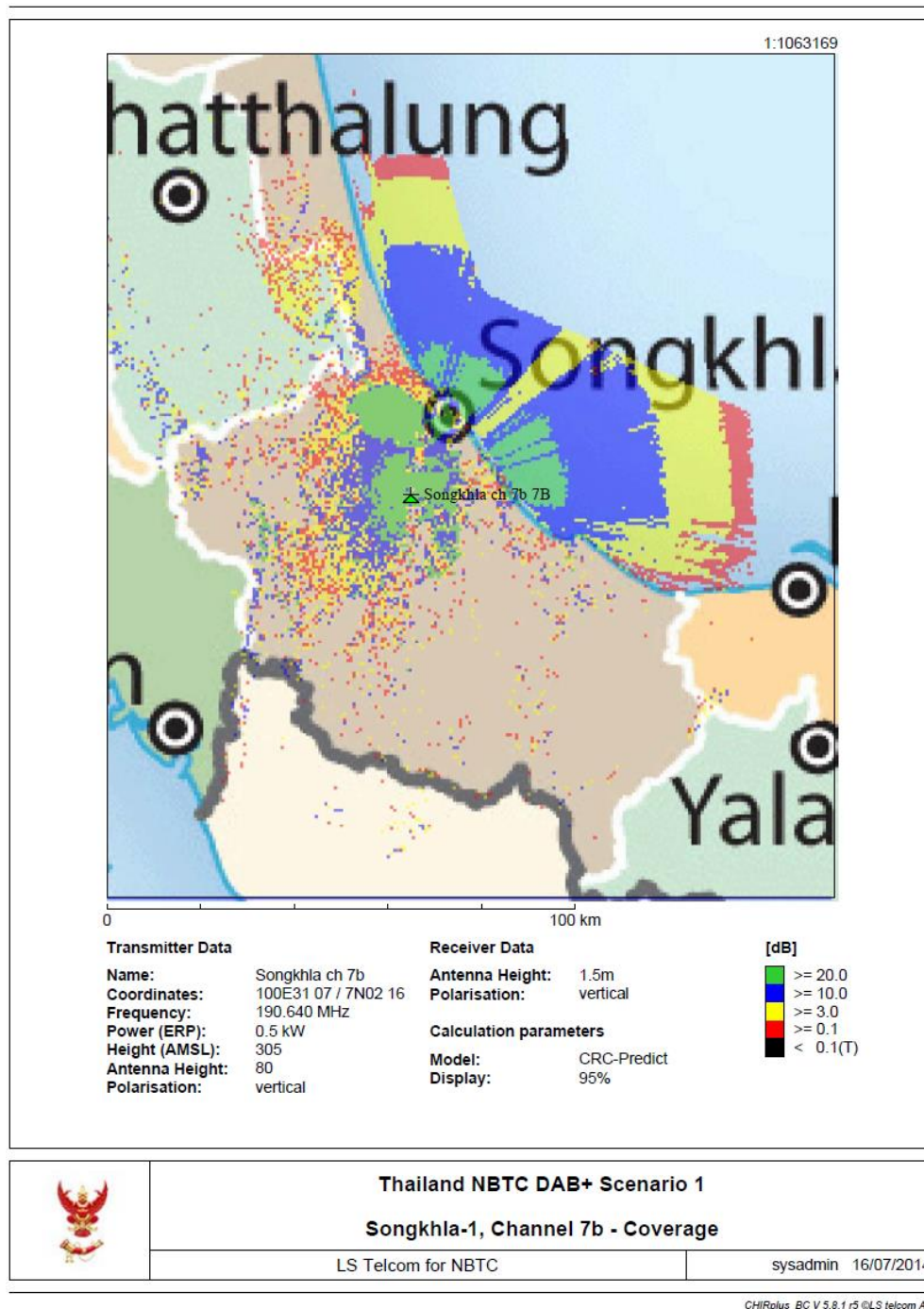


Figure 29 - DAB+ Allotment Coverage Songkhla – 1

C.14 Songkhla 2 – ch7C – DAB+ Coverage

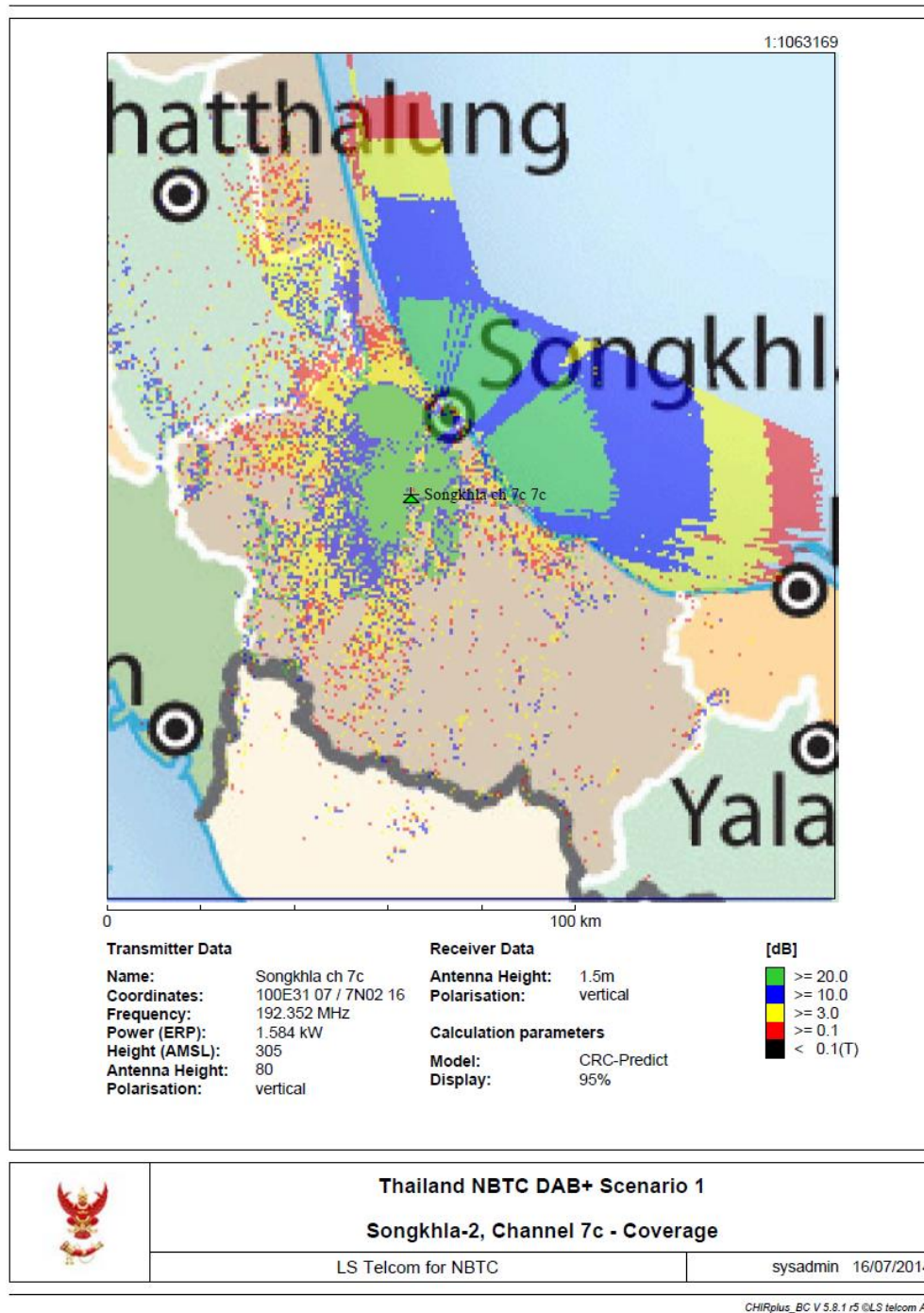


Figure 30 - DAB+ Allotment Coverage Songkhla – 2

C.15 Songkhla 3 – ch7D – DAB+ Coverage

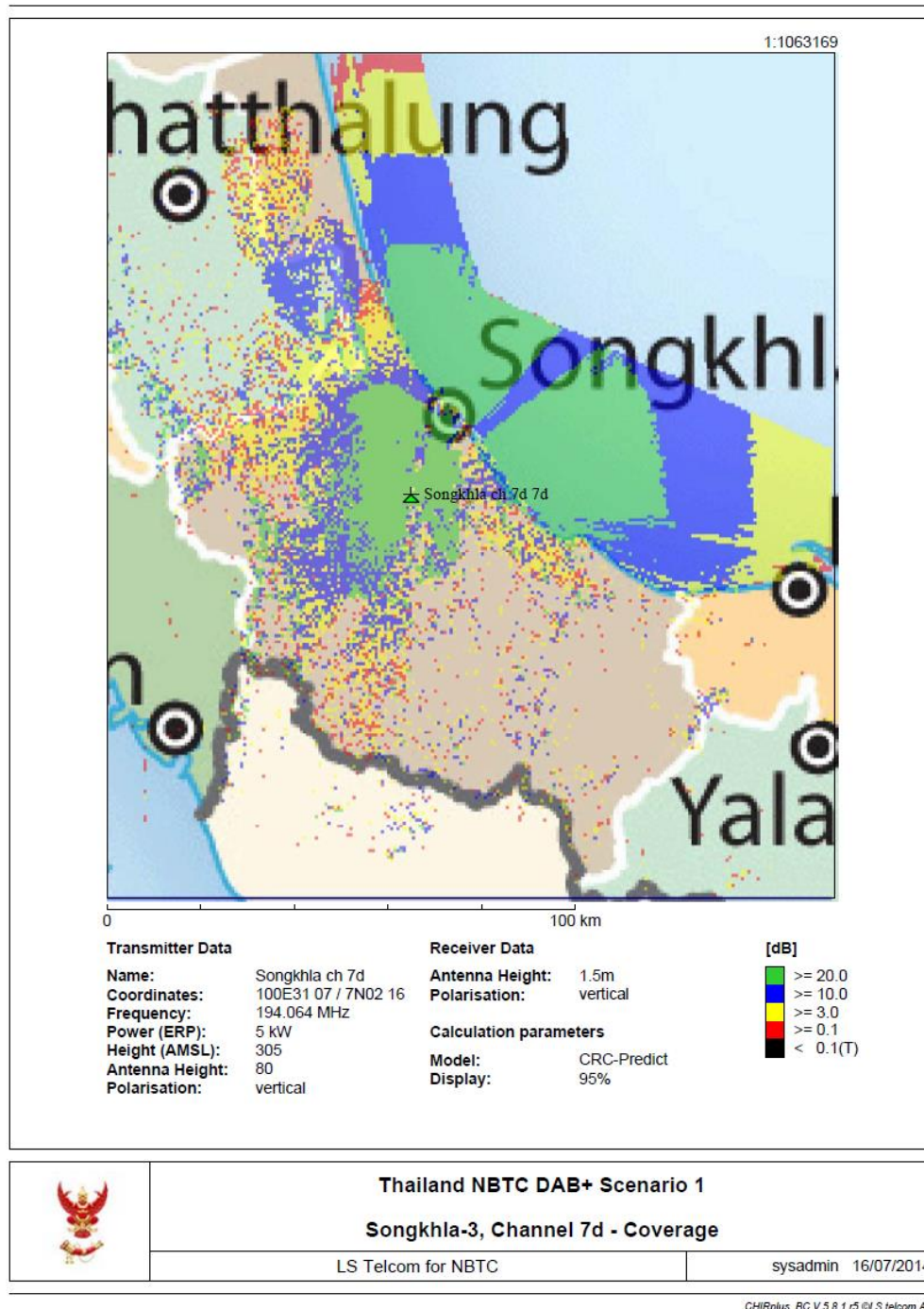


Figure 31 - DAB+ Allotment Coverage Songkhla – 3

C.16 Nakhon Sri Thammarat 1 – ch8B – DAB+ Coverage

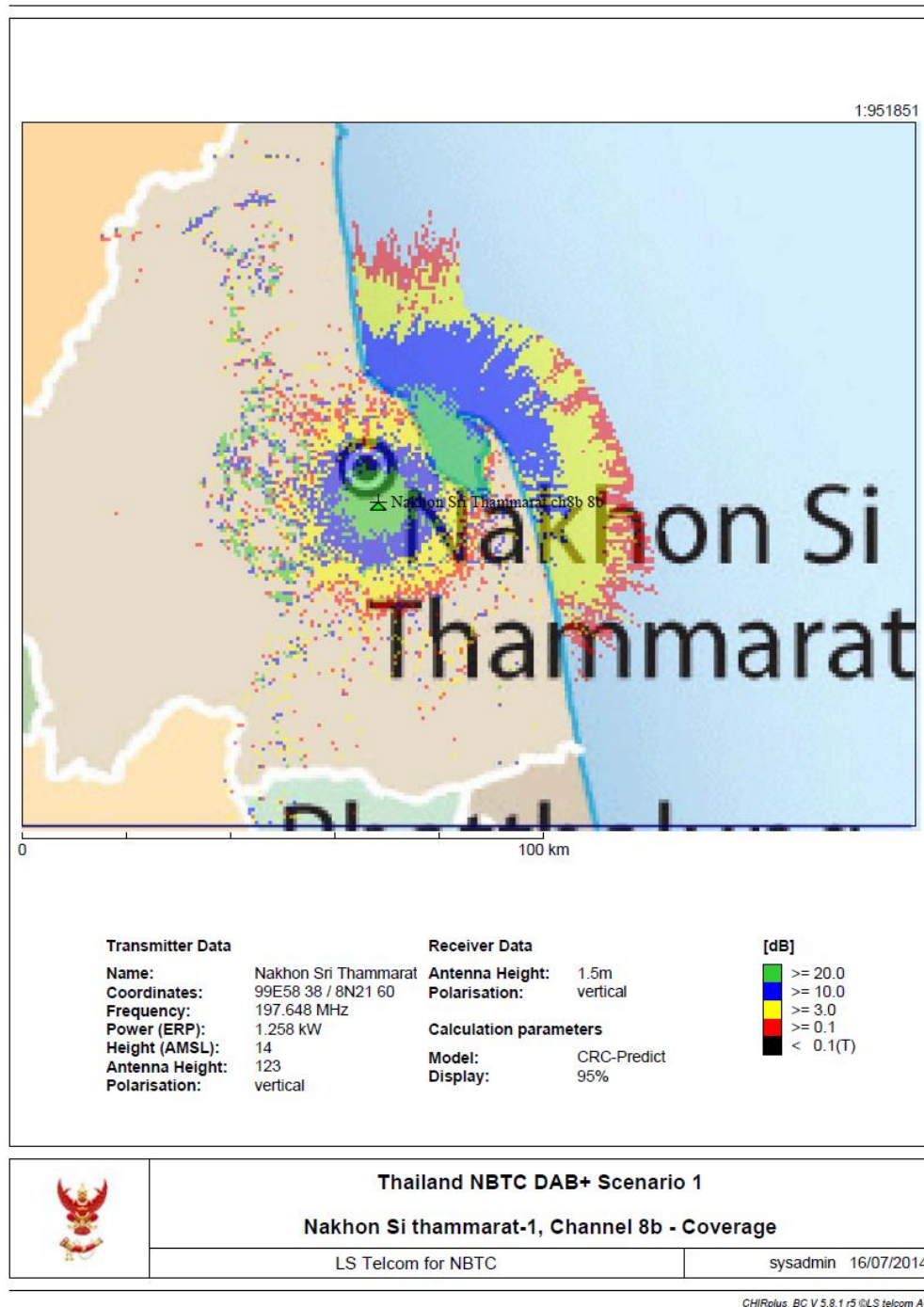


Figure 32 - DAB+ Allotment Coverage Nakhon Sri Thammarat – 1

C.17 Nakhon Sri Thammarat – 2 – ch8C – DAB+ Coverage

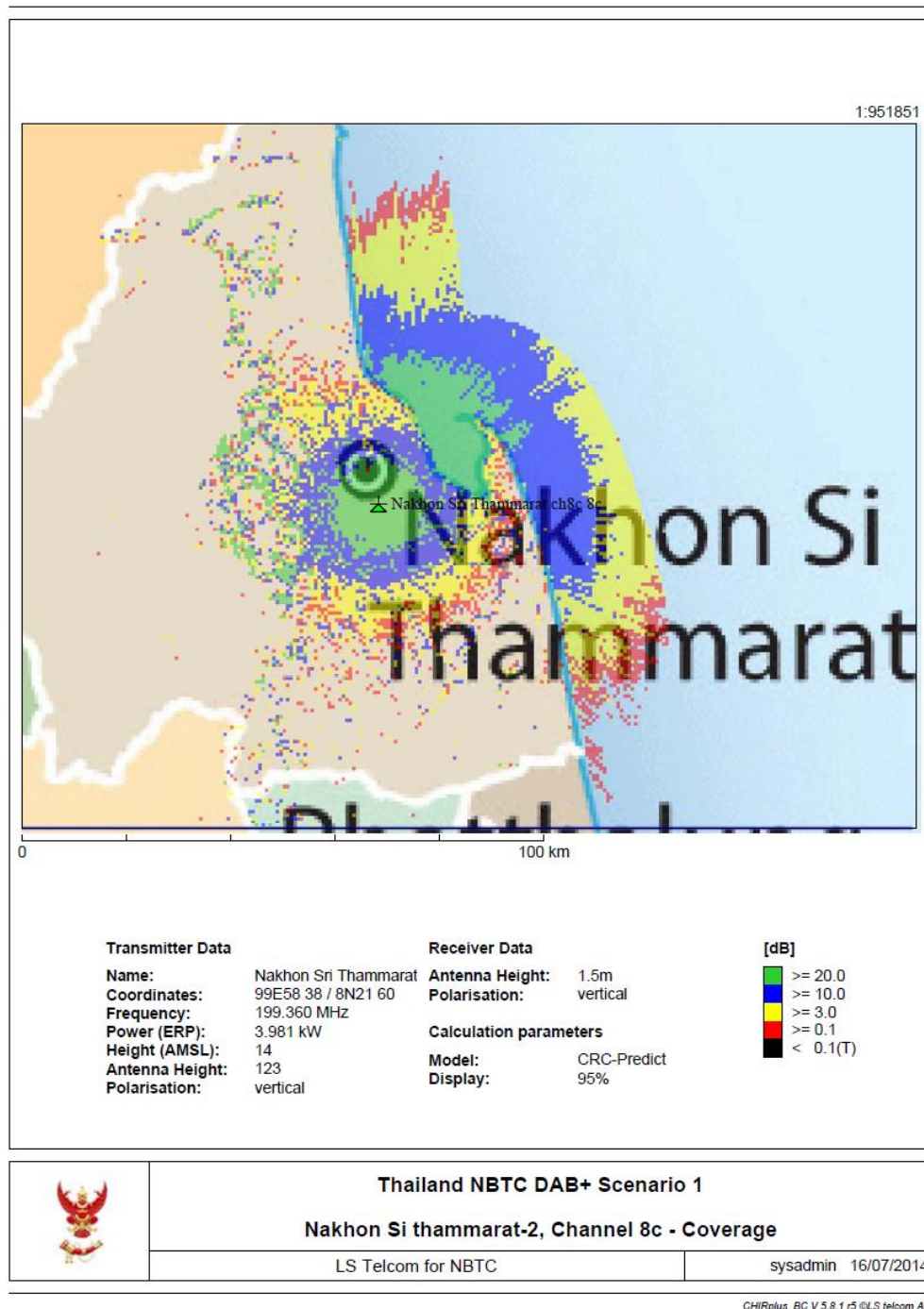


Figure 33 - DAB+ Allotment Coverage Nakhon Sri Thammarat – 2

C.18 Nakhon Sri Thammarat 3 – ch8D – DAB+ Coverage

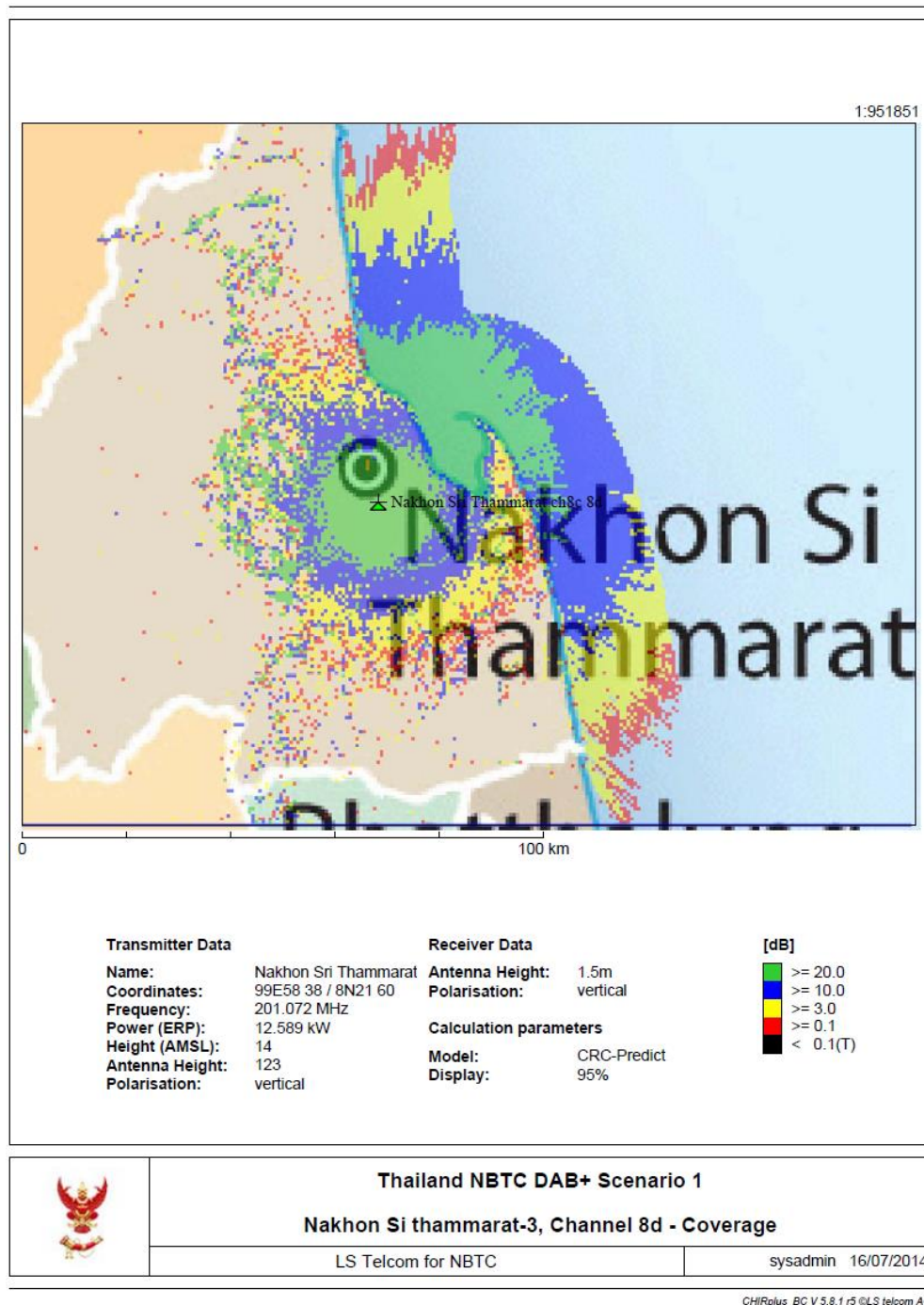


Figure 34 - DAB+ Allotment Coverage Nakhon Sri Thammarat – 3

C.19 Chonburi 1 – ch8C – DAB+ Coverage

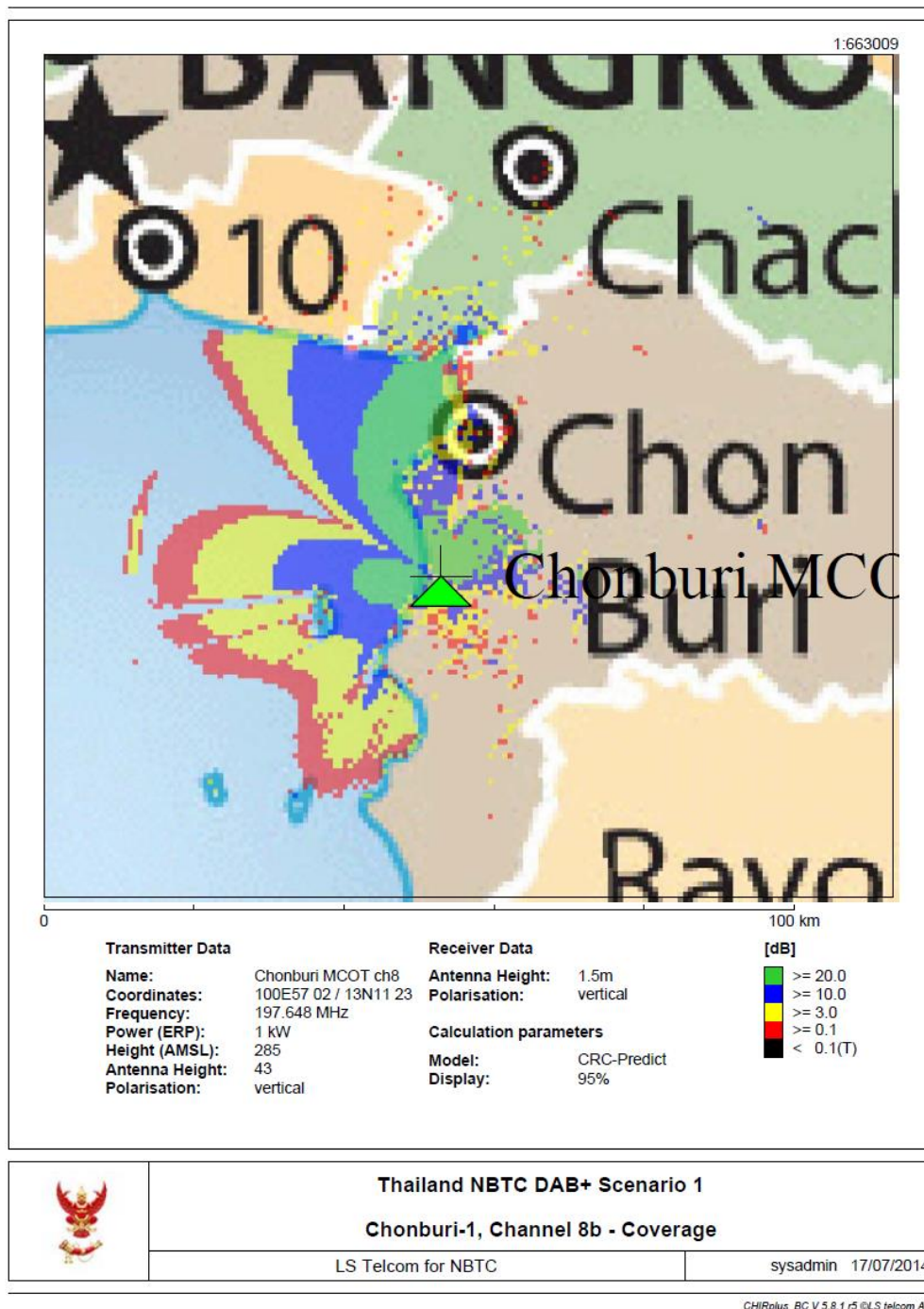


Figure 35 - DAB+ Allotment Coverage Chonburi – 1

C.20 Chonburi 2 – ch8C – DAB+ Coverage

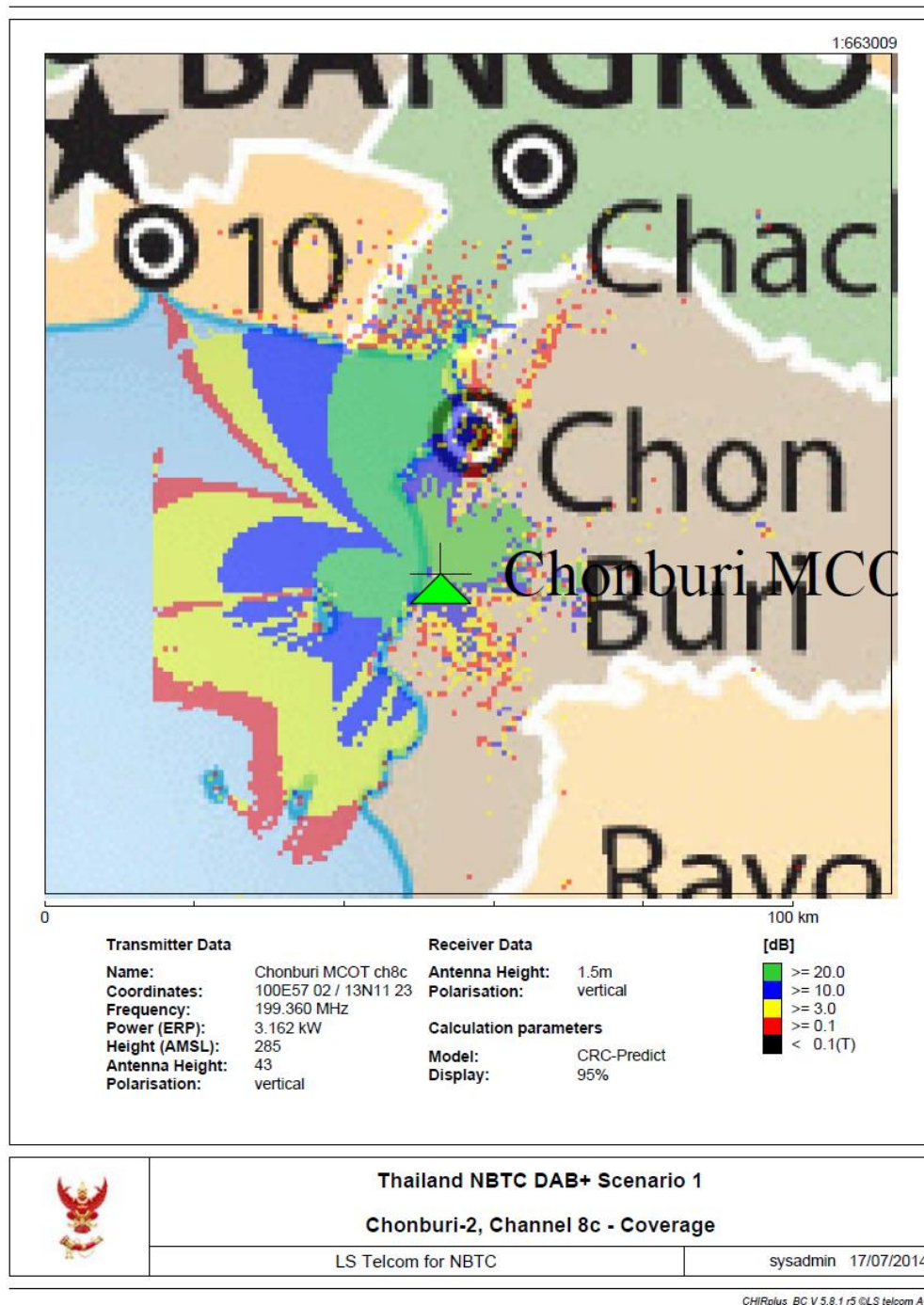


Figure 36 - DAB+ Allotment Coverage Chonburi – 2

C.21 Chonburi 3 – ch8D – DAB+ Coverage

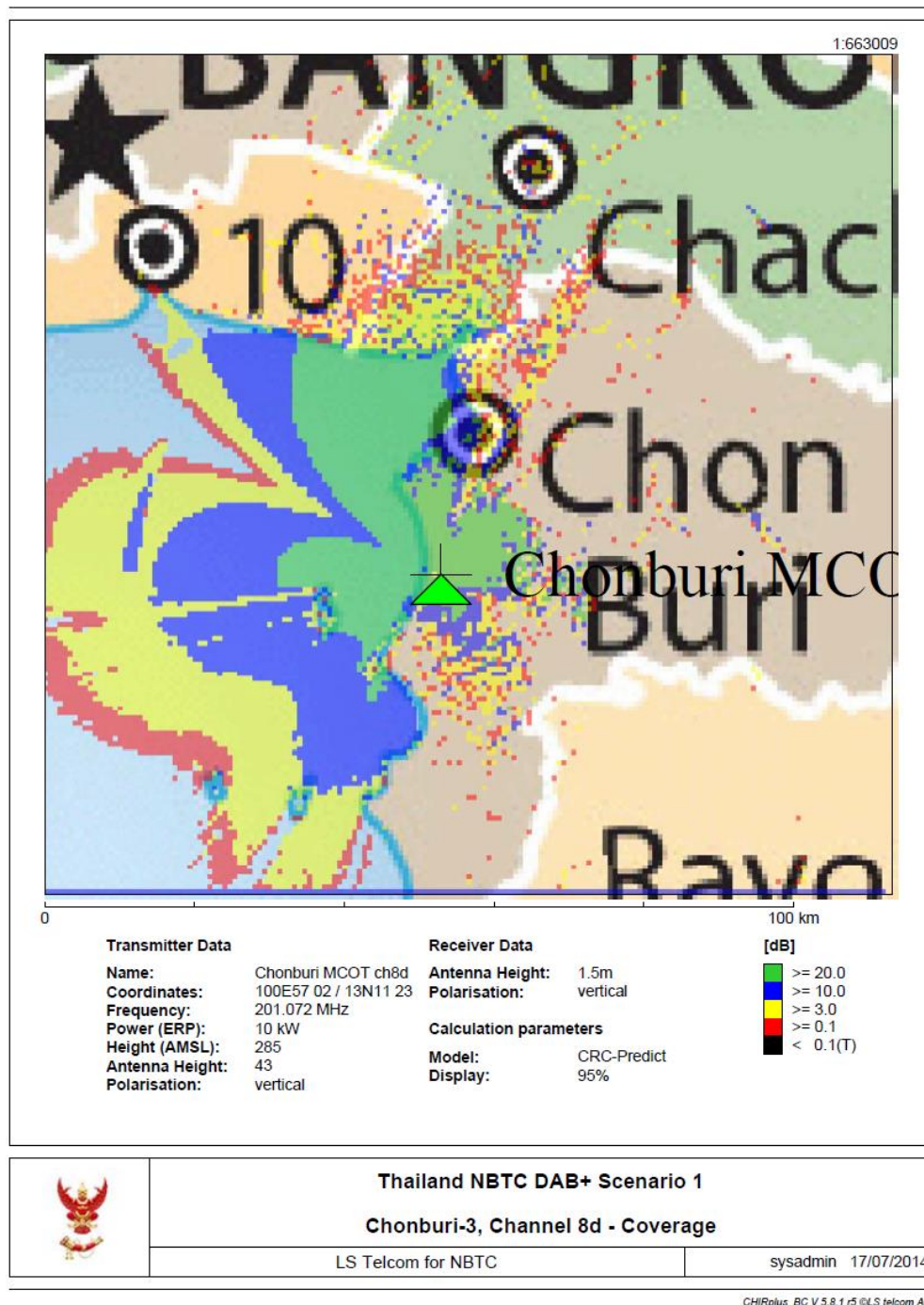


Figure 37 - DAB+ Allotment Coverage Chonburi – 3

C.22 Hua Hin 1 – ch8B – DAB+ Coverage

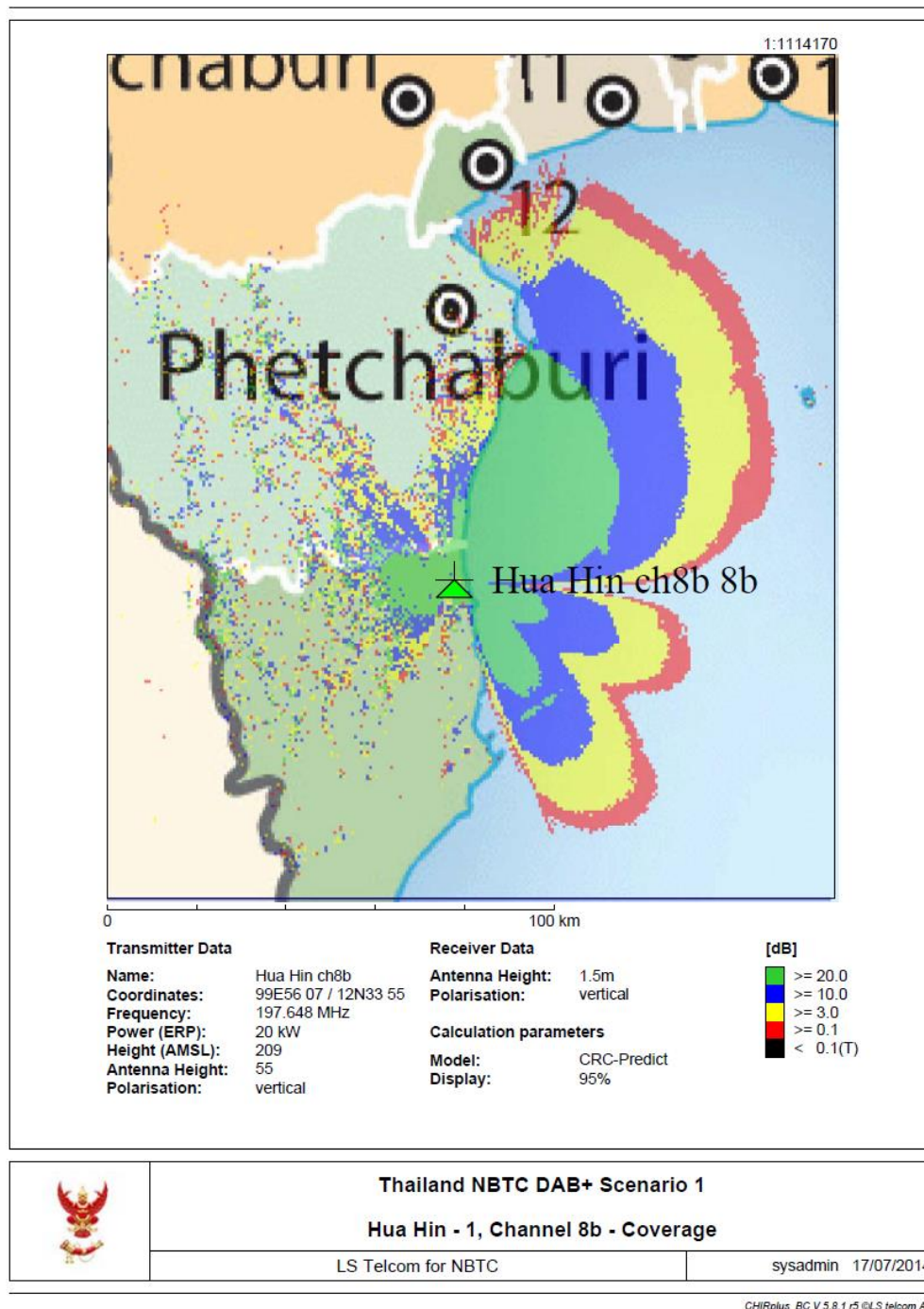


Figure 38 - DAB+ Allotment Coverage Hua Hin – 1

C.23 Hua Hin 2 – ch8C – DAB+ Coverage

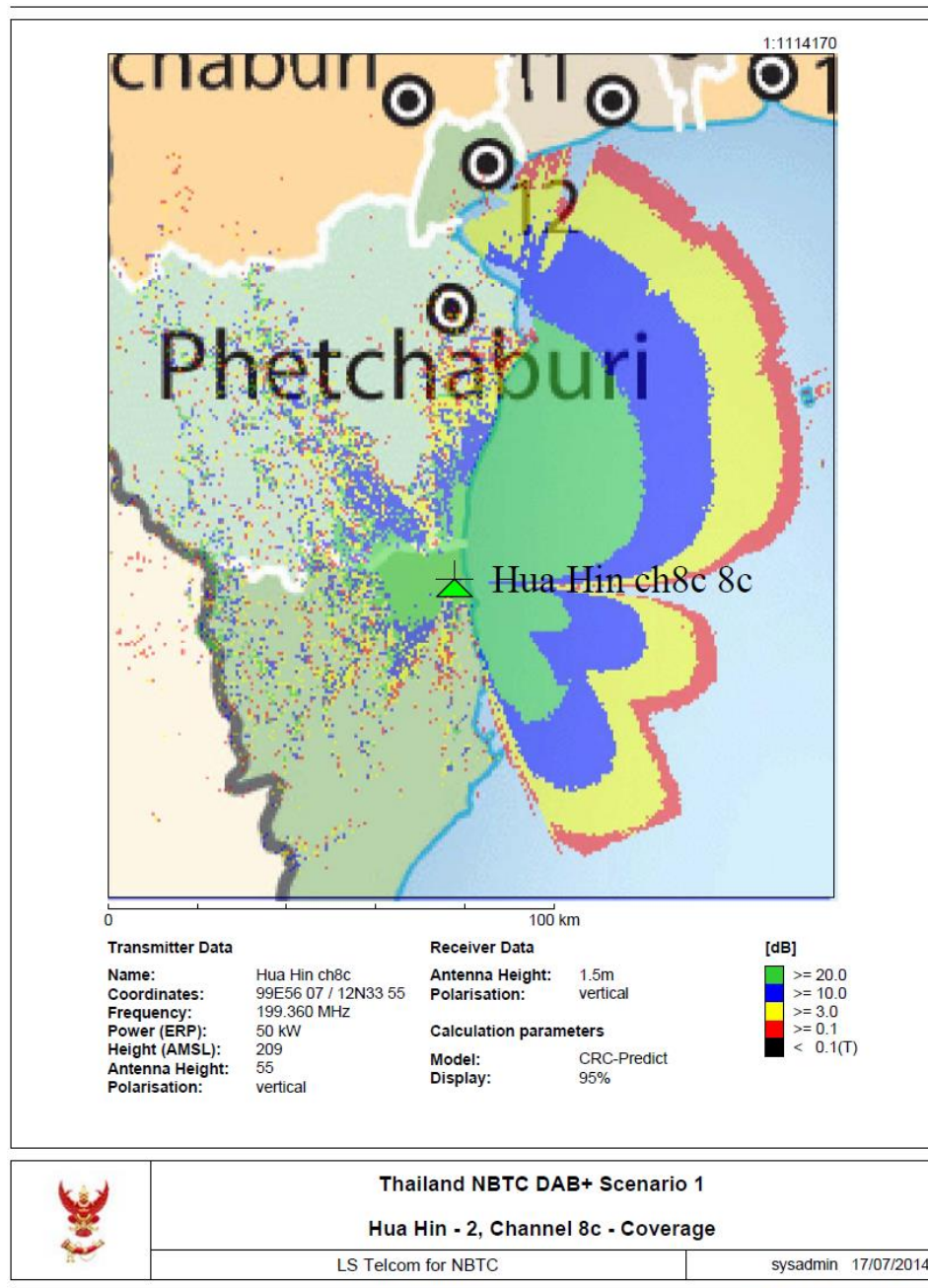


Figure 39 - DAB+ Allotment Coverage Hua Hin – 2

C.24 Hua Hin 3 – ch8D – DAB+ Coverage

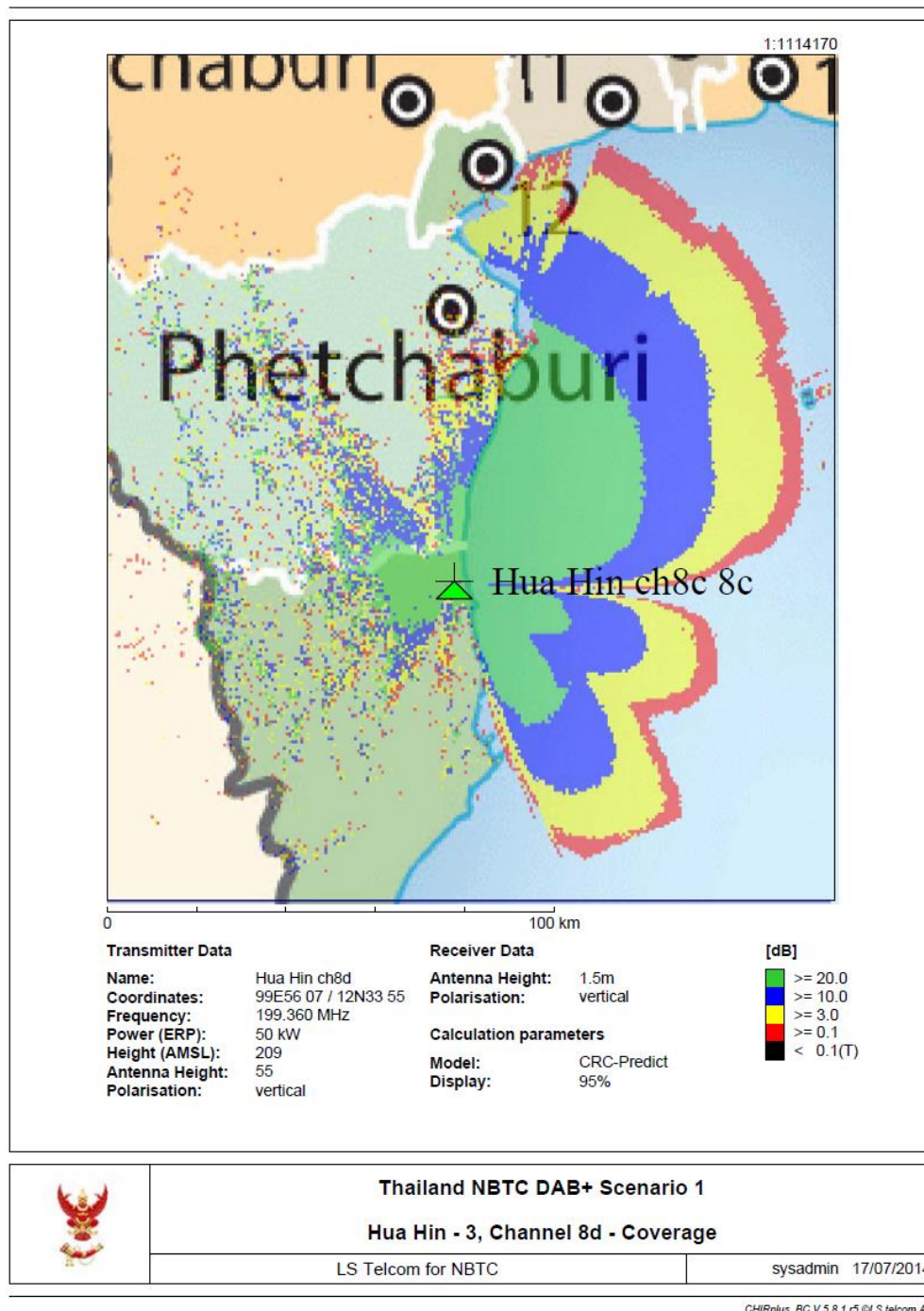


Figure 40 - DAB+ Allotment Coverage Hua Hin – 3

Appendix D - U/D Ratio between DAB+ Allotments and Analogue Television

Analog TV Channel		5	U/D	6	U/D	7	U/D	8	U/D	9	U/D	10	U/D	11	U/D	12	U/D
DAB+ ch	Freq	175.25		182.25		189.25		196.25		203.25		210.25		217.25		224.25	
5A	174.928	-0.322	30	-7.322	-3.7	-14.322	#N/A	-21.322	#N/A	-28.322	#N/A	-35.322	#N/A	-42.322	#N/A	-49.322	#N/A
5B	176.64	1.39	42	-5.61	-7	-12.61	#N/A	-19.61	#N/A	-26.61	#N/A	-33.61	#N/A	-40.61	#N/A	-47.61	#N/A
5C	178.352	3.102	37	-3.898	-9	-10.898	#N/A	-17.898	#N/A	-24.898	#N/A	-31.898	#N/A	-38.898	#N/A	-45.898	#N/A
5D	180.064	4.814	32	-2.186	-6	-9.186	#N/A	-16.186	#N/A	-23.186	#N/A	-30.186	#N/A	-37.186	#N/A	-44.186	#N/A
6A	181.936	6.686	31	-0.314	30	-7.314	-3.7	-14.314	#N/A	-21.314	#N/A	-28.314	#N/A	-35.314	#N/A	-42.314	#N/A
6B	183.648	8.398	-9.2	1.398	42	-5.602	-7	-12.602	#N/A	-19.602	#N/A	-26.602	#N/A	-33.602	#N/A	-40.602	#N/A
6C	185.36	10.11	-13	3.11	37	-3.89	-9	-10.89	#N/A	-17.89	#N/A	-24.89	#N/A	-31.89	#N/A	-38.89	#N/A
6D	187.072	11.822	-15	4.822	32	-2.178	-6	-9.178	#N/A	-16.178	#N/A	-23.178	#N/A	-30.178	#N/A	-37.178	#N/A
7A	188.928	13.678	-19	6.678	31	-0.322	30	-7.322	-3.7	-14.322	#N/A	-21.322	#N/A	-28.322	#N/A	-35.322	#N/A
7B	190.64	15.39	-21	8.39	-9.2	1.39	42	-5.61	-7	-12.61	#N/A	-19.61	#N/A	-26.61	#N/A	-33.61	#N/A
7C	192.352	17.102	-22	10.102	-13	3.102	37	-3.898	-9	-10.898	#N/A	-17.898	#N/A	-24.898	#N/A	-31.898	#N/A
7D	194.064	18.814	-22	11.814	-15	4.814	32	-2.186	-6	-9.186	#N/A	-16.186	#N/A	-23.186	#N/A	-30.186	#N/A
8A	195.936	20.686	-22	13.686	-19	6.686	31	-0.314	30	-7.314	-3.7	-14.314	#N/A	-21.314	#N/A	-28.314	#N/A
8B	197.648	22.398	-22	15.398	-21	8.398	-9.2	1.398	42	-5.602	-7	-12.602	#N/A	-19.602	#N/A	-26.602	#N/A
8C	199.36	24.11	-22	17.11	-22	10.11	-13	3.11	37	-3.89	-9	-10.89	#N/A	-17.89	#N/A	-24.89	#N/A
8D	201.072	25.822	-22	18.822	-22	11.822	-15	4.822	32	-2.178	-6	-9.178	#N/A	-16.178	#N/A	-23.178	#N/A
9A	202.928	27.678	-22	20.678	-22	13.678	-19	6.678	31	-0.322	30	-7.322	-3.7	-14.322	#N/A	-21.322	#N/A
9B	204.64	29.39	-22	22.39	-22	15.39	-21	8.39	-9.2	1.39	42	-5.61	-7	-12.61	#N/A	-19.61	#N/A
9C	206.352	31.102	-22	24.102	-22	17.102	-22	10.102	-13	3.102	37	-3.898	-9	-10.898	#N/A	-17.898	#N/A

Analog TV Channel		5	U/D	6	U/D	7	U/D	8	U/D	9	U/D	10	U/D	11	U/D	12	U/D
DAB+ ch	Freq	175.25		182.25		189.25		196.25		203.25		210.25		217.25		224.25	
9D	208.064	32.814	-22	25.814	-22	18.814	-22	11.814	-15	4.814	32	-2.186	-6	-9.186	#N/A	-16.186	#N/A
10A	209.936	34.686	-22	27.686	-22	20.686	-22	13.686	-19	6.686	31	-0.314	30	-7.314	-3.7	-14.314	#N/A
10B	211.648	36.398	-22	29.398	-22	22.398	-22	15.398	-21	8.398	-9.2	1.398	42	-5.602	-7	-12.602	#N/A
10C	213.36	38.11	-22	31.11	-22	24.11	-22	17.11	-22	10.11	-13	3.11	37	-3.89	-9	-10.89	#N/A
10D	215.072	39.822	-22	32.822	-22	25.822	-22	18.822	-22	11.822	-15	4.822	32	-2.178	-6	-9.178	#N/A
11A	216.928	41.678	-22	34.678	-22	27.678	-22	20.678	-22	13.678	-19	6.678	31	-0.322	30	-7.322	-3.7
11B	218.64	43.39	-22	36.39	-22	29.39	-22	22.39	-22	15.39	-21	8.39	-9.2	1.39	42	-5.61	-7
11C	220.352	45.102	-22	38.102	-22	31.102	-22	24.102	-22	17.102	-22	10.102	-13	3.102	37	-3.898	-9
11D	222.064	46.814	-22	39.814	-22	32.814	-22	25.814	-22	18.814	-22	11.814	-15	4.814	32	-2.186	-6
12A	223.936	48.686	-22	41.686	-22	34.686	-22	27.686	-22	20.686	-22	13.686	-19	6.686	31	-0.314	30
12B	225.648	50.398	-22	43.398	-22	36.398	-22	29.398	-22	22.398	-22	15.398	-21	8.398	-9.2	1.398	42
12C	227.36	52.11	-22	45.11	-22	38.11	-22	31.11	-22	24.11	-22	17.11	-22	10.11	-13	3.11	37
12D	229.072	53.822	-22	46.822	-22	39.822	-22	32.822	-22	25.822	-22	18.822	-22	11.822	-15	4.822	32
13A	230.784	55.534	-22	48.534	-22	41.534	-22	34.534	-22	27.534	-22	20.534	-22	13.534	-19	6.534	31
13B	232.496	57.246	-22	50.246	-22	43.246	-22	36.246	-22	29.246	-22	22.246	-22	15.246	-21	8.246	-9.2
13C	234.208	58.958	-22	51.958	-22	44.958	-22	37.958	-22	30.958	-22	23.958	-22	16.958	-22	9.958	-11
13D	235.776	60.526	-22	53.526	-22	46.526	-22	39.526	-22	32.526	-22	25.526	-22	18.526	-22	11.526	-15
13E	237.488	62.238	-22	55.238	-22	48.238	-22	41.238	-22	34.238	-22	27.238	-22	20.238	-22	13.238	-19
13F	239.2	63.95	-22	56.95	-22	49.95	-22	42.95	-22	35.95	-22	28.95	-22	21.95	-22	14.95	-20

Table 9: U/D Ratio between DAB+ Allotments and Analogue Television

Appendix E – Thailand VHF Analogue Television Database as provided by NBTC

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_BE2539.pdf
1	Bangkok TV5	กรุงเทพมหานคร ททบ.5	13.790514	100.525346	177.5	Analog TV (VHF)	no information	215	400.00	1.00
2	Bangkok Ch7	กรุงเทพมหานคร ททบ.7	13.790541	100.525346	191.5	Analog TV (VHF)	55.76	215	376.70	
3	Bangkok MCOT (Baiyok)	กรุงเทพมหานคร อสมท. (ไบยอก)	13.75416667	100.5403611	205.5	Analog TV (VHF)	no information	324	400.00	1.00
4	Bangkok MCOT (Nong Khaem)	กรุงเทพมหานคร อสมท. (หนองแขม)	13.711689	100.3604	205.5	Analog TV (VHF)	no information	244	400.00	1.00
5	Bangkok PRD	กรุงเทพมหานคร กปส.	13.75416667	100.5403611	219.5	Analog TV (VHF)	48.96	324	78.70	
6	Bangkok PRD (Phetburi Rd.)	กรุงเทพมหานคร กปส. (ถนนเพชรบุรีตัดใหม่)	13.74953	100.571897	219.5	Analog TV (VHF)	no information	180	468.00	1.00
7	Kanchana Buri PRD	กาญจนบุรี กปส. เขาสามห้วย(ทสท)	14.75114444	98.6706778	219.5	Analog TV (VHF)	no information	80	0.50	3.10

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
8	Kanchana Buri PRD	กาญจนบุรี กปส. (สังกะบุรี)	15.13965833	98.4452222	226.5	Analog TV (VHF)	no information	100	0.20	3.30
9	Surin MCOT3	สุรินทร์ อสมท.3	14.807352	103.459560	191.5	Analog TV (VHF)	51.72	100	148.59	
10	Surin MCOT9	สุรินทร์ อสมท.9	14.807352	103.459560	205.5	Analog TV (VHF)	no information	100	100.00	11.00
11	Surin PRD	สุรินทร์ กปส.	14.894170	103.457000	219.5	Analog TV (VHF)	no information	100	100.00	11.00
12	Ubon Ratchathani MCOT3	อุบลราชธานี อสมท.3	15.305669	104.893792	184.5	Analog TV (VHF)	52.88	120	194.09	
13	Ubon Ratchathani MCOT9	อุบลราชธานี อสมท.9	15.305669	104.893792	198.5	Analog TV (VHF)	no information	100	100.00	12.00
14	Ubon Ratchathani TV5	อุบลราชธานี ททบ.5	15.339109	104.909545	212.5	Analog TV (VHF)	no information	110	100.00	12.00
15	Ubon Ratchathani Ch7	อุบลราชธานี ททบ.7สี	15.339109	104.909545	226.5	Analog TV (VHF)	52.7	120	186.21	
16	Mukdahan MCOT9	มุกดาหาร อสมท.9	16.468177	104.629577	198.5	Analog TV (VHF)	no information	100	6.00	13.00
17	Mukdahan Ch5	มุกดาหาร ททบ.5	16.543764	104.684082	212.5	Analog TV (VHF)	no information	90	6.00	13.00
18	Nan Ch5	น่าน ททบ.5	18.73739444	100.7396083	177.5	Analog TV (VHF)	no information	95	100.00	24.00

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
19	Nan MCOT3	น่าน อสมท.3	18.74342222	100.7416944	191.5	Analog TV (VHF)	no information	60	100.00	24.00
20	Nan MCOT9	น่าน อสมท.9	18.74342222	100.7416944	205.5	Analog TV (VHF)	no information	60	100.00	24.00
21	Nan PRD	น่าน กปส.	18.74261944	100.7411722	219.5	Analog TV (VHF)	no information	60	100.00	24.00
22	Phrae MCOT3	แพร่ อสมท.3	17.93311667	100.0008139	184.5	Analog TV (VHF)	46.87	60	48.64	
23	Phrae PRD	แพร่ กปส.	17.93265278	100.0010306	198.5	Analog TV (VHF)	no information	60	20.00	25.00
24	Phrae MCOT9	แพร่ อสมท.9	17.93311667	100.0008139	212.5	Analog TV (VHF)	no information	60	20.00	25.00
25	Lampang MCOT3	ลำปาง อสมท.3	18.23498056	99.56059444	184.5	Analog TV (VHF)	51.3	70	134.90	
26	Lampang PRD	ลำปาง กปส.	18.24316667	99.56283889	198.5	Analog TV (VHF)	no information	100	100.00	21.00
27	Lampang MCOT9	ลำปาง อสมท.9	18.23498056	99.56059444	212.5	Analog TV (VHF)	no information	70	100.00	21.00
28	Lampang Ch7	ลำปาง ททบ.7 สี	18.43200278	99.71356944	226.5	Analog TV (VHF)	51.7	100	147.91	
29	Chiang Rai Ch7	เชียงราย ททบ.7 สี	20.10519167	99.88648056	184.5	Analog TV (VHF)	52.9	100	194.98	
30	Chiang Rai MCOT3	เชียงราย อสมท.3	19.81567222	99.86772778	198.5	Analog TV	51.1	92	128.82	

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
						(VHF)				
31	Chiang Rai PRD	เข็ญราช กปส	19.81358333	99.86701389	212.5	Analog TV (VHF)	no information	60	100.00	22.00
32	Chiang Rai Ch5	เข็ญราช ททบ.5	20.10508056	99.88707778	226.5	Analog TV (VHF)	no information	90	100.00	22.00
33	Song Khla Ch7	สงขลา ททบ.7สี	7.040002	100.519011	184.5	Analog TV (VHF)	53.9	88	245.47	
34	Song Khla Ch 5	สงขลา ททบ. 5	7.037696	100.51864	198.5	Analog TV (VHF)	no information	100	100.00	38.00
35	Song Khla PRD	สงขลา กปส.	7.015807	100.520298	212.5	Analog TV (VHF)	no information	55	100.00	38.00
36	Trang MCOT3	ตรัง อสมท.3	7.66488	99.585039	184.5	Analog TV (VHF)	44.01	49	25.18	
37	Trang Ch5	ตรัง ททบ.5	7.644978	99.579416	198.5	Analog TV (VHF)	no information	93	100.00	37.00
38	Trang MCOT9	ตรัง อสมท.9	7.66448	99.585039	212.5	Analog TV (VHF)	no information	87	100.00	37.00
39	Trang กปส	ตรัง กปส	7.663519	99.583935	226.5	Analog TV (VHF)	no information	98	100.00	37.00
40	Satun Ch5	สตูล ททบ.5	6.6526	100.087123	191.5	Analog TV (VHF)	no information	60	1.00	39.00
41	Satun MCOT9	สตูล อสมท.9	6.635305556	100.02525	205.5	Analog TV (VHF)	no information	94	20.00	39.00

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
42	Yala MCOT9	ยะลา อสมท.9	6.336511	101.387812	177.5	Analog TV (VHF)	no information	55	100.00	40.00
43	Yala Ch7	ยะลา ททบ.7 สี	6.339167	101.389361	191.5	Analog TV (VHF)	52.1	90	162.18	
44	Yala MCOT3	ยะลา อสมท.3	6.336511	101.387812	205.5	Analog TV (VHF)	51.7	55	147.91	
45	Yala PRD	ยะลา กปส.	6.335666	101.387833	219.5	Analog TV (VHF)	no information	45	100.00	40.00
46	Rayong MCOT3	ระยอง อสมท.3	12.673701	101.412145	184.5	Analog TV (VHF)	51.39	96	137.72	
47	Rayong Ch7	ระยอง ททบ.7	12.651441	101.417753	198.5	Analog TV (VHF)	53.9	80	245.47	
48	Rayong MCOT9	ระยอง อสมท.9	12.673701	101.412145	212.5	Analog TV (VHF)	no information	96	100.00	5.00
49	Rayong PRD	ระยอง กปส.	12.676003	101.412956	226.5	Analog TV (VHF)	no information	55	100.00	5.00
50	Sakaeo MCOT3	สระแก้ว อสมท.3	13.853385	102.032662	184.5	Analog TV (VHF)	51.39	130	137.72	
51	Sakaeo Ch5	สระแก้ว ททบ.5	13.800443	102.124948	198.5	Analog TV (VHF)	no information	90	100.00	6.00
52	Sakaeo MCOT9	สระแก้ว อสมท.9	13.853385	102.032662	212.5	Analog TV (VHF)	no information	130	100.00	6.00
53	Sakaeo PRD	สระแก้ว กปส.	13.786796	102.089988	226.5	Analog TV	no information	90	100.00	6.00

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
						(VHF)				
54	Trat Ch 7	ตราด ททบ. 7สี	12.196005	102.298914	177.5	Analog TV (VHF)	55	85	316.23	
55	Trat MCOT3	ตราด อสมท.3	12.37058	102.445574	191.5	Analog TV (VHF)	53.55	90	226.46	
56	Trat MCOT9	ตราด อสมท.9	12.37058	102.445574	205.5	Analog TV (VHF)	no information	90	100.00	7.00
57	Trat PRD	ตราด กปส.	12.19547	102.29834	219.5	Analog TV (VHF)	no information	55	100.00	7.00
58	Loie MCOT9 (Phu Pha sat)	เลข อสมท.9 (ภูผาสาด)	17.469806	101.444556	184.5	Analog TV (VHF)	no information	40	50.00	16.00
59	Loie Ch7 (Phu Pha sat)	เลข ททบ.7 สี (ภูผาสาด)	17.281028	101.522722	198.5	Analog TV (VHF)	53.9	98	245.47	
60	Loie PRD (Phu Pha sat)	เลข กปส. (ภูผาสาด)	17.470667	101.444528	212.5	Analog TV (VHF)	no information	50	50.00	16.00
61	Loie MCOT3 (Phu Pha sat)	เลข อสมท.3 (ภูผาสาด)	17.469806	101.444556	226.5	Analog TV (VHF)	46.45	40	44.16	
62	Khon Kaen Ch7	ขอนแก่น ททบ.7 สี	16.836750	102.913778	177.5	Analog TV (VHF)	52.3	90	169.82	
63	Khon Kaen MCOT3	ขอนแก่น อสมท.3	16.453378	102.950160	191.5	Analog TV (VHF)	52.88	136	194.09	
64	Khon Kaen MCOT9	ขอนแก่น อสมท.9	16.453378	102.950160	205.5	Analog TV (VHF)	no information	136	100.00	15.00

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
65	Khon Kaen Ch5	ขอนแก่น ททบ.5	16.836639	102.912500	219.5	Analog TV (VHF)	no information	90	100.00	15.00
66	Nong Bua Lamphu MCOT3	หนองบัวลำภู อสมท.3	17.230389	102.483556	226.5	Analog TV (VHF)	51.1	74	128.82	
67	Nakhon Ratchasima PRD	นครราชสีมา กปส.	14.78958333	101.5523611	184.5	Analog TV (VHF)	no information	73	100.00	9.00
68	Nakhon Ratchasima Ch5	นครราชสีมา ททบ.5	14.78613889	101.5470278	198.5	Analog TV (VHF)	no information	90	100.00	9.00
69	Nakhon Ratchasima MCOT9	นครราชสีมา อสมท.9	14.78958333	101.5523611	212.5	Analog TV (VHF)	no information	73	100.00	9.00
70	Nakhon Ratchasima Ch7	นครราชสีมา ททบ.7 สี	14.790308	101.551275	226.5	Analog TV (VHF)	52.9	85	194.98	
71	Buriram Ch5	บุรีรัมย์ ททบ.5	14.93436111	103.0982222	177.5	Analog TV (VHF)	no information	86	100.00	11.00
72	Sakhon Nakhon Ch5	สกลนคร ททบ.5	17.142387	103.985908	177.5	Analog TV (VHF)	no information	90	100.00	18.00
73	Sakhon Nakhon MCOT3	สกลนคร อสมท.3	17.137666	103.989097	191.5	Analog TV (VHF)	53.4	67	218.78	
74	Sakhon Nakhon MCOT9	สกลนคร อสมท.9	17.137666	103.989097	205.5	Analog TV (VHF)	no information	67	100.00	18.00
75	Sakhon Nakhon Ch7	สกลนคร ททบ.7 สี	17.137956	103.987725	219.5	Analog TV (VHF)	52.85	82	192.75	
76	Udonthani PRD	อุดรธานี กปส.	17.653836	102.790077	212.5	Analog TV	no information	83	100.00	17.00

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
						(VHF)				
77	Nong Khai Ch5	หนองคาย ททบ.5	17.908634	102.792635	184.5	Analog TV (VHF)	no information	100	100.00	17.00
78	Mae Hong Son MCOT3	แม่ฮ่องสอน อสมท.3	19.106032	98.035706	184.5	Analog TV (VHF)	41.61	45	14.49	
79	Mae Hong Son Ch7	แม่ฮ่องสอน ททบ.7 สี	19.298041	97.958001	198.5	Analog TV (VHF)	40.44	36	11.07	
80	Mae Hong Son MCOT9	แม่ฮ่องสอน อสมท.9	19.106032	98.035706	212.5	Analog TV (VHF)	no information	45	100.00	20.00
81	Mae Hong Son PRD	แม่ฮ่องสอน กปส.	19.106345	98.034847	226.5	Analog TV (VHF)	no information	50	100.00	20.00
82	Mae Hong Son Ch7 (Doi Chang)	แม่ฮ่องสอน ททบ.7 สี (ดอยช้าง)	18.169813	97.945361	198.5	Analog TV (VHF)	34.34	45	2.72	
83	Mae Hong Son Ch7 (Pai)	แม่ฮ่องสอน ททบ.7 สี (ปาย)	19.38833333	98.42102778	198.5	Analog TV (VHF)	37.24	37	5.30	
84	Chiang Mai Ch5	เชียงใหม่ ททบ.5	18.85397222	98.95952778	177.5	Analog TV (VHF)	no information	110	100.00	19.00
85	Chiang Mai Ch7	เชียงใหม่ ททบ.7 สี	18.79788889	98.94266667	191.5	Analog TV (VHF)	54.7	100	295.12	
86	Chiang Mai MCOT9	เชียงใหม่ อสมท.9	18.80905556	98.91247222	205.5	Analog TV (VHF)	no information	60	100.00	19.00
87	Chiang Mai PRD	เชียงใหม่ กปส	18.80797222	98.91541667	219.5	Analog TV (VHF)	no information	70	100.00	19.00

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_BE2539.pdf
88	Mae Hong Son (Mae Sariang) MCOT9	แม่ฮ่องสอน (แม่สะเรียง) อสมท.9	18.169743	97.945381	212.5	Analog TV (VHF)	no information	76	0.50	20.10
89	Mae Hong Son (Mae Sariang) PRD	แม่ฮ่องสอน (แม่สะเรียง) กปส.	18.16858333	97.94452778	226.5	Analog TV (VHF)	no information	40	0.50	20.10
90	Sukhothai Ch7	สุโขทัย ททบ.7 สี	16.78022222	99.70780556	177.5	Analog TV (VHF)	53	106	199.53	
91	Phitsanulok PRD	พิษณุโลก กปส.	16.839777	100.403105	191.5	Analog TV (VHF)	no information	114	100.00	26.00
92	Sukhothai MCOT9	สุโขทัย อสมท.9	16.963368	99.967094	205.5	Analog TV (VHF)	no information	140	100.00	26.00
93	Phitsanulok Ch5	พิษณุโลก ททบ.5	16.8415	100.402	219.5	Analog TV (VHF)	no information	112	100.00	26.00
94	Tak MCOT3	ตาก อสมท.3	16.78022222	98.92622222	184.5	Analog TV (VHF)	48.01	87	63.24	
95	Tak PRD	ตาก กปส.	16.77883333	98.92766667	198.5	Analog TV (VHF)	no information	95	50.00	26.40
96	Tak MCOT9	ตาก อสมท.9	16.78022222	98.92622222	212.5	Analog TV (VHF)	no information	87	50.00	26.40
97	Tak Ch7	ตาก ททบ.7 สี	16.77922222	98.92697222	226.5	Analog TV (VHF)	51	94	125.89	
98	Nakhon Sawan MCOT3	นครสวรรค์ อสมท.3	15.715916	100.133575	184.5	Analog TV (VHF)	52.6	70	181.97	
99	Nakhon Sawan Ch5	นครสวรรค์ ททบ.5	15.714719	100.13228	198.5	Analog TV	no information	73	100.00	28.00

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
						(VHF)				
100	Nakhon Sawan PRD	นครสวรรค์ กปส.	15.71597222	100.1335278	212.5	Analog TV (VHF)	no information	95	100.00	28.00
101	Nakhon Sawan Ch7	นครสวรรค์ ททบ.7 สี	15.71479	100.133085	226.5	Analog TV (VHF)	no information	58	100.00	28.00
102	Phetchabun MCOT9	เพชรบูรณ์ อสมท.9	16.253299	101.134471	177.5	Analog TV (VHF)	no information	90	50.00	29.00
103	Phetchabun PRD	เพชรบูรณ์ กปส.	16.42681	101.153704	191.5	Analog TV (VHF)	no information	114	50.00	29.00
104	Phetchabun MCOT3	เพชรบูรณ์ อสมท.3	16.25330556	101.1344722	219.5	Analog TV (VHF)	47.61	90	57.68	
105	Phang Nga MCOT3	พังงา อสมท.3	8.839513	98.351455	184.5	Analog TV (VHF)	40.74	55	11.86	
106	Phang Nga MCOT9	พังงา อสมท.9	8.839513	98.351455	212.5	Analog TV (VHF)	no information	55	6.67	33.00
107	Phang Nga PRD	พังงา กปส.	8.839513	98.351455	226.5	Analog TV (VHF)	no information	55	10.00	33.00
108	Phuket PRD	ภูเก็ต กปส.	7.898699	98.395233	177.5	Analog TV (VHF)	no information	55	100.00	34.00
109	Phuket Ch7	ภูเก็ต ททบ.7 สี	7.897646	98.395203	191.5	Analog TV (VHF)	54.2	80	263.03	
110	Phuket MCOT9	ภูเก็ต อสมท.9	7.898639	98.39563	205.5	Analog TV (VHF)	no information	75	100.00	34.00

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
111	Phuket MCOT3	ภูเก็ต อสมท.3	7.898639	98.39563	219.5	Analog TV (VHF)	53.85	75	242.66	
112	Surat Thani MCOT3	สุราษฎร์ธานี อสมท.3	9.092881	99.348907	184.5	Analog TV (VHF)	51.7	73	147.91	
113	Surat Thani Ch7	สุราษฎร์ธานี ททบ.7 สี	9.095638889	99.34990556	198.5	Analog TV (VHF)	52.1	82	162.18	
114	Surat Thani MCOT9	สุราษฎร์ธานี อสมท.9	9.092881	99.348907	212.5	Analog TV (VHF)	no information	73	100.00	32.00
115	Surat Thani PRD	สุราษฎร์ธานี กปส.	9.092255556	99.34856389	226.5	Analog TV (VHF)	no information	74	100.00	32.00
116	Nakhon Sri Thamarat PRD	นครศรีธรรมราช กปส	8.366633333	99.97735556	177.5	Analog TV (VHF)	no information	113	100.00	36.00
117	Nakhon Sri Thamarat Ch7	นครศรีธรรมราช ททบ.7 สี	8.238216667	99.80552778	191.5	Analog TV (VHF)	53	50	199.53	
118	Nakhon Sri Thamarat MCOT9	นครศรีธรรมราช อสมท.9	8.236697222	99.80393333	205.5	Analog TV (VHF)	no information	54	100.00	36.00
119	Nakhon Sri Thamarat MCOT3	นครศรีธรรมราช อสมท.3	8.236697222	99.80393333	219.5	Analog TV (VHF)	no information	54	100.00	36.00
120	Ranong PRD	ระนอง กปส.	10.02391	98.668675	177.5	Analog TV (VHF)	no information	126	20.00	31.00
121	Ranong Ch7	ระนอง ททบ.7 สี	10.033316	98.671602	191.5	Analog TV (VHF)	42.11	62	16.26	
122	Ranong MCOT9	ระนอง อสมท.9	10.031944	98.671167	205.5	Analog TV	no information	63	20.00	31.00

No.	English Name	*Antenna Site Name (Thai)	Lat	Long	*Assign Frequency (MHz)	Service	*Horizontal e.r.p (dBW)	*Antenna AGL	ERP (kW)	**TV_plan_ BE2539.pdf
						(VHF)				
123	Ranong MCOT3	ระนอง อสมท.3	10.031944	98.671167	219.5	Analog TV (VHF)	40.27	51	10.64	
124	Prachuap Khiri Khan MCOT3	ประจวบคีรีขันธ์ อสมท.3	11.905942	99.801317	184.5	Analog TV (VHF)	52.29	60	169.43	
125	Prachuap Khiri Khan Ch7	ประจวบคีรีขันธ์ ททบ.7 สี	11.4185	99.588398	198.5	Analog TV (VHF)	55.13	100	325.84	
126	Prachuap Khiri Khan MCOT9	ประจวบคีรีขันธ์ อสมท.9	11.905942	99.801317	212.5	Analog TV (VHF)	no information	60	100.00	8.00
127	Prachuap Khiri Khan PRD	ประจวบคีรีขันธ์ กปส.	11 50 7.20	99 48 03	226.5	Analog TV (VHF)	no information	150	100.00	8.00
128	Chumphon PRD	ชุมพร กปส.	10.525866	99.192413	177.5	Analog TV (VHF)	no information	110	100.00	30.00
129	Chumphon Ch5	ชุมพร ททบ.5	10.445803	99.134538	191.5	Analog TV (VHF)	no information	90	100.00	30.00
130	Chumphon MCOT9	ชุมพร อสมท.9	10.44615	99.134647	205.5	Analog TV (VHF)	no information	140	100.00	30.00
131	Chumphon MCOT3	ชุมพร อสมท.3	10.445978	99.134143	219.5	Analog TV (VHF)	no information	140	100.00	30.00