Government of **Western Australia**
Department of **Environment and Conservation**

Redetermination of maximum permissible quantities of sulphur dioxide under the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999

July 2009

2009211

Recommended reference

The recommended reference for this report is: Department of Environment and Conservation, W.A., July 2009, *Redetermination of maximum permissible quantities of sulphur dioxide under the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999.*

Contents

1. Introduction

This report describes the process and results of a redetermination of maximum permissible quantities of sulphur dioxide under the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999 (hereafter called the Kwinana EPP or EPP). The redetermination, which includes all industries covered by the current determination, has been prompted primarily by the benefits of redefining maximum permissible quantities on a statistical basis, as permitted under the EPP.

This report does not repeat in detail previously published information about the Kwinana EPP or the previous determination and redeterminations of maximum permissible quantities (i.e. emissions limits) but provides references and, where appropriate, summary information. Publications referenced herein (other than scientific papers from international journals) may be downloaded from the following website:

http://www.dec.wa.gov.au/pollution-prevention/air-quality-publications/technical-reports.html

The Environmental Protection Authority (EPA) Bulletin 644 can be downloaded from the EPA website at:

http://www.epa.wa.gov.au/docs/708_B644.pdf

The computer modelling results and portions of the text and figures in this report have been provided by the Kwinana Industries Council (prepared by ENVIRON Australia Pty Ltd). These have been assessed and verified by DEC. The cooperation of the Kwinana Industries Council and assistance of ENVIRON is gratefully acknowledged.

Throughout this report the abbreviations “Kwinana EPP” and “EPP” refer to the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999 and, where relevant, the *Environmental Protection (Kwinana) (Atmospheric Wastes) Regulations 1992* (Regulations)

2. The Kwinana EPP 1992 to 2009

2.1 Overview of the EPP

The Kwinana EPP was first approved in 1992 and reviewed without change in 1999. The 1999 EPP review process is described in EPA (1999). While the regulations associated with the Kwinana EPP prescribe sulphur dioxide and total suspended particulates as atmospheric wastes for the purposes of the EPP, the primary focus of emissions management under the EPP has been on sulphur dioxide. Only sulphur dioxide is considered in this report.

At the time of writing, the EPA has initiated the process for reviewing the Kwinana EPP under s 36 of the *Environmental Protection Act 1986*.

The Kwinana EPP defines three areas (Areas A, B and C), where:

- Area A is the area of land on which heavy industry is located;
- Area B is a buffer area surrounding industry;
- Area C is beyond Areas A and B, predominantly rural and residential.

Figure 1 in Appendix A shows these areas and the location of monitoring stations.

The Kwinana EPP sets ambient standard and limits for the three EPP areas, with these increasing in stringency from Area A to Area C. Standards and Limits for sulphur dioxide were set for 1-hour, 24-hour and annual averaging periods with the most important of these being 1-hour averages with respect to controlling air quality in Kwinana. Table 1 sets out the Standards and Limits.

Table 1: Kwinana EPP Standards and Limits for Sulphur Dioxide

Averaging Period		Concentration (μg/m^3)		
		Area A	Area B	Area C
1-hour	Standard	700	500	350
	Limit	1,400	1,000	700
24-hour	Standard	200	150	125
	Limit	365	200	200
Annual	Standard	60	50	50
	Limit	80	60	60

Notes

1. μg/m^3 means the concentration in micrograms per cubic metre of dry air at 0 degrees Celsius and one atmosphere pressure (101.325 kilopascals).

The Kwinana EPP provides for the CEO (of DEC) to determine the maximum permissible quantities (emission limits) of sulphur dioxide from significant sources in the EPP Area so that, in his opinion, the EPP Standards and Limits will be complied with. The EPP also provides for a redetermination of emission limits as and when required (e.g. to accommodate new industries or variations to existing industry emissions).

EPA Bulletin 644 (1992) provides a detailed description of the background to the EPP development, the underlying management strategy (which is current) and the computer model employed for calculating maximum permissible quantities. This bulletin also fulfils the reporting requirements of the EPP in relation to the determination procedure and the maximum permissible quantities as determined in 1992.

2.2 Ambient sulphur dioxide monitoring

Under the provisions of the EPP, ambient concentrations of sulphur dioxide have been monitored by six monitoring stations in the Kwinana Region since 1993. Three of these have been operated at fixed locations by DEC and three have been operated by industry through the Kwinana Industries Council (KIC). Two of these industry operated stations were located at fixed locations, with the third station moving between successive locations. Details of the monitoring sites are as follows:

- Wattleup (DEC owned and operated);
- Hope Valley (DEC owned and operated);
- Rockingham (also called North Rockingham) (DEC owned and operated);
- Miguel Road (KIC owned and operated);
- Abercrombie Road (KIC owned and operated); and
- One KIC monitoring station operated at the following locations in sequence:- Hillman Primary School, Rhodes Park in Calista, Henderson Road, Fanstone Avenue and Fancote Avenue.

The industry monitoring program described above has been approved by DEC at each stage.

Figure 2 in Appendix A presents the maximum and 99.9th percentile (i.e. 9th highest) 1-hour average concentrations of sulphur dioxide recorded at each of the monitoring stations since 1993 through to the end of 2008.

These data show that over the 16 years, there have been no exceedances of the EPP limits at any of the monitoring stations. The maximum recorded 1-hour average concentrations of sulphur dioxide exceeded the relevant EPP standard:

- three times at Hope Valley (1993, 1994 and 2007); and
- once at Wattleup (1993), Miguel Road (1994) and Rockingham (1994).

The 1993 and 1994 exceedances of the EPP standards were associated with unexpected process upsets. The exceedance of the EPP standard at Hope Valley during 2007 was the first exceedance of the standard recorded since 1994 and no specific cause for this has been identified.

The monitoring data show that the ambient concentrations of sulphur dioxide are generally well below the EPP standard although the maximum recorded concentrations have tended to increase at the Hope Valley and Abercrombie monitoring sites during 2006, 2007 and 2008. The Hope Valley monitoring site was decommissioned in 2008 due to its location no longer being available to DEC. Hope Valley is no longer a residential area.

2.3 Computer model evaluation

As envisaged in Bulletin 644, the accumulated data on emissions, ambient concentrations and meteorology has allowed progressive evaluation and improvement of the computer model used for determination of maximum permissible quantities.

At the time that the maximum permissible quantities were defined in 1992, limitations in the scientific basis of the model (know as DISPMOD) were recognized and documented in Bulletin 644 and by Rayner (1992).

A major field experiment was conducted at Kwinana in early 1995 to better understand the process of plume mixing within sea breezes (specifically the process known as “shoreline fumigation”, see Figure 3). The experiment and subsequent theoretical work was led by the CSIRO (Sawford *et al.*, 1996). Results of this work were incorporated as improvements to DISPMOD. These and other improvements described by Rayner and Blockley (2000) form the basis for an improved version of the model named (for the purposes of this report) **DISPMOD97**.

DISPMOD97 was run for the 1995, 1996 and 1997 calendar years using the actual emission characteristics provided by industry as part of their licence conditions. The modelled versus measured 1-hour average concentration statistics for two years are presented in Figure 4. Each annual plot for each monitoring station (identified on the horizontal axis) shows the measured and modelled 9^{th} highest 1-hour average concentration and the average of the top ten 1-hour average concentrations. Apart from a tendency to over-predict at Henderson Road, the model results are very good (more detail is given by Rayner and Blockley (2000)).

A revised version of the model called **DISPMOD05** was subsequently created from DISPMOD97 to address the following issues:

- The convective dispersion formulation used by AUSPLUME was incorporated into DISPMOD05 to more correctly model plumes released within the coastal boundary layer and offshore flow mixed layer. The plume lofting scheme from the US model AERMOD was also added to DISPMOD05.
- Testing of the lateral dispersion relationship in DISPMOD97 showed that it performed poorly under light wind conditions. The relevant formula proposed by Draxler (1976) as used in earlier version of DISPMOD was reinstated in the model as a preferred option.
- Alternative schemes to compute plume trapping under, or penetration through, temperature inversions were added to DISPMOD05 and used in associated meteorological pre-processing. The original method is believed to over-predict plume trapping and associated predicted concentrations.

DISPMOD05 was run for 1995 and 1996 using the actual emission characteristics provided by industry as part of their licence conditions (as for DISPMOD97). The modelled versus measured 1-hour average concentration statistics for these years are presented in Figure 5. The key outcomes of the modelling using DISPMOD05 are:

- Increased over-prediction at the North Rockingham station (for 1995 at least).
- Improved predictions for the Miguel Rd station (due to a correction of the treatment of the mechanical internal boundary layer).

- Minor over-prediction at the Wattleup station with other sites remaining relatively unchanged. There is good reason to believe higher concentrations within 1-2 km northeast of the stacks are due to the convective down-mixing of plumes, as now simulated by all reputable models.

DISPMOD05 also results in very high concentrations immediately west of BP Refinery which are likely to be primarily due to the convective down-mixing and Draxler's lateral dispersion formula. The existence of these high concentrations so close to the sources is questionable and, in any event, irrelevant to a redetermination under the EPP as they do not occur on neighbouring properties.

In summary, apart from the North Rockingham site there is not a strong argument that one version of DISPMOD (i.e. DISPMOD97 or DISPMOD05) matches the monitoring results better than the other. Both give very good results by the standards commonly accepted for such tests. Both versions were therefore run for the current redetermination.

2.3 Forms of maximum permissible quantities

The EPP allows maximum permissible quantities to be expressed as constant values, as formulae describing variations, or on a statistical (probabilistic) basis. (The latter option means to define the allowable probability of emissions reaching various levels including, for some industries, high emissions associated with plant upset conditions that occur for a small fraction of the year.) For the first determination in 1992, most maximum permissible quantities were specified as constant values which set upper limits on emissions (with the Verve [SECWA at the time], CSBP and BP maximum permissible quantities expressed as formulae). At that time the emissions data necessary to define emissions limits on a probabilistic basis were not available (had not yet been collected). Computer modelling, using the constant emission values, showed the air capacity (relative to the EPP Area C standard) to be almost fully allocated at key locations. (As described in the previous section we are confident in the model's capability).

In reality, most industrial emissions are considerably less than these constant upper limits most of the time. This fact is clearly reflected in the monitoring results of Figure 2 which show the 99.9 percentile measurements to be well below EPP standards at all sites.

The option of expressing maximum permissible quantities on a statistical (probabilistic) basis has advantages for industries (it much better accommodates their operational requirements) while at the same time allowing more realistic management of the total ambient loading of sulphur dioxide and more reliable assessment of the acceptability of additional emissions in the EPP area.

Since 1992 there have been two redeterminations of the maximum permissible quantities, with probabilistic values being applied in both cases:

- In 1994 the maximum permissible quantities of BP and Alcoa were redetermined to provide for low probability / high emissions associated with failure of sulphur recover units at BP.

- In 2000 the maximum permissible quantities for Tiwest were redetermined to provide for the emissions profile for Stage 1 of the expansion approved by the Minister for Environment in 1997.

DEC has developed software to handle probabilistic emissions (summarised by Rayner and Blockley, 2000). In essence the software post-processes the results of a DISPMOD run completed with constant emissions, scaling the DISPMOD results for each non-negligible combination of probabilistic emissions across a full year, computing exceedance frequencies of a range of concentrations for that combination of emissions (as if they occurred for the full year), multiplying these exceedance frequencies by the probability of the emissions combination, and summing these probability-weighted exceedance frequencies across all non-negligible combinations of emissions to give a final result. The same outcome can be achieved via a Monte Carlo simulation (this has been verified).

The two versions of DISPMOD and the software for processing probabilistic emissions were provided to the KIC.

3. Redetermination principles and procedure

All Kwinana industries covered under the current EPP determination have indicated either collectively through the KIC or via other interactions with DEC or EPA that they wish to have their maximum permissible quantities redetermined on a probabilistic basis.

3.1 Principles

In the course of discussions, DEC has advised the KIC and its individual members of the following principles which must be followed in addition to those which are obvious from the EPP itself:

1. All maximum permissible quantities are to be determined in accordance with the principle of waste minimisation (as specified in the *Environmental Protection Act 1986*) which states that *all reasonable and practicable measures should be taken to minimise the generation of waste and its discharge to the environment*.

2. All maximum permissible quantities must be in accordance with any relevant approvals and associated conditions under Part IV of the *Environmental Protect Act 1986*.
3. Maximum permissible quantities that are in accordance with principles 1 and 2 and represent the reasonable needs of an industry, with allowance for variability as appropriate to that industry, will be considered by DEC to be a secure allocation (not to be reduced to make room for new sources).
4. The capacity of the airshed to accommodate additional emissions beyond secure allocations (as per principle 3) will be reserved by DEC for future uses, as per the EPP clause 7(2).
5. Any emissions which DEC permits in excess of a secure allocation will have a specified end date and will not be a secure allocation.
6. Ambient sulphur dioxide monitoring can reduce only to the extent that licensed emissions limits reduce, thereby reducing the likelihood of exceedance of the EPP Standards and Limits.

3.2 Procedure for redetermining maximum permissible quantities of sulphur dioxide

Clause 14 of the EPP requires DEC to make details of the procedure for determining or redetermining maximum permissible quantities of atmospheric waste (EPP Clause 7(1)) available for public inspection. The following summary of the procedure relating to sulphur dioxide is provided to fulfil this requirement. It is based on the procedure in EPA Bulletin 644 (1992) with changes in bold type. The change to point (4) reflects the fact that there is now a large amount of emissions monitoring data and other information available which can be used to assess industry emissions requirements.

(1) For the purpose of this procedure, define maximum permissible quantity to mean the mass of sulphur dioxide emitted per unit time, expressed in units of grams per second, kilograms per second or dimensionally equivalent units.

(2) Accept the computer model DISPMOD **(both versions DISPMOD97 and DISPMOD05)** together with the data files, or samples thereof, in Appendix B as being the best available means of calculating ground level concentrations of sulphur dioxide in the

Policy Area, noting that multiple calculations may be performed as necessary to exclude from the concentration within any industrial premises the concentration contribution from that premise's own discharges, in accordance with Clause 6 of the EPP.

(3) Provide the model and data files to representatives of Kwinana industry so that they, with the assistance of expert consultants, might propose maximum permissible quantities of sulphur dioxide for each industrial source which enable the ambient air quality standards and limits to be achieved and complied with.

(4) Use the model and data files to verify that the industry proposal is correct and acceptable and, if so, determine the maximum permissible quantities of sulphur dioxide to be those proposed by industry, **subject to point (6)**.

(5) In the event that the industry proposal is unsuitable, for whatever reason, **interact with Kwinana industries to define acceptable emissions** and proceed to determine the maximum permissible quantities, **subject to point (6)**.

(6) **If maximum permissible quantities are to be expressed on a statistical basis, DEC may (after modelling) convert detailed source emissions information to industry site totals of maximum permissible quantities (possibly with associated upper limits on specified sources), if industries agree to provide evidence on an annual basis, to DEC's satisfaction, that the distribution of emissions is substantially as modelled or that any changes are inconsequential with respect to increasing ambient concentrations of sulphur dioxide.**

(7) Under the provisions of the EPP, **continue** the programme of monitoring the discharge of sulphur dioxide from all relevant industrial sources and of monitoring the ambient concentrations of sulphur dioxide at selected sites in the Policy Area and use this data to assess the adequacy of the model, the associated data and, therefore, the determination of (4) or (5).

4. Emissions and modelling results

4.1 Industry emissions proposals and decisions

Industries, through the KIC, were asked to identify and quantify between one (i.e. fixed emissions) and ten emissions cases that were expected to occur at their facilities and the associated probability that each emissions case would occur. An "emissions case" is a defined combination of emissions from the various sulphur dioxide sources within a plant. For some industries, the details of probabilistic emission limits had been previously determined via Part IV approvals or direct interaction with DEC.

The emissions defined by industries were reviewed by DEC for conformity with the principles in Section 3.1.

For each industry emission case, the emission characteristics for each individual source (i.e. volume, temperature, and mass emission rates) were also defined. The combined details of industry emissions are given in Table 2, for use in modelling. The source called BP THEORETIC refers to a collection of low emission rate sources.

Table 2: Proposed Industry Emission Cases for Sulphur Dioxide

Case No.	Probability (%)	Source	SO_2 Emission Rate (kg/s)	Volumetric Flowrate (m^3/s)	Density (kg/m^3)
BP Refinery					
Case 1 Normal 200-300 g/s	56.929%	BP VDU 2	0.0049	7.5	0.7
		BP WEST 10	0	10	0.6
		BP WEST 20	0.01	20	0.6
		BP WEST 70	0	70	0.6
		BP WEST 200	0	200	0.6
		BP WEST 300	0	300	0.6
		BP CRACKER	0.215	90	0.59
		BP SRU 1	0.0304	4.8	0.39
		BP SRU 2	0.0371	5.1	0.39
		BP THEORETIC	0.0026	16.8	0.7
Case 2 Normal 150-200g/s	20.000%	BP VDU 2	0.0033	7.5	0.7
		BP WEST 10	0.005	10	0.6
		BP WEST 20	0	20	0.6
		BP WEST 70	0	70	0.6
		BP WEST 200	0	200	0.6
		BP WEST 300	0	300	0.6
		BP CRACKER	0.14	90	0.59
		BP SRU 1	0.0225	4.8	0.39
		BP SRU 2	0.0275	5.1	0.39
		BP THEORETIC	0.0018	16.8	0.7
Case 3 RCU and SRU Shutdown Hydrofiners to flare	10.959%	BP VDU 2	0.013	7.5	0.7
		BP WEST 10	0	10	0.6
		BP WEST 20	0	20	0.6
		BP WEST 70	0	70	0.6
		BP WEST 200	0.28	200	0.6
		BP WEST 300	0	300	0.6
		BP CRACKER	0	90	0.59
		BP SRU 1	0	4.8	0.39
		BP SRU 2	0	5.1	0.39
		BP THEORETIC	0.007	16.8	0.7

Table 2: Proposed Industry Emission Cases for Sulphur Dioxide

Case No.	Probability (%)	Source	SO_2 Emission Rate (kg/s)	Volumetric Flowrate (m^3/s)	Density (kg/m^3)
Case 4 Normal <150 g/s	10.000%	BP VDU 2	0.0033	7.5	0.7
		BP WEST 10	0.005	10	0.6
		BP WEST 20	0	20	0.6
		BP WEST 70	0	70	0.6
		BP WEST 200	0	200	0.6
		BP WEST 300	0	300	0.6
		BP CRACKER	0.1	90	0.59
		BP SRU 1	0.018	4.8	0.39
		BP SRU 2	0.022	5.1	0.39
		BP THEORETIC	0.0018	16.8	0.7
Case 5 Normal High RCU S feed	0.936%	BP VDU 2	0.0033	7.5	0.7
		BP WEST 10	0	10	0.6
		BP WEST 20	0.01	20	0.6
		BP WEST 70	0	70	0.6
		BP WEST 200	0	200	0.6
		BP WEST 300	0	300	0.6
		BP CRACKER	0.25	90	0.59
		BP SRU 1	0.03825	4.8	0.39
		BP SRU 2	0.04675	5.1	0.39
		BP THEORETIC	0.0018	16.8	0.7
Case 6 Minor Flaring Events @ Low S RCU Feed	0.342%	BP VDU 2	0.0033	7.5	0.7
		BP WEST 10	0	10	0.6
		BP WEST 20	0	20	0.6
		BP WEST 70	0.18	70	0.6
		BP WEST 200	0	200	0.6
		BP WEST 300	0	300	0.6
		BP CRACKER	0.1	90	0.59
		BP SRU 1	0.02925	4.8	0.39
		BP SRU 2	0.03575	5.1	0.39
		BP THEORETIC	0.0018	16.8	0.7
Case 7 Minor Flaring Events @ High S RCU Feed	0.285%	BP VDU 2	0.0033	7.5	0.7
		BP WEST 10	0	10	0.6
		BP WEST 20	0	20	0.6
		BP WEST 70	0.13	70	0.6
		BP WEST 200	0	200	0.6
		BP WEST 300	0	300	0.6
		BP CRACKER	0.2	90	0.59
		BP SRU 1	0.02925	4.8	0.39
		BP SRU 2	0.03575	5.1	0.39
		BP THEORETIC	0.0018	16.8	0.7
Case 8 SRU Trip, Wet Gas Compressor Upset and Other major Flaring Events @ Low Sulphur RCU feed	0.263%	BP VDU 2	0.0033	7.5	0.7
		BP WEST 10	0	10	0.6
		BP WEST 20	0	20	0.6
		BP WEST 70	0	70	0.6
		BP WEST 200	0	200	0.6
		BP WEST 300	0.86	300	0.6
		BP CRACKER	0.1	90	0.59
		BP SRU 1	0.01575	4.8	0.39
		BP SRU 2	0.01925	5.1	0.39
		BP THEORETIC	0.0018	16.8	0.7
Case 9 SRU Trip, Wet Gas Compressor Upset and Other major Flaring Events @	0.228%	BP VDU 2	0.0033	7.5	0.7
		BP WEST 10	0	10	0.6
		BP WEST 20	0	20	0.6
		BP WEST 70	0	70	0.6
		BP WEST 200	0	200	0.6

Table 2: Proposed Industry Emission Cases for Sulphur Dioxide

Case No.	Probability (%)	Source	SO_2 Emission Rate (kg/s)	Volumetric Flowrate (m^3/s)	Density (kg/m^3)
High Sulphur RCU feed		BP WEST 300	0.73	300	0.6
		BP CRACKER	0.2	90	0.59
		BP SRU 1	0.02925	4.8	0.39
		BP SRU 2	0.03575	5.1	0.39
		BP THEORETIC	0.0018	16.8	0.7
Case 10 Furnace Upset	0.057%	BP VDU 2	0.0248	7.5	0.7
		BP WEST 10	0.005	10	0.6
		BP WEST 20	0	20	0.6
		BP WEST 70	0	70	0.6
		BP WEST 200	0	200	0.6
		BP WEST 300	0	300	0.6
		BP CRACKER	0.16	90	0.59
		BP SRU 1	0.0315	4.8	0.39
		BP SRU 2	0.0385	5.1	0.39
		BP THEORETIC	0.1403	16.8	0.7
Tiwest					
Case 1	80.00%	TIWEST BYPASS	0.005	5.9	0.347
Case 2	18.00%		0.085	28.5	0.347
Case 3	2.00%		0.155	49.1	0.347
International Power					
Case 1	99.00%	HRSG1A	0.01	173.7	0.827
		HRSG1B	0.01	173.7	0.827
Case 2	1.00%	HRSG1A	0.025	173.7	0.827
		HRSG1B	0.025	173.7	0.827
Nickel West - KNR					
Case 1 Normal Operations	98.50%	KNR SF 123	0.002	6.9	0.5
		KNR H2S PLANT	0	1.4	0.28
		KNR H2S SCRUB	0	0.3	0.28
Case 2 H_2S Vent Gas Scrubber Flare upset	1.20%	KNR SF 123	0.002	6.9	0.5
		KNR H2S FLARE	0	1.4	0.28
		KNR H2S SCRUB	0.0095	0.3	0.28
Case 3 New H2S Plant Flare Upset	0.30%	KNR SF 123	0.002	6.9	0.5
		KNR H2S FLARE	0.007	1.4	0.28
		KNR H2S SCRUB	0	0.3	0.28
Alcoa					
Case 1 Normal	50.00%	ALC POWERHSE 1	0.00055	55.1	0.735
		ALC POWERHSE 2	0.00055	56.8	0.767
		ALC POWERHSE 3	0.00055	65.8	0.735
		ALC POWERHSE 4	0.00055	66.2	0.731
		ALC CALCINER 1	0.00067	58.1	0.614
		ALC CALCINER 2	0.00067	66.8	0.614
		ALC CALCINER 3	0.00067	73.9	0.614
Case 2 Oil Test	40.00%	ALC POWERHSE 1	0.00055	55.1	0.735
		ALC POWERHSE 2	0.00055	56.8	0.767
		ALC POWERHSE 3	0.00055	65.8	0.735
		ALC POWERHSE 4	0.00055	66.2	0.731
		ALC CALCINER 1	0.00167	58.1	0.614
		ALC CALCINER 2	0.00167	66.8	0.614
		ALC CALCINER 3	0.00167	73.9	0.614
Case 3 Gas Outage	10.00%	ALC POWERHSE 1	0.00055	55.1	0.735
		ALC POWERHSE 2	0.00055	56.8	0.767
		ALC POWERHSE 3	0.00055	65.8	0.735
		ALC POWERHSE 4	0.00055	66.2	0.731
		ALC CALCINER 1	0.00467	58.1	0.614
		ALC CALCINER 2	0.00467	66.8	0.614

Table 2: Proposed Industry Emission Cases for Sulphur Dioxide

Case No.	Probability (%)	Source	SO_2 Emission Rate (kg/s)	Volumetric Flowrate (m^3/s)	Density (kg/m^3)
		ALC CALCINER 3	0.00467	73.9	0.614
Cockburn Cement					
Case 1 30g/s	50.00%	CC KILN 1&2	0.00675	29.6	0.64
		CC KILN 3	0.00987	77.8	0.74
		CC KILN 4	0.00987	93.5	0.73
		CC KILN 5	0.00339	116	0.71
		CC KILN 6	0.00012	113.7	0.91
Case 2 80 g/s	40.00%	CC KILN 1&2	0.018	29.6	0.64
		CC KILN 3	0.02632	77.8	0.74
		CC KILN 4	0.02632	93.5	0.73
		CC KILN 5	0.00904	116	0.71
		CC KILN 6	0.00032	113.7	0.91
Case 3 130g/s	9.00%	CC KILN 1&2	0.068	29.6	0.64
		CC KILN 3	0.02632	77.8	0.74
		CC KILN 4	0.02632	93.5	0.73
		CC KILN 5	0.00904	116	0.71
		CC KILN 6	0.00032	113.7	0.91
Case 4 180g/s	1.00%	CC KILN 1&2	0.118	29.6	0.64
		CC KILN 3	0.02632	77.8	0.74
		CC KILN 4	0.02632	93.5	0.73
		CC KILN 5	0.00904	116	0.71
		CC KILN 6	0.00032	113.7	0.91
Verve					
Case 1	100.00%	SEC STAGE A	0.34	356	0.823
		SEC STAGE B	0	354	0.805
		SEC STAGE C	0.35	374	0.84
HIsmelt					
Case 1	100.00%	HISMELT	0.035	130	1.07

Notes

1. Emission volume and density provided at stack conditions.

Within Table 2 the “BP WEST 10” to “BP WEST 300” emission sources represent the Western Flare at the BP Refinery operating under different flow conditions. For the purpose of processing emissions cases it is convenient to treat the different flow conditions as multiple co-located sources (flares), each of which only emits within the case related to its flow condition. The Tiwest Bypass stack was also modelled as three co-located sources due to the differences in its emission volume.

HIsmelt’s emissions are constrained to comply with its Public Environmental Review (PER) (HIsmelt, 2002) and associated approvals under Part IV of the *Environmental Protect Act 1986.* A probabilistic distribution of sulphur dioxide emissions is defined by the data in Appendix C of the HIsmelt PER, with emissions well below the peak 35 g/s most of the time. HIsmelt has indicated that it is likely to require an allocation for emissions greater than 35 g/s to accommodate outages of its scrubbing equipment. HIsmelt will need to seek advice from the EPA in relation to this change to its proposal. The current determination reflects HIsmelt’s 2002 approval, however a constant emission rate of 35 g/s has been used in the modelling to informally reserve “space” for HIsmelt’s scrubber outage requirements.

DEC advised Cockburn Cement in 2001 about its decision regarding acceptable sulphur dioxide emissions from its Munster operations based on an analysis of emission monitoring data provided to DEC under licence conditions. This advice was for site-wide total emissions as follows:

- 30 g/s for 50% of the time;
- 80 g/s for 40% of the time;
- 130 g/s for 9% of the time; and
- 180 g/s for 1% of the time.

In order to complete the modelling, it was assumed that the distribution of the emissions between the Cockburn Cement stacks for the 30 g/s and 80 g/s cases were as per the ratios used in the 1992 determination with a small amount allocated to Kiln 6. For the remaining two cases, the emissions above the 80 g/s were assumed to be emitted from the Kiln 1 and 2 stack which had the lowest emission volume and was therefore assumed to most likely result in the highest predicted ground level concentrations. The modelling is likely to be conservative (i.e. results in a conservatively high estimate of the maximum ground level concentrations).

4.2 Modelling of industry emissions - setup

As per the redetermination procedure, both versions of DISPMOD (i.e. DISPMOD97 and DISPMOD05) have been used in modelling to determine the acceptability of industry emissions for the purpose of the current redetermination. The models have been run for three individual years of meteorological data being 1980 (the data used in the 1992 determination), 1995 and 1996 (the data used in the verification studies discussed in Section 2.3).

The air dispersion modelling was completed using three model domains as summarised in Table 3.

Table 3: Proposed Industry Emission Cases for Sulphur Dioxide

Domain Name	Full	Eastern	Northern
Bottom Left Coordinate (mE AMG)	375000	385700	386350
Bottom Left Coordinate (mN AMG)	6424000	6433050	6442600
Number of x coordinates	21	18	18
Number of x coordinates	26	18	18
Grid Interval (m)	1000	100	100

The full model domain is the same as that used in the 1992 determination and covers the area shown on Figure 6 with a grid interval of 1,000 m. The northern and eastern model domains were used to better define the potential impacts in areas where elevated concentrations (1-hour average for northern and 24-hour average for eastern) were predicted to occur on the full grid. The northern and eastern model domains used a grid interval of 100 m and are also shown on Figure 6.

All model input files are held by the DEC Air Quality Management Branch and are available for inspection.

4.3 Modelling of industry emissions - results

Table 4 presents the summary of the modelling results for the three model domains and the predicted ground level concentrations are also presented as Figures 7 to 52 (Appendix A).

- **Full Model Domain**

The results presented in Table 4 and Figures 7 to 28 show that there are no predicted exceedances of the EPP limits across the model domain for either model (i.e. DISPMOD97 or DISMPOD05) or modelled year. DISPMOD05 predicted a very localised area of exceedance of the 1-hour standard (based on the predicted 9th highest concentrations being above the standards) in the immediate vicinity of the BP Refinery. Based on the information presented in Section 2.3, it is thought that these high concentrations are associated with the modelled convective down-mixing and Draxler's lateral plume dispersion formulation and may represent an over-prediction of the actual ground level concentrations in this area. In any event the apparent exceedances are predicted to occur on BP's property due to BP's emissions – this is not covered under the EPP (see the EPP clause 6(2)).

DISPMOD05 also predicted exceedances of the EPP 24-hour standard in Area A over an area in the vicinity of the BP Refinery for the 2006 model year (see Figure 24). The second highest 24-hour average concentration of sulphur dioxide predicted for each grid point across the model domain is presented as Figure 25 and shows that the maximum second highest predicted 24-hour average concentration (193 µg/m^3) was below the EPP 24-hour standard for Area A. Again, the apparent exceedance on BP property is not covered by the EPP.

- **Eastern and Northern Model Domains**

No exceedances of the EPP limits were predicted across the eastern and northern modelling domains. While there were a number of predicted exceedances of the 1-hour standard in some of the modelled years, there were no more than four exceedances of the Area C 1-hour standard predicted in any single year. The 99.9th percentile 1-hour average and maximum 24-hour average concentrations were all predicted to be well below the EPP standard for each of the EPP areas.

DISPMOD05 tended to predict higher ground level concentrations than DISPMOD97 over the northern model domain and it is expected that this is due to the convective down-mixing, Draxler's lateral plume dispersion formulation and the proximity of the Cockburn Cement emission sources.

Over the eastern modelling domain DISPMOD97 and DISPMOD05 tended to predict similar ground level concentrations.

Table 4a: Air Dispersion Modelling Results – Full Modelling Domain

Full Domain	EPP Area	DISPMOD 1997			DISPMOD 2005			EPP Guidelines		% of guidelines DM 1997			% of guidelines DM 2005		
		1980	1995	1996	1980	1995	1996	Standard	Limit	1980	1995	1996	1980	1995	1996
1hr max. (µg/m^3)	A	682	717	700	965	1016	1084	na	1400	*49%*	*51%*	*50%*	*69%*	*73%*	*77%*
	B	422	412	416	454	481	450	na	1000	*42%*	*41%*	*42%*	*45%*	*48%*	*45%*
	C	305	316	323	375	357	339	na	700	*44%*	*45%*	*46%*	*54%*	*51%*	*48%*
1hr 99.9th percentile (µg/m^3)	A	515	605	591	730	872	869	700	na	*74%*	*86%*	*84%*	*104%*	*125%*	*124%*
	B	319	298	338	335	322	362	500	na	*64%*	*60%*	*68%*	*67%*	*64%*	*72%*
	C	233	223	257	235	233	258	350	na	*67%*	*64%*	*73%*	*67%*	*67%*	*74%*
No. hours 1hr max. >350 µg/m^3	A	33	80	63	132	166	127								
	B	3	2	7	5	4	12								
	C	0	1	0	1	1	1								
No. hours 1hr max. >500 µg/m^3	A	10	27	23	34	96	72								
	B	0	0	0	0	1	0								
	C	0	0	0	0	0	0								
No. hours 1hr max. >700 µg/m^3	A	0.7	1.6	1.0	11	39	32								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
24hr max. (µg/m^3)	A	106	117	121	143	186	208	200	365	*29%*	*32%*	*33%*	*39%*	*51%*	*57%*
	B	84	94	91	98	93	126	150	200	*42%*	*47%*	*45%*	*49%*	*47%*	*63%*
	C	72	97	67	70	87	68	125	200	*36%*	*49%*	*34%*	*35%*	*44%*	*34%*
No. days 24hr max. >125 µg/m^3	A	0	0	0	3	6	5								
	B	0	0	0	0	0	1								
	C	0	0	0	0	0	0								
Annual average (µg/m^3)	A	24	22	23	31	26	29	60	80	*41%*	*36%*	*38%*	*52%*	*43%*	*48%*
	B	14	12	15	14	13	16	50	60	*28%*	*25%*	*30%*	*29%*	*25%*	*32%*
	C	11	11	12	10	10	11	50	60	*23%*	*21%*	*25%*	*21%*	*20%*	*22%*

Table 4b: Air Dispersion Modelling Results – Eastern Modelling Domain

Eastern Domain	EPP Area	DISPMOD 1997			DISPMOD 2005			EPP Guidelines		% of guidelines DM 1997			% of guidelines DM 2005		
		1980	1995	1996	1980	1995	1996	Standard	Limit	1980	1995	1996	1980	1995	1996
1hr max. (µg/m^3)	A	305	311	342	331	353	354	na	1400	*22%*	*22%*	*24%*	*24%*	*25%*	*25%*
	B	431	391	405	470	431	433	na	1000	*43%*	*39%*	*41%*	*47%*	*43%*	*43%*
	C	356	358	329	397	405	379	na	700	*51%*	*51%*	*47%*	*57%*	*58%*	*54%*
1hr 99.9th percentile (µg/m^3)	A	202	228	210	220	241	228	700	na	*29%*	*33%*	*30%*	*31%*	*34%*	*33%*
	B	261	292	261	281	311	281	500	na	*52%*	*58%*	*52%*	*56%*	*62%*	*56%*
	C	200	251	208	218	266	227	350	na	*57%*	*72%*	*59%*	*62%*	*76%*	*65%*
No. hours 1hr max. >350 µg/m^3	A	0	1	1	1	1	1								
	B	3	3	4	4	6	4								
	C	1	2	0	1	3	1								
No. hours 1hr max. >500 µg/m^3	A	0	0	0	0	0	0								
	B	0	0	0	1	1	0								
	C	0	0	0	1	0	0								
No. hours 1hr max. >700 µg/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
24hr max. (µg/m^3)	A	62	52	70	63	53	70	200	365	*31%*	*26%*	*35%*	*31%*	*26%*	*19%*
	B	88	72	64	89	74	67	150	200	*59%*	*48%*	*43%*	*60%*	*49%*	*45%*
	C	54	68	50	56	70	51	125	200	*43%*	*55%*	*40%*	*44%*	*56%*	*41%*
No. days 24hr max. >125 µg/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
Annual average (µg/m^3)	A	6	5	5	6	5	5	60	80	*9%*	*9%*	*9%*	*9%*	*9%*	*9%*
	B	8	7	8	8	7	8	50	60	*17%*	*14%*	*16%*	*17%*	*14%*	*16%*
	C	5	5	4	5	5	4	50	60	*9%*	*9%*	*9%*	*10%*	*9%*	*9%*

Table 4c: Air Dispersion Modelling Results – Northern Modelling Domain

Northern Domain	EPP Area	DISPMOD 1997			DISPMOD 2005			EPP Guidelines		% of guidelines DM 1997			% of guidelines DM 2005		
		1980	1995	1996	1980	1995	1996	Standard	Limit	1980	1995	1996	1980	1995	1996
1hr max. (µg/m^3)	A	381	320	381	480	434	506	na	1400	*27%*	*23%*	*27%*	*34%*	*31%*	*36%*
	B	329	308	356	371	367	409	na	1000	*33%*	*31%*	*36%*	*37%*	*37%*	*41%*
	C	350	305	363	396	359	416	na	700	*50%*	*44%*	*52%*	*57%*	*51%*	*59%*
1hr 99.9th percentile (µg/m^3)	A	292	250	300	350	313	369	700	na	*42%*	*36%*	*43%*	*50%*	*45%*	*53%*
	B	269	248	287	292	272	317	500	na	*54%*	*50%*	*57%*	*58%*	*54%*	*63%*
	C	277	246	288	298	263	315	350	na	*79%*	*70%*	*82%*	*85%*	*75%*	*90%*
No. hours 1hr max. >350 µg/m^3	A	2	1	2	9	5	12								
	B	1	0	1	2	1	4								
	C	1	0	1	3	1	4								
No. hours 1hr max. >500 µg/m^3	A	0	0	0	1	0	1								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
No. hours 1hr max. >700 µg/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
24hr max. (µg/m^3)	A	80	103	66	90	94	80	200	365	*40%*	*52%*	*33%*	*45%*	*47%*	*22%*
	B	75	105	69	82	95	72	150	200	*50%*	*70%*	*46%*	*55%*	*63%*	*48%*
	C	74	105	65	78	95	68	125	200	*59%*	*84%*	*52%*	*62%*	*76%*	*54%*
No. days 24hr max. >125 µg/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
Annual average (µg/m^3)	A	14	12	14	15	13	16	60	80	*23%*	*20%*	*24%*	*25%*	*22%*	*26%*
	B	13	12	14	15	13	15	50	60	*27%*	*25%*	*28%*	*29%*	*26%*	*30%*
	C	13	12	13	12	12	13	50	60	*25%*	*24%*	*27%*	*25%*	*24%*	*26%*

5. Redetermination of maximum permissible quantities

This section provides details of the redetermination of maximum permissible quantities of sulphur dioxide following the procedure of Section 3.2 and in light of the successful modelling of emissions described in Section 4.

Table 5 lists the maximum permissible quantities of sulphur dioxide for each industry with significant emissions of sulphur dioxide in the Policy Area of the Kwinana EPP. The maximum permissible quantities are expressed as site totals as per the revised procedure. maximum permissible quantities have been obtained from the detailed information in Table 2 (exceptions and variations described below) but have been re-expressed in a form more appropriate for licence conditions and more useful for progressive tracking of compliance. If the percentage of time is 0%, this means the associated maximum permissible quantity is never to be exceeded

Some of the 10 cases modelled for BP had exactly the same total emission rates as other cases. Such cases have been combined yielding six cases in Table 5.

The formula for Verve is as per the 1992 determination (the emissions for Verve in Table 2 were in accordance with this formula).

The maximum permissible quantities assigned to HIsmelt were derived by DEC from Figure 4-4 of Appendix C in the PER (HIsmelt, 2002). A small comfort margin was applied to the emissions profile except for the upper limit of 35 g/s. HIsmelt has the opportunity to seek approval from the EPA for a change to its project as approved in 2002 in order to accommodate infrequent plant upset conditions with an emission rate greater than 35 g/s. If this is approved, HIsmelt’s maximum permissible quantities will be redetermined accordingly.

Separate from the redetermination of maximum permissible quantities in the form of site totals, it may be the case for some industries that DEC applies conditions of licence specifying limits and/or targets on the sulphur dioxide emissions from particular sources within industrial premises, as is currently done. Any such limits and/or targets will not be inconsistent with the maximum permissible quantities expressed as site totals.

Table 5. maximum permissible quantities of sulphur dioxide for each industry in the Kwinana EPP Policy Area

	Column A	Column B
	Maximum Permissible Quantities (g/s)	**% of time in any 12 consecutive calendar months for which total site emissions may exceed the emission rate in Column A**
BP Refinery		
	150.1	90.00%
	200.1	70.00%
	300	2.11%
	350.1	0.83%
	400.1	0.49%
	1000.1	0.00%
Tiwest		
	5	20.00%
	85	2.00%
	155	0.00%
International Power		
	20	1.00%
	50	0.00%
Nickelwest - KNR		
	2	1.50%
	9	1.20%
	11.5	0.00%
Alcoa		
	4.21	50.00%
	7.21	10.00%
	16.21	0.00%
Cockburn Cement		
	30	50.00%
	80	10.00%
	130	1.00%
	180	0.00%
Verve		
	Formula for Stages A and C: QA+QC/2.2=530; QC not greater than 530, where QA and QC are quantities from Stages A and C respectively.	0.00%
HiSmelt		
	13	65.00%
	21	5.00%
	35	0.00%

6. Monitoring

Monitoring and reporting of sulphur dioxide emissions is required as an ongoing condition of licence on all industries covered under this redetermination.

There are no changes currently envisaged to monitoring and reporting of ambient concentrations of sulphur dioxide. As described in 2.2 and marked on Figure 1, monitoring is currently occurring at:

- Wattleup (DEC owned and operated);
- Rockingham (DEC owned and operated);
- Miguel Road (KIC owned and operated);
- Abercrombie Road (KIC owned and operated); and
- Fancote Avenue (KIC owned and operated).

7. References

Draxler, R.R, 1976. “Determination of Atmospheric Diffusion Parameters” *Atmospheric Environment*, 10, 99-105

EPA, 1992. “Development of an Environmental Protection Policy for Air Quality at Kwinana”. Environmental Protection Authority, Bulletin 644, August 1992

EPA 1999, Revised Draft Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999. Report to the Minister for the Environment. Environmental Protection Authority, Perth, Western Australia, June 1999

HIsmelt. 2002, Commercial HIsmelt Plant Kwinana Western Australia : Public Environmental Review. HIsmelt (Operations) Pty Ltd, April 2002.

Rayner K. 1992, ‘Development of an Environmental Protection Policy for air quality at Kwinana’, Proceedings of the *11th International Clean Air and Environment Conference, Brisbane, 1992*, Clean Air Society of Australia & New Zealand, Eastwood, NSW, Australia

Rayner, K. and Blockley, A. 2000. “Improvements in the coastal dispersion model DISPMOD”. *Proceedings of the 15th Conference of the Clean Air Society of Aust. and New Zealand, Sydney, November, 2000.* Clean Air Society of Australia & New Zealand, Eastwood, NSW, Australia

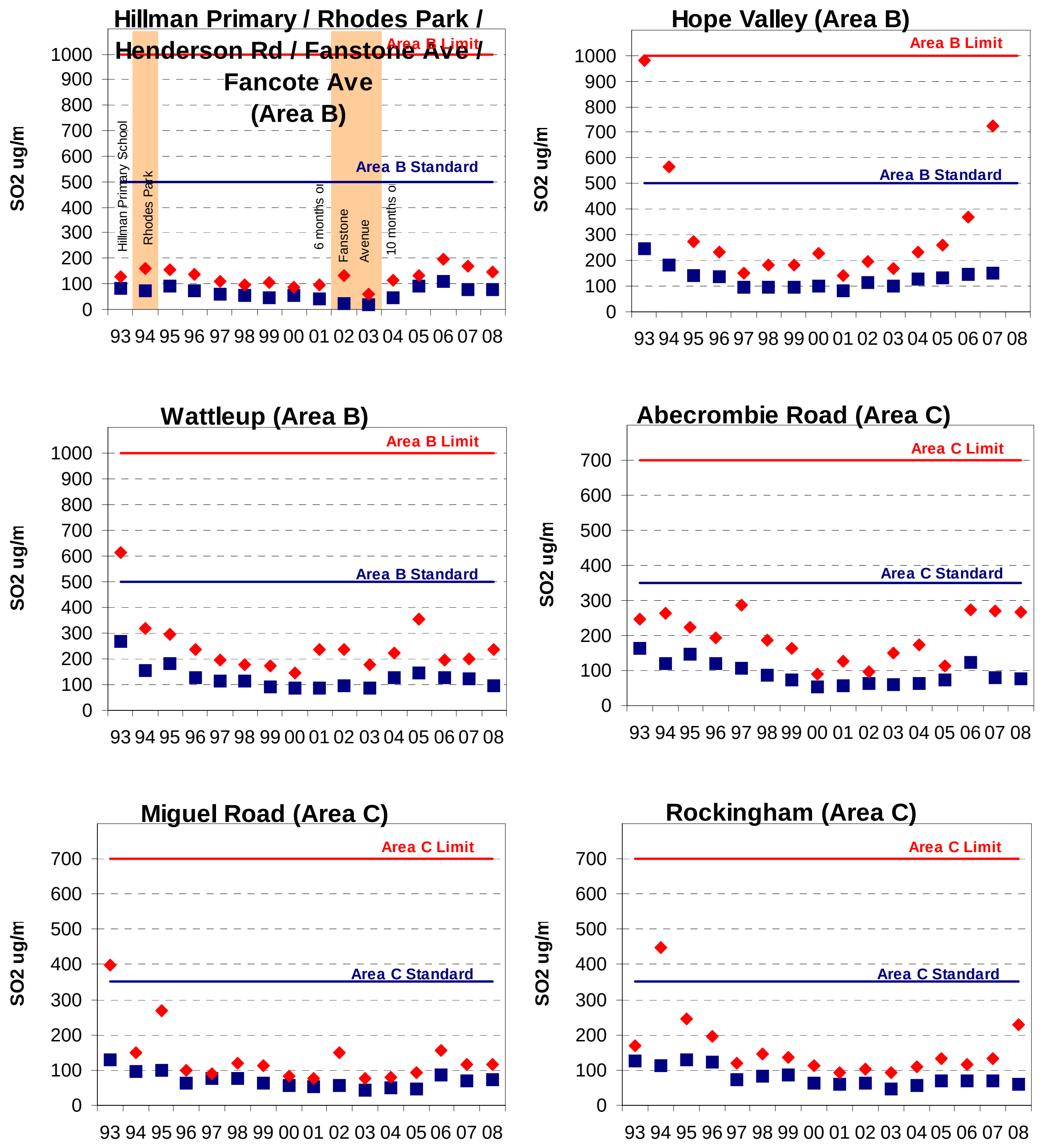
Sawford B. L., Young S. A., Noonan J. A., Luhar A. K., Hacker J. M., Carras J. N., Williams D. J. and Rayner K. N. 1996 ‘The 1995 Kwinana Fumigation Study - I. Program overview, experimental design and some results.’ *Proceedings of the 13th International Clean Air and Environment Conference, Adelaide, 1996*, Clean Air Society of Australia & New Zealand, Eastwood, NSW, Australia.

Appendix A Figures

Figure 1. Kwinana EPP Area A and B Boundaries and Monitoring Station Sites

Note: The areas shown on this map are approximate only. The official map is the DEP Map 990902 held by the DEC.

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09



Graphs showing, for each monitoring station in the Kwinana region, the maximum hourly-averaged (red diamonds) and 99.9th percentile (blue squares) sulfur dioxide (SO_2) concentrations for each year, compared to the EPP limit (red line) and EPP standard (blue line) respectively.

Figure 2. Ambient Sulphur Dioxide Monitoring Results for the Kwinana Region

Source: DEC (*Pers. comm*. Arthur Grieco, DEC, 2 April 2009)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

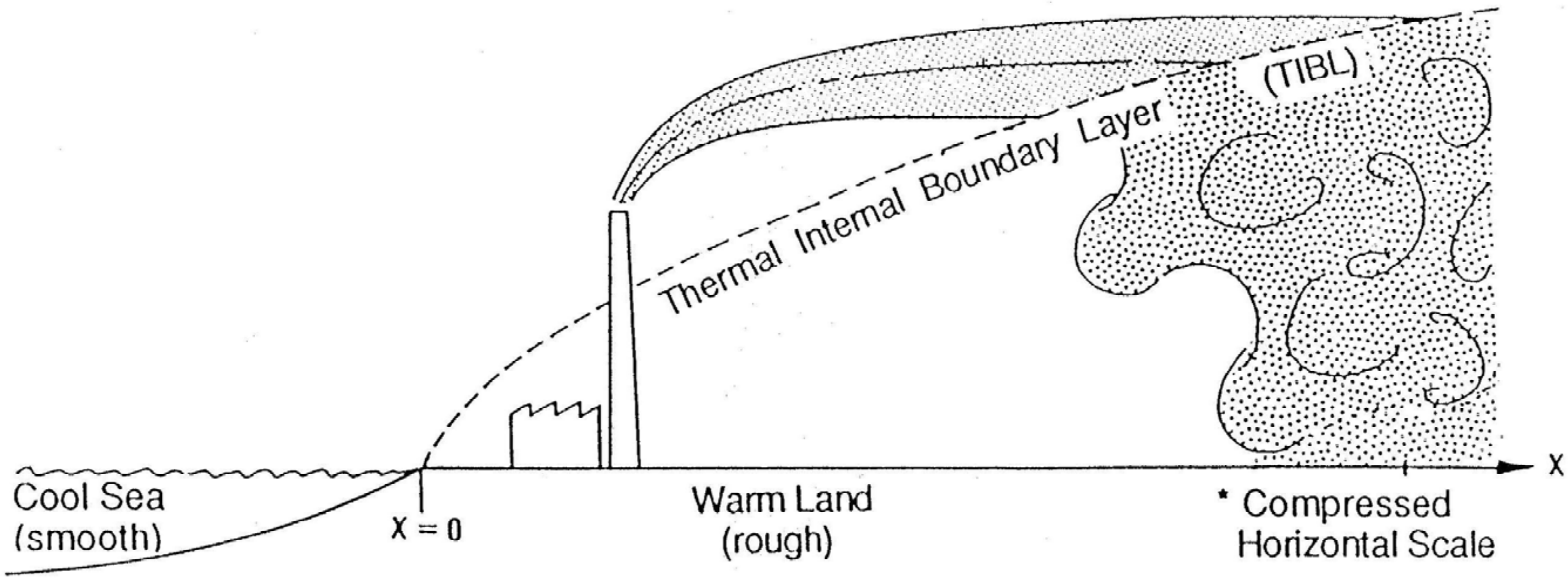
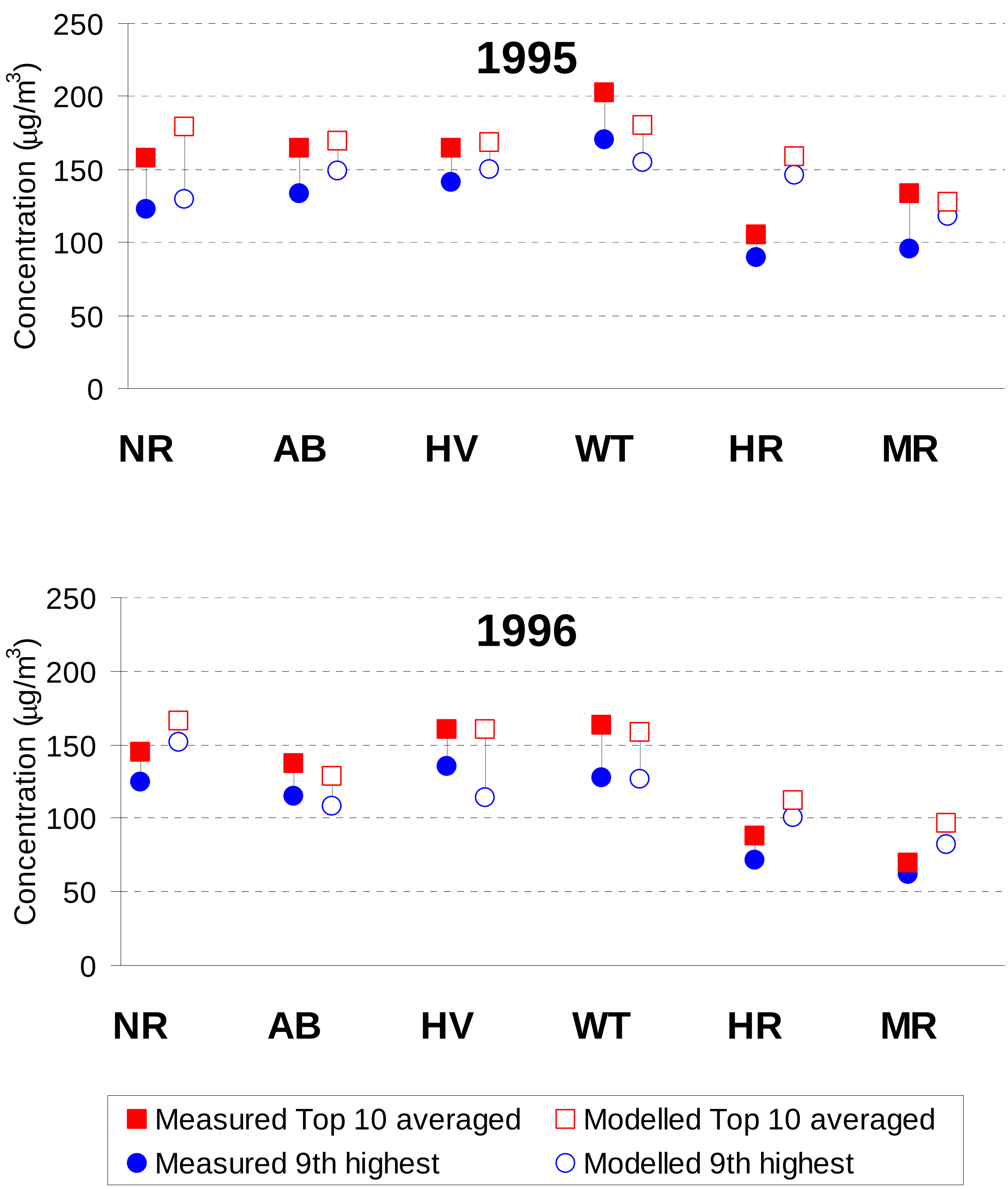


Figure 3. Illustration of Shoreline Fumigation under a TIBL

Source: EPA (1992)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09



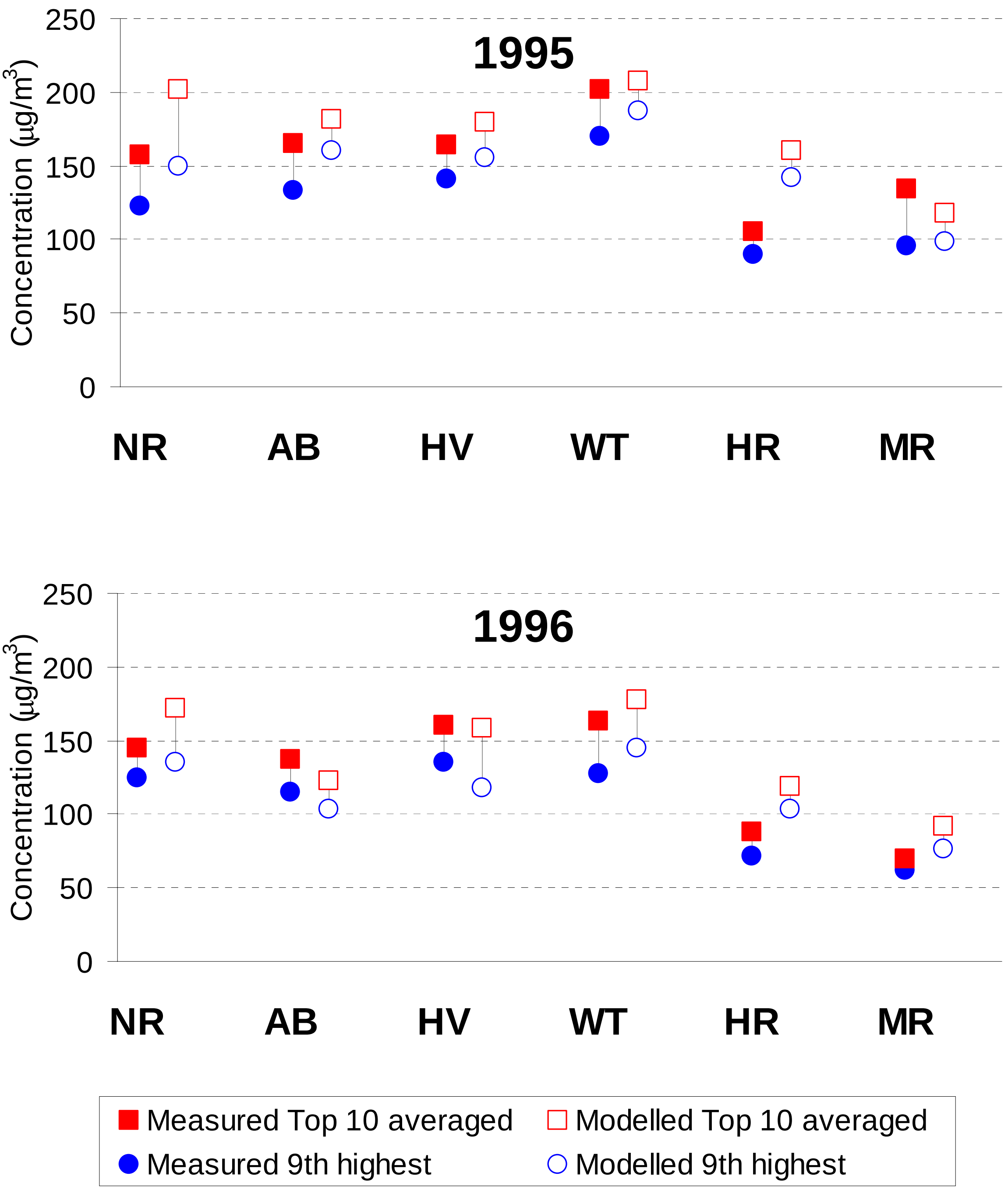
NR = North Rockingham
AB = Abercrombie Road
HV = Hope Valley

WT = Wattleup
HR = Henderson Road
MR= Miguel Road

Figure 4. Comparison of Monitored and Predicted 1-Hour Average Ground Level Concentrations of Sulphur Dioxide – DISPMOD97

(Source: Ken Rayner, *Pers. Comm.* DEC, 24 March 2009)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09



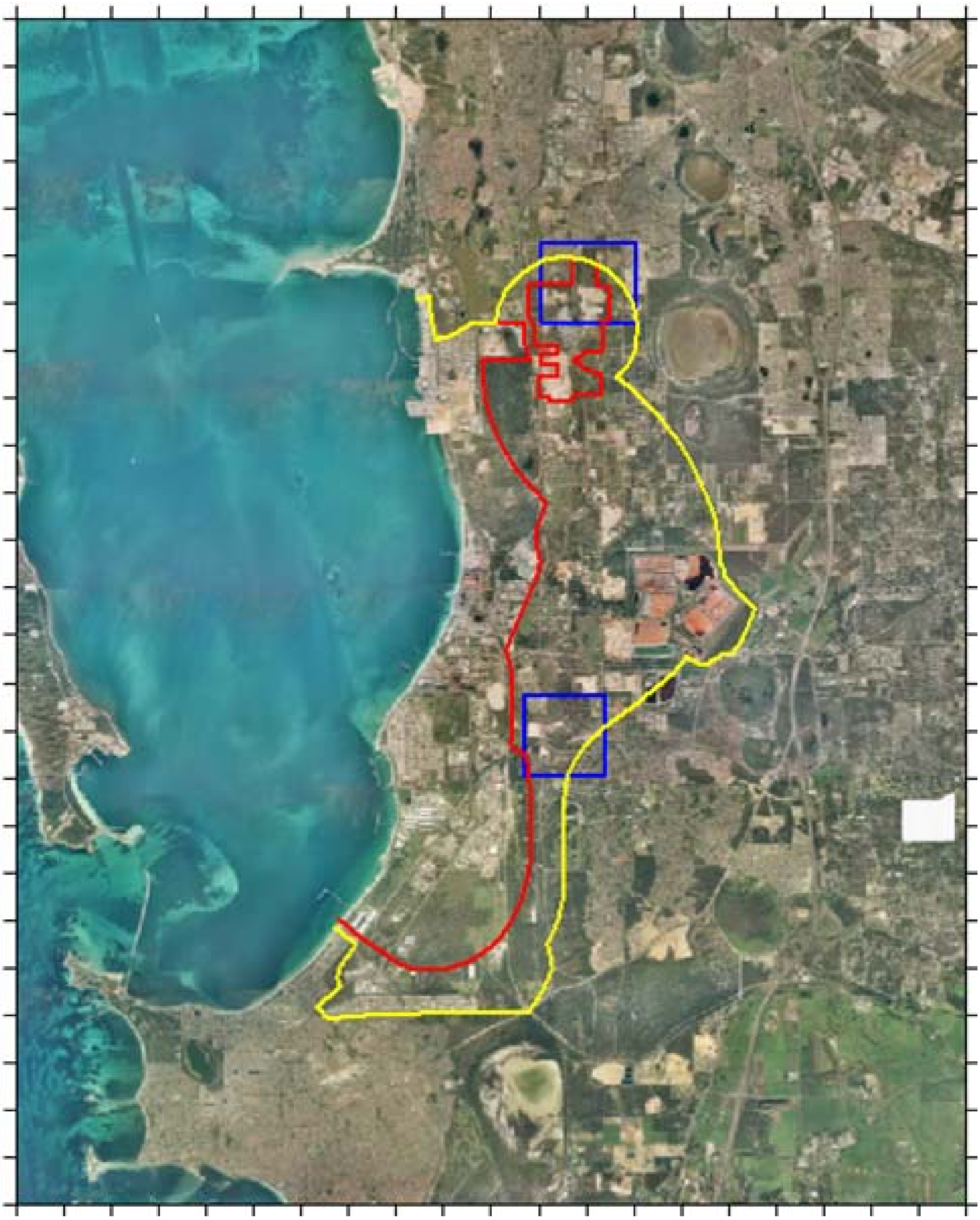
NR = North Rockingham
AB = Abercrombie Road
HV = Hope Valley

WT = Wattleup
HR = Henderson Road
MR= Miguel Road

Figure 5. Comparison of Monitored and Predicted 1-Hour Average Ground Level Concentrations of Sulphur Dioxide – DISPMOD05

(Source: Ken Rayner, *Pers. Comm.* DEC, 24 March 2009)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09



Area A to B Boundary

Area B to C Boundary

Northern and Eastern Model Domains

Figure 6. Kwinana EPP Redetermination Modelling Domains

Note: The areas shown on this map are approximate only. The official map is the DEP Map 990902 held by the DEC.

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

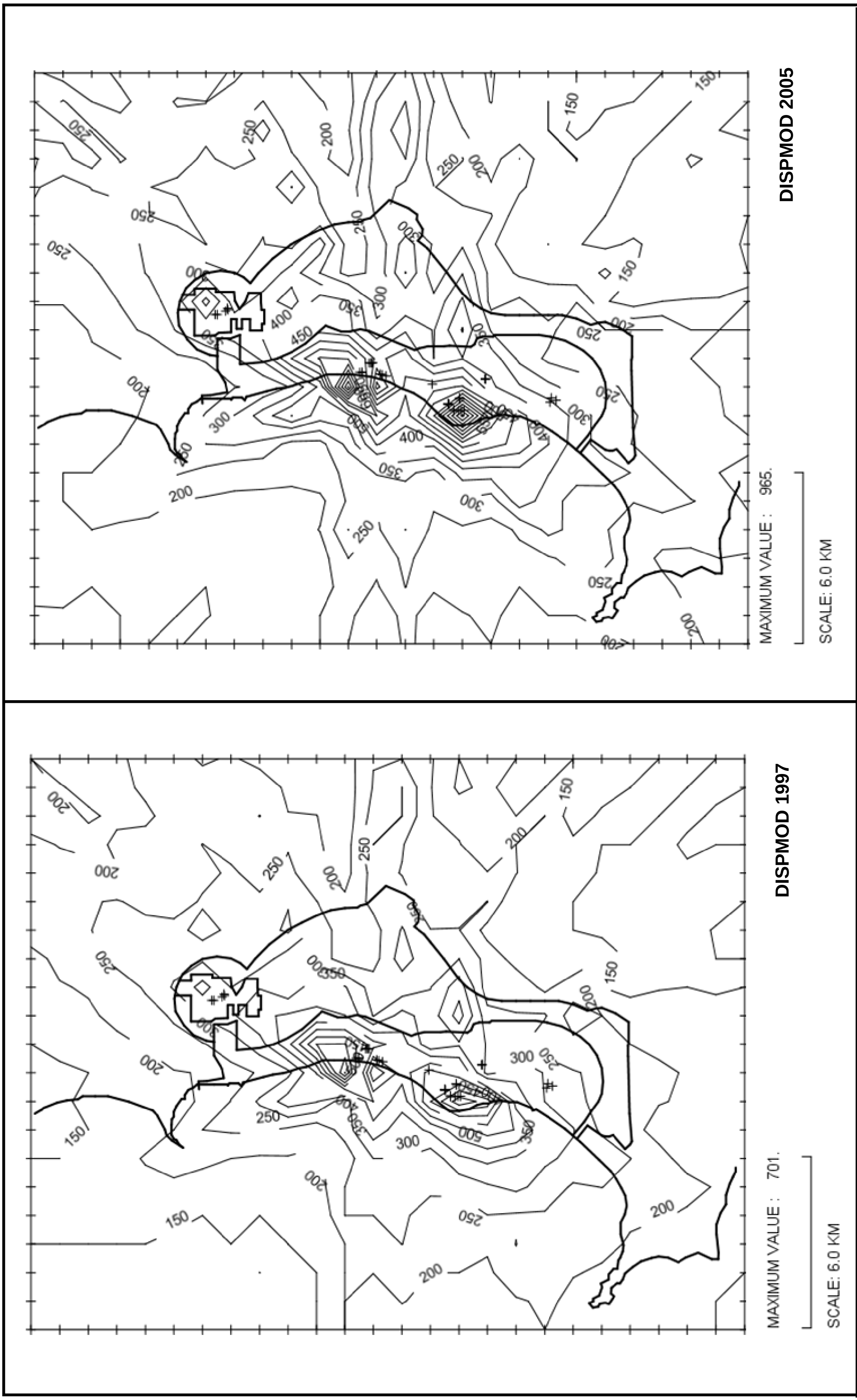


Figure 7. Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

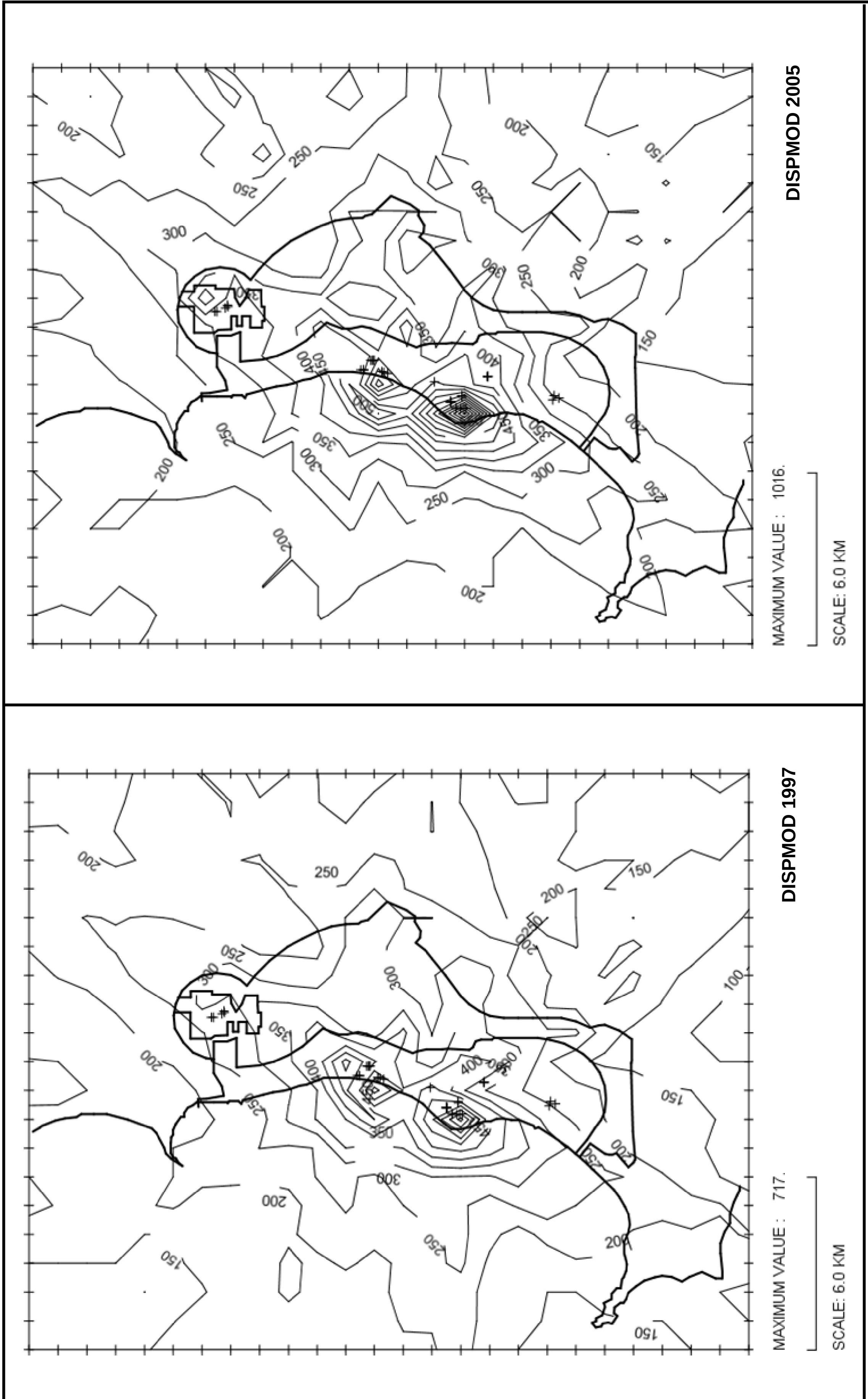


Figure 8. Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1995 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

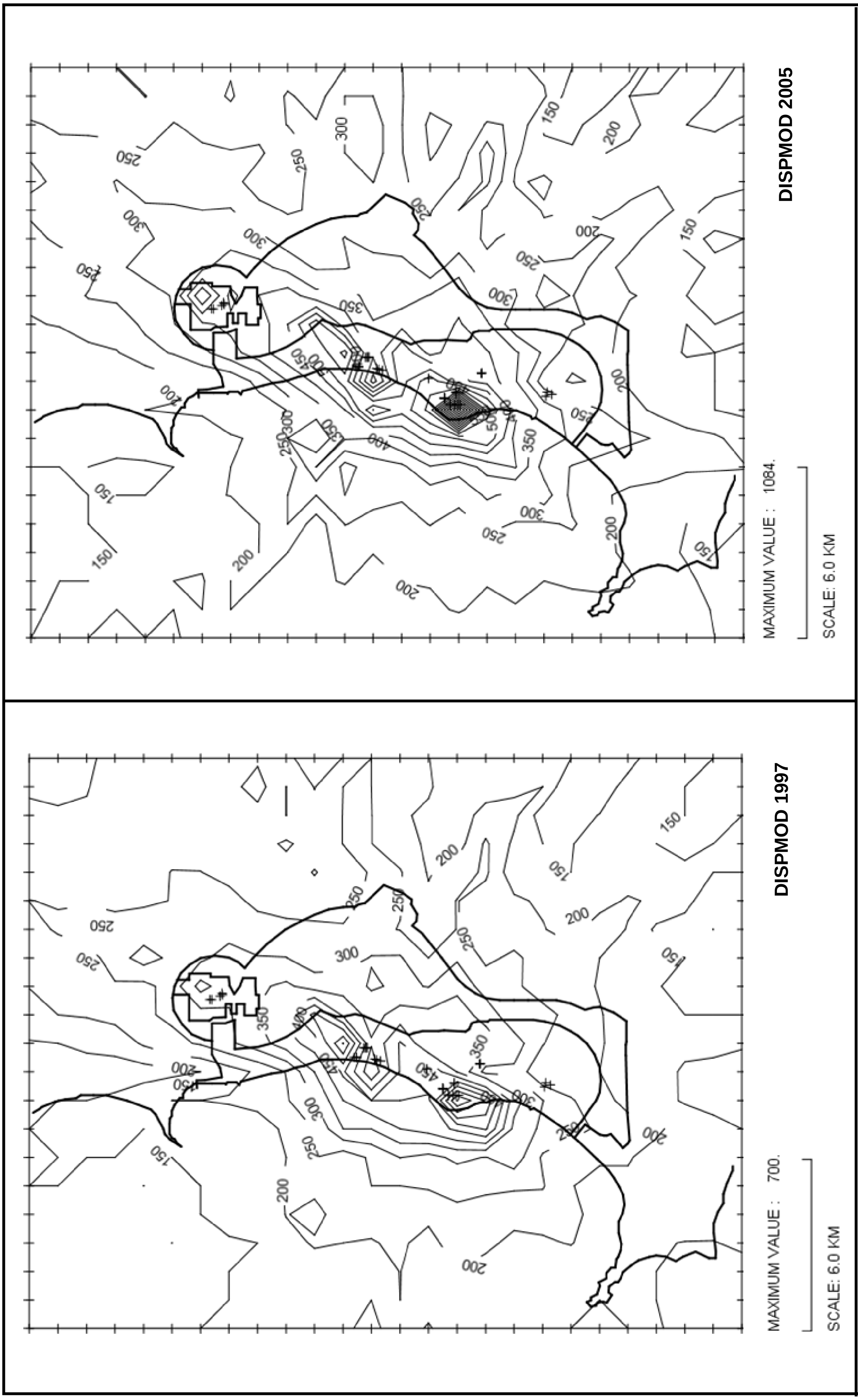


Figure 9. Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1996 meteorology)

Client: Kwinana Industries Council	
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

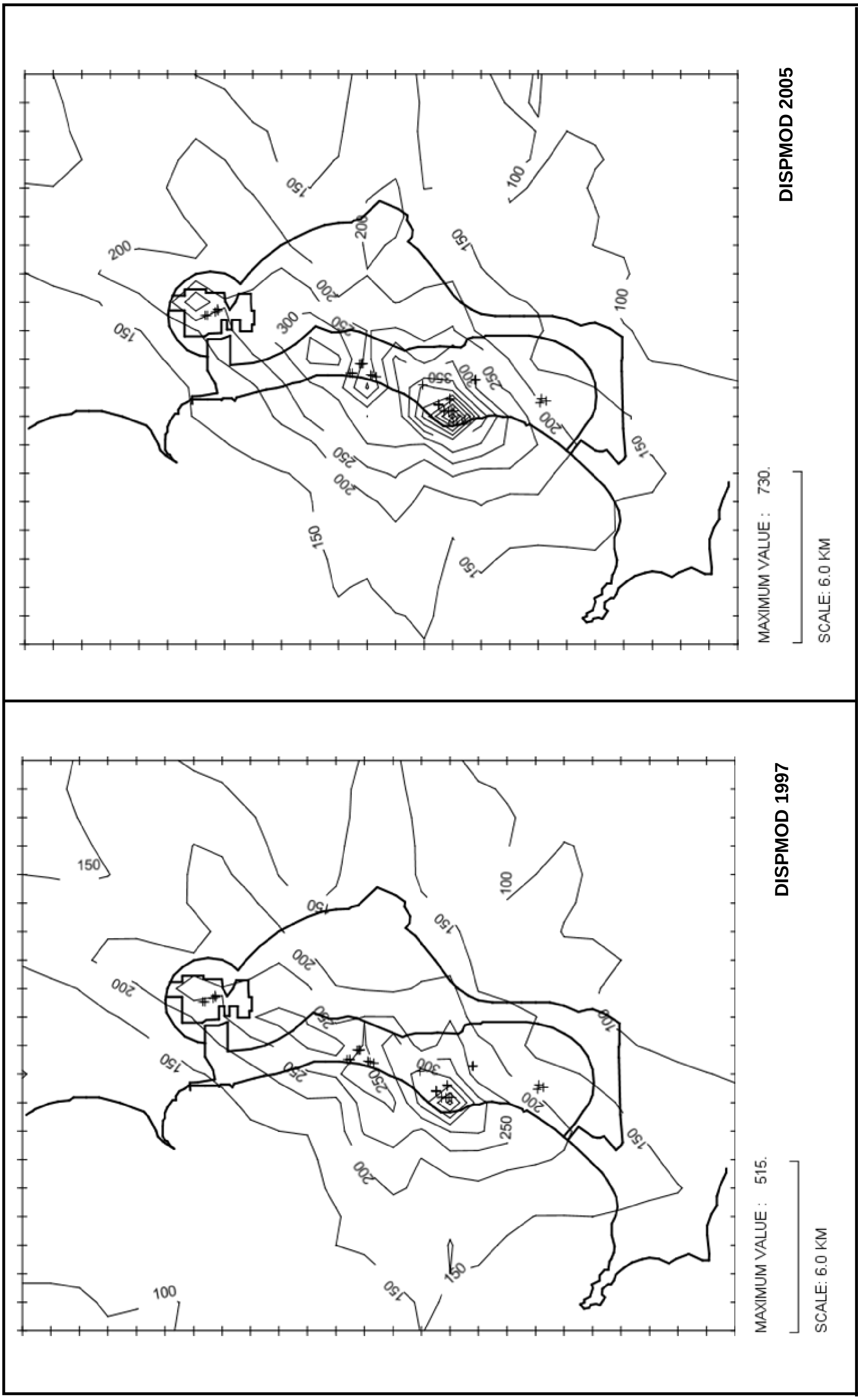


Figure 10. 99.9th Percentile 1-hour Average Ground Level Concentration of Sulphur Dioxide (μg/m³)

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

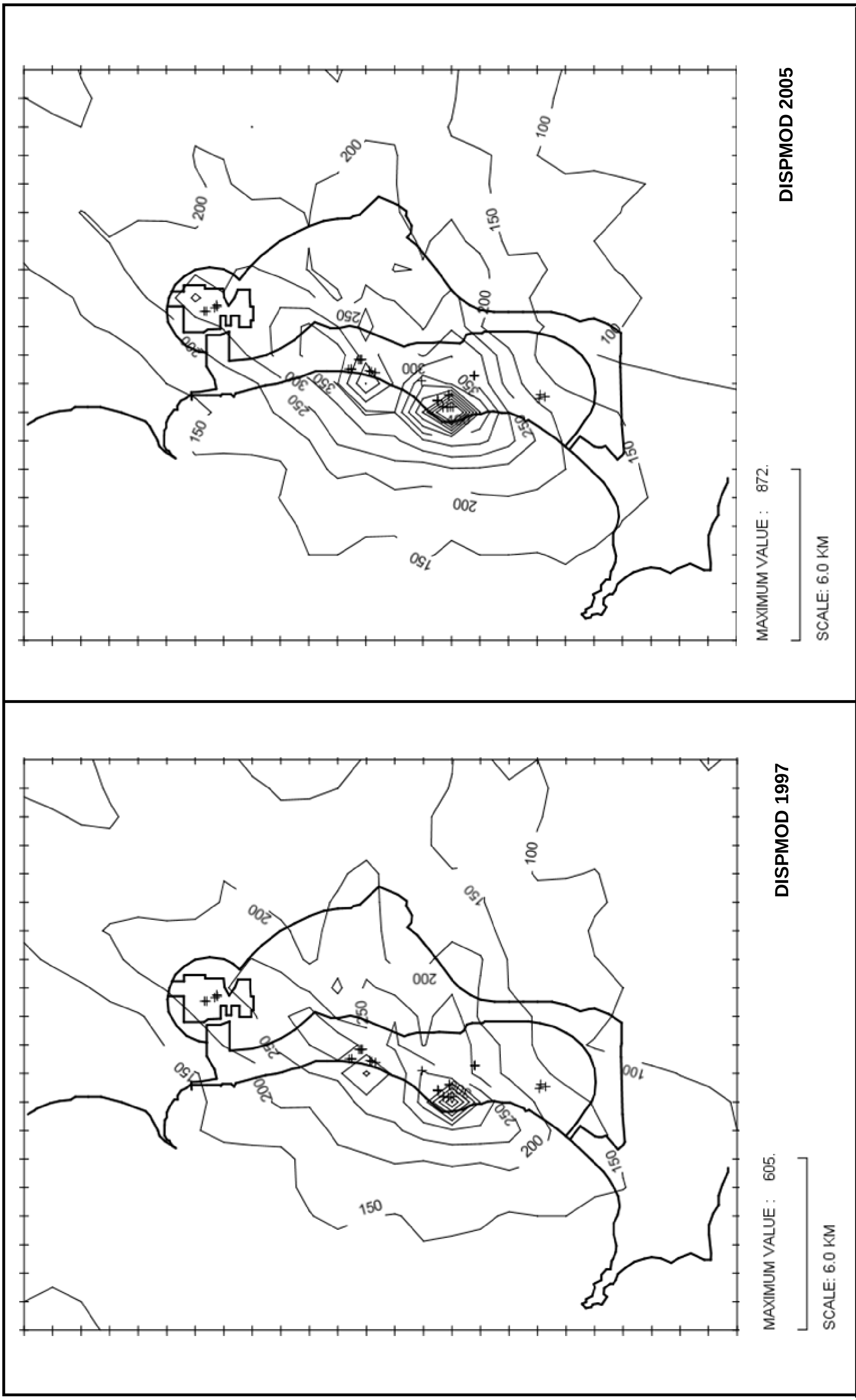


Figure 11. 99.9th Percentile 1-hour Average Ground Level Concentration of Sulphur Dioxide ($\mu g/m^3$)

(1995 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

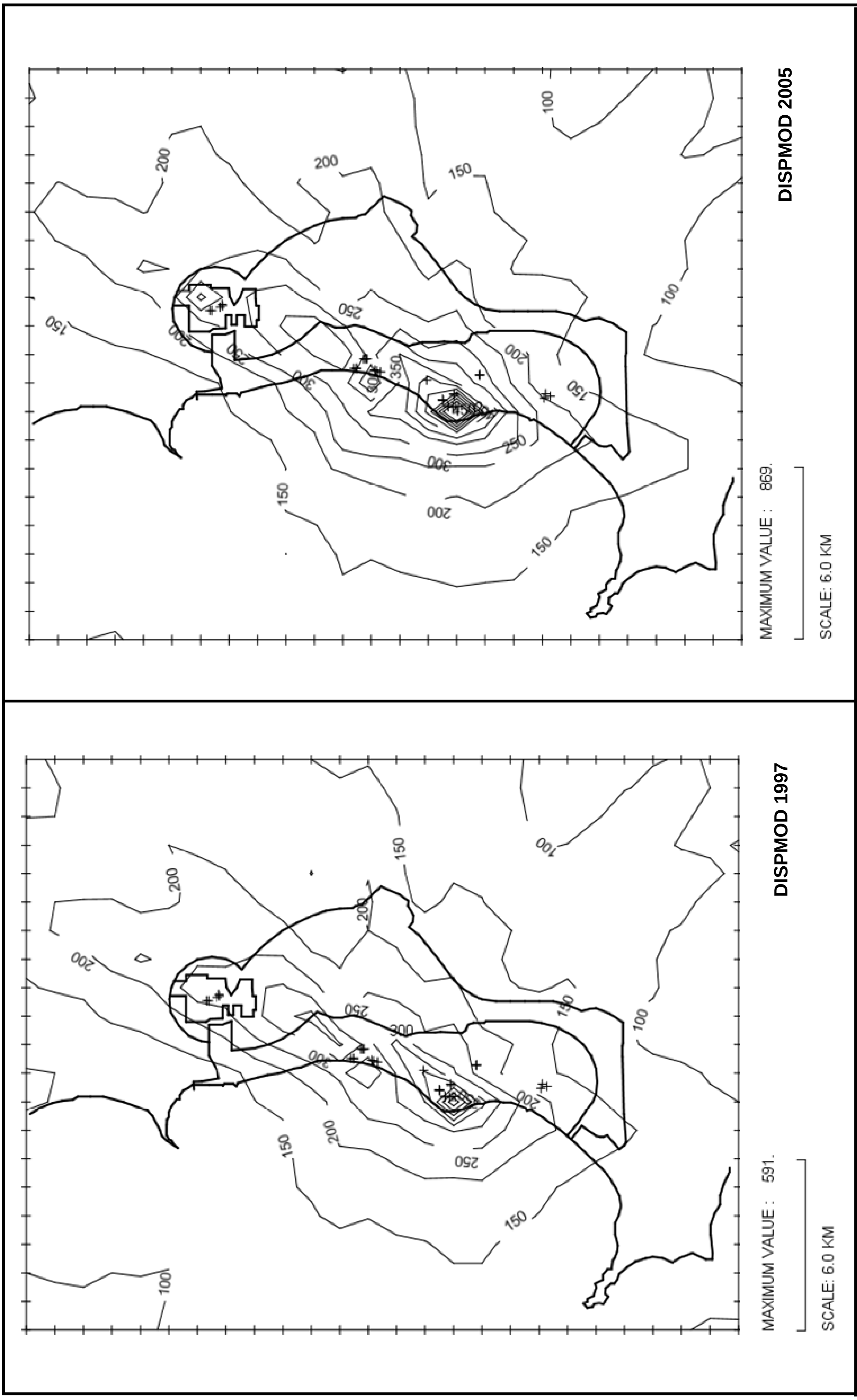
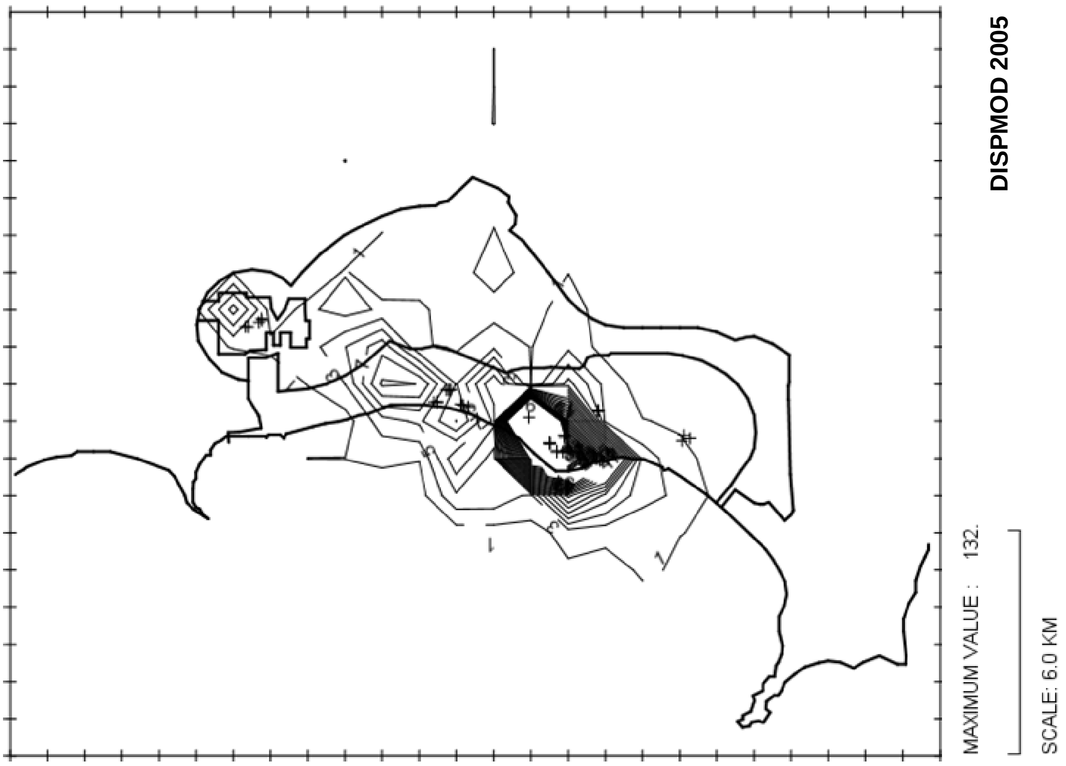


Figure 12. 99.9th Percentile 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³)
(1996 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09



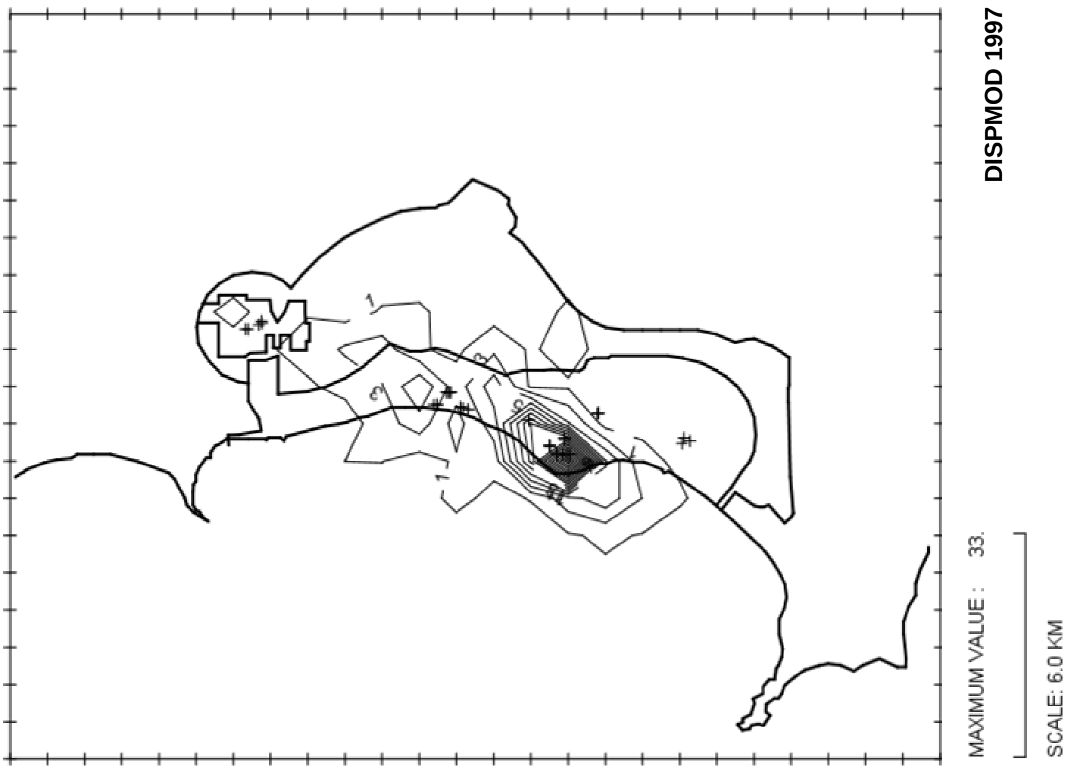


Figure 13. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 350 µg/m³

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

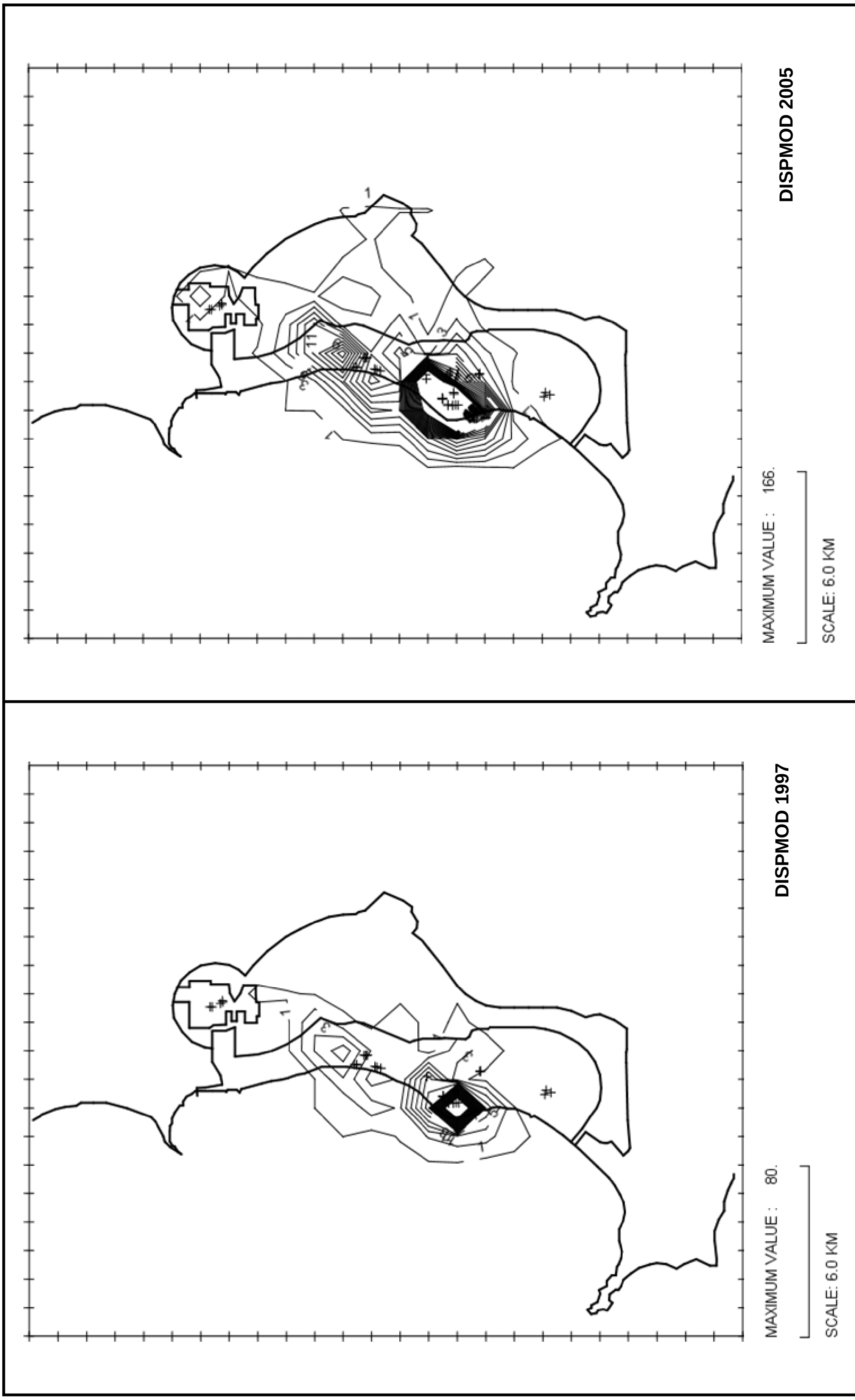


Figure 14. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 350 µg/m³

(1995 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

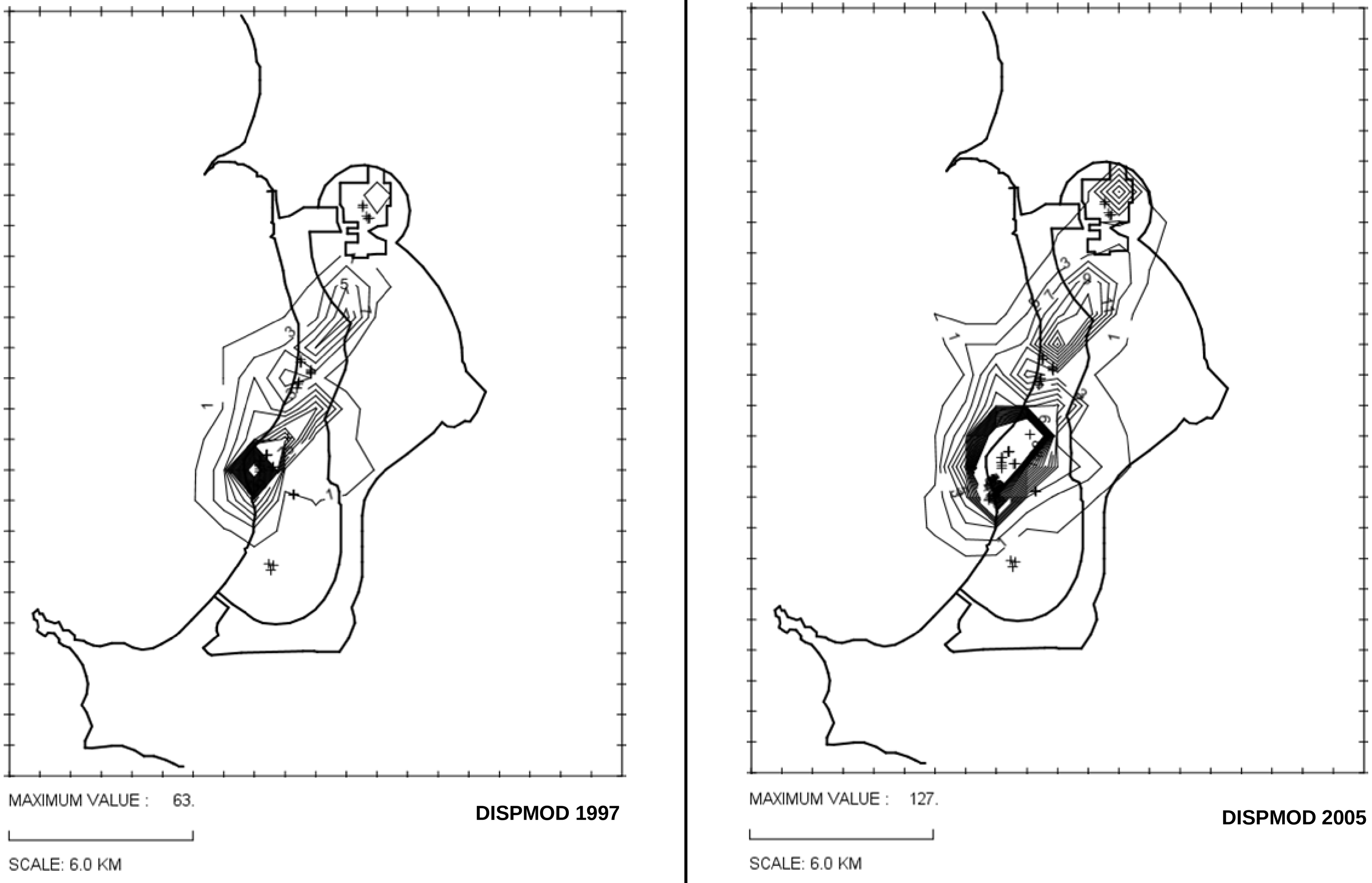


Figure 15. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 350 µg/m³

(1996 meteorology)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

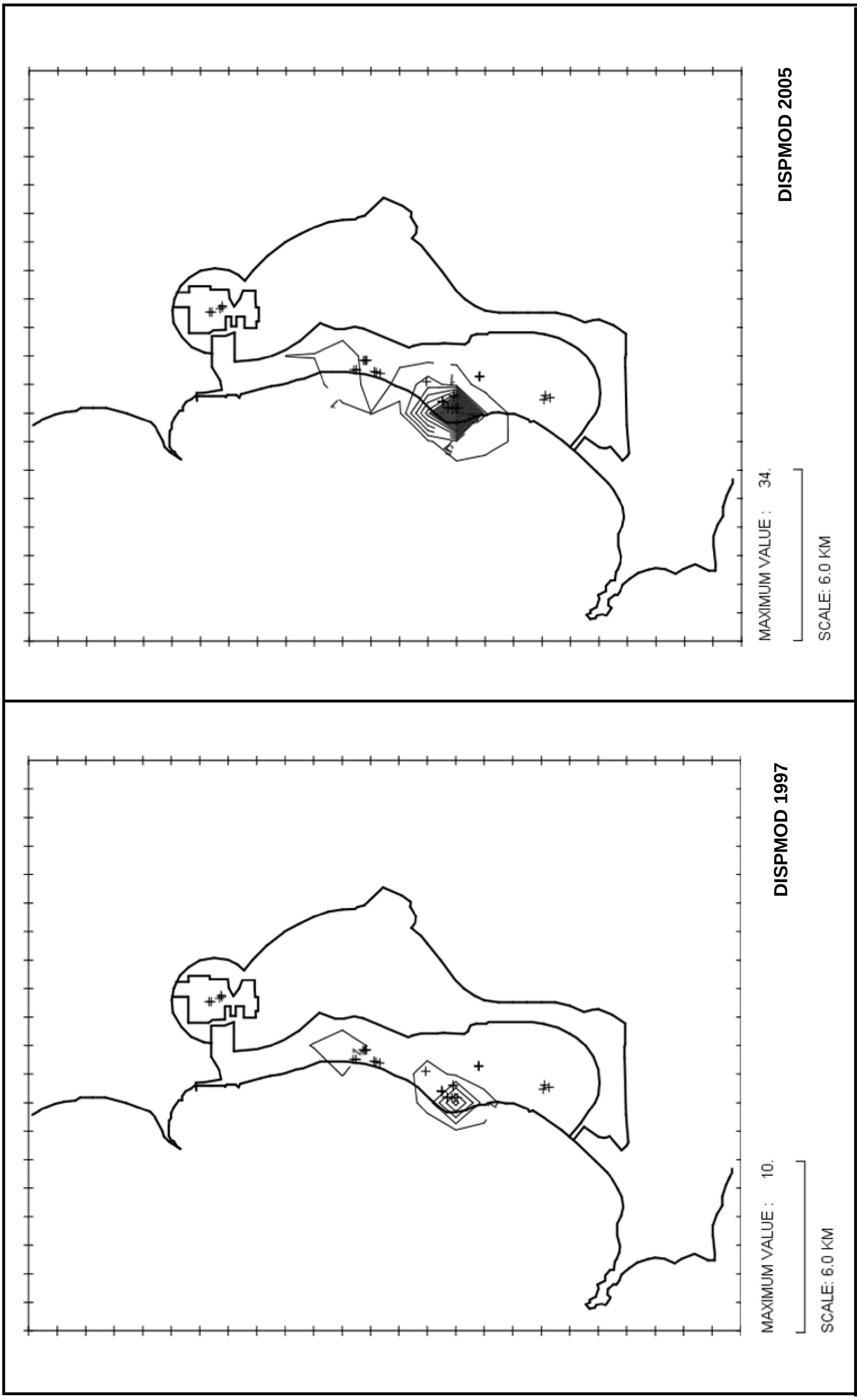


Figure 16. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 500 µg/m³

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

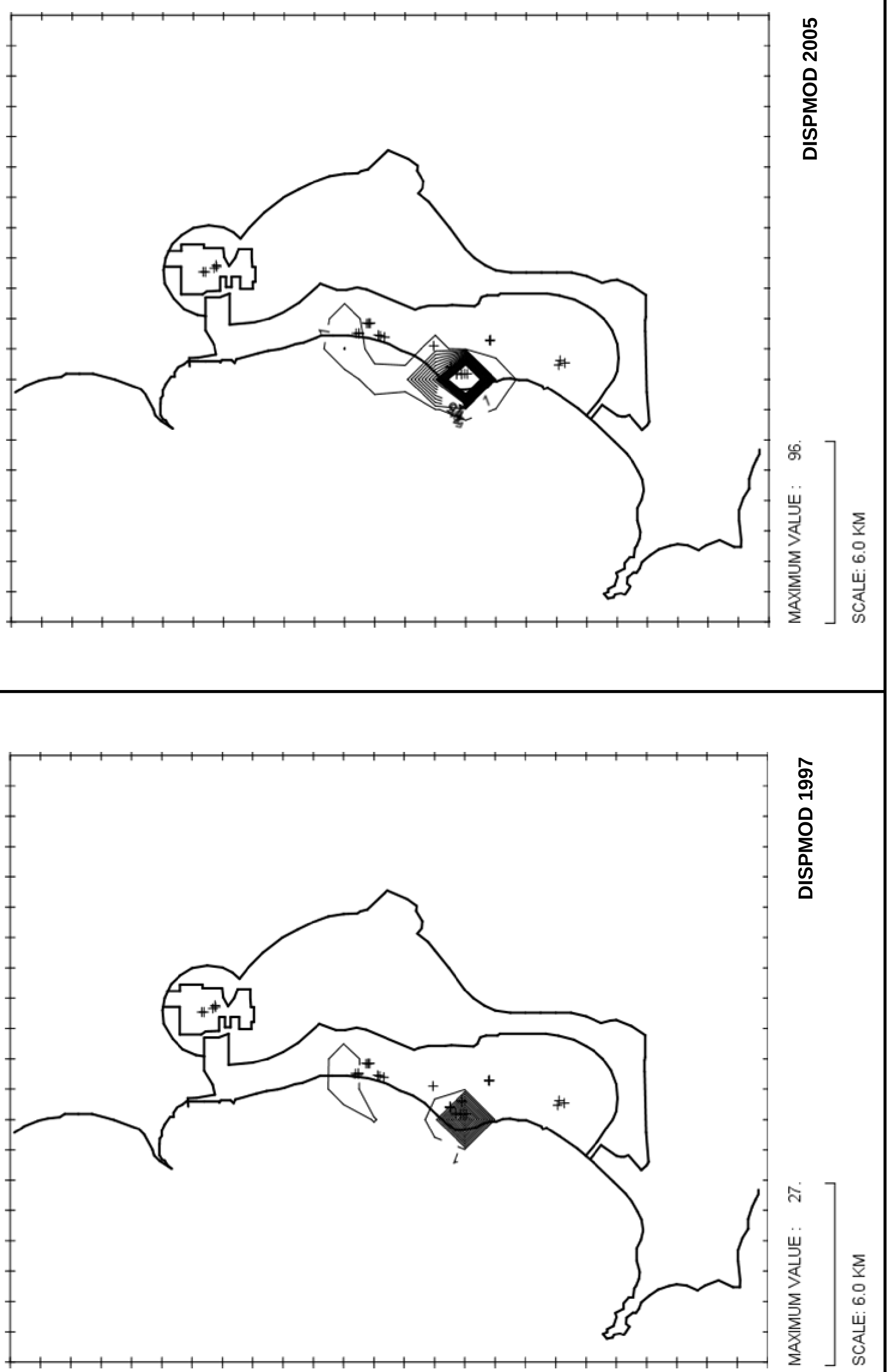


Figure 17. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 500 µg/m^3

(1995 meteorology)

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

Drawn: BB

Date: 15 April 09

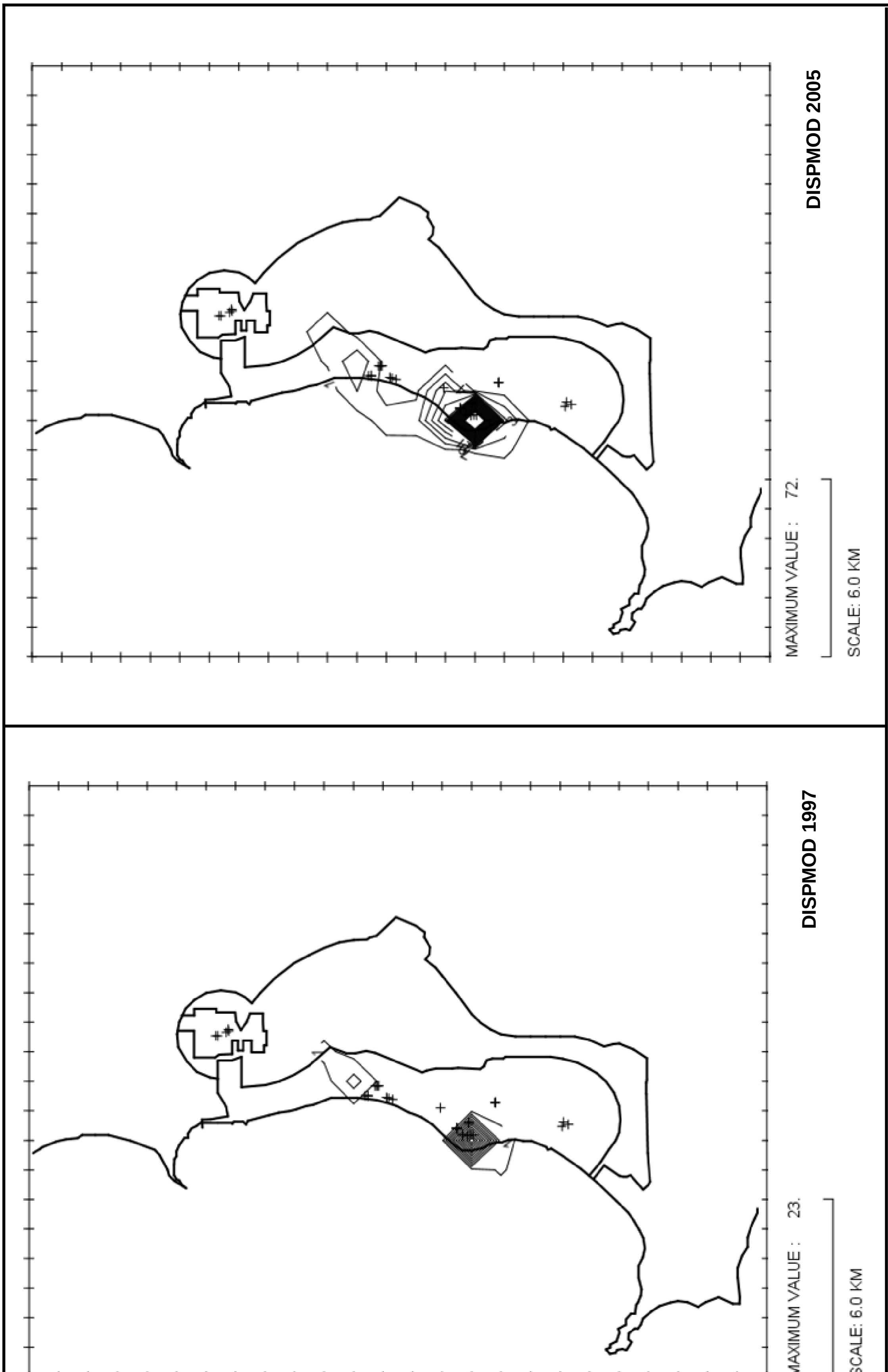


Figure 18. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 500 µg/m³

(1996 meteorology)

Client: Kwinana Industries Council
Project: EPP SO2 Redetermination
Drawn: BB
Date: 15 April 09

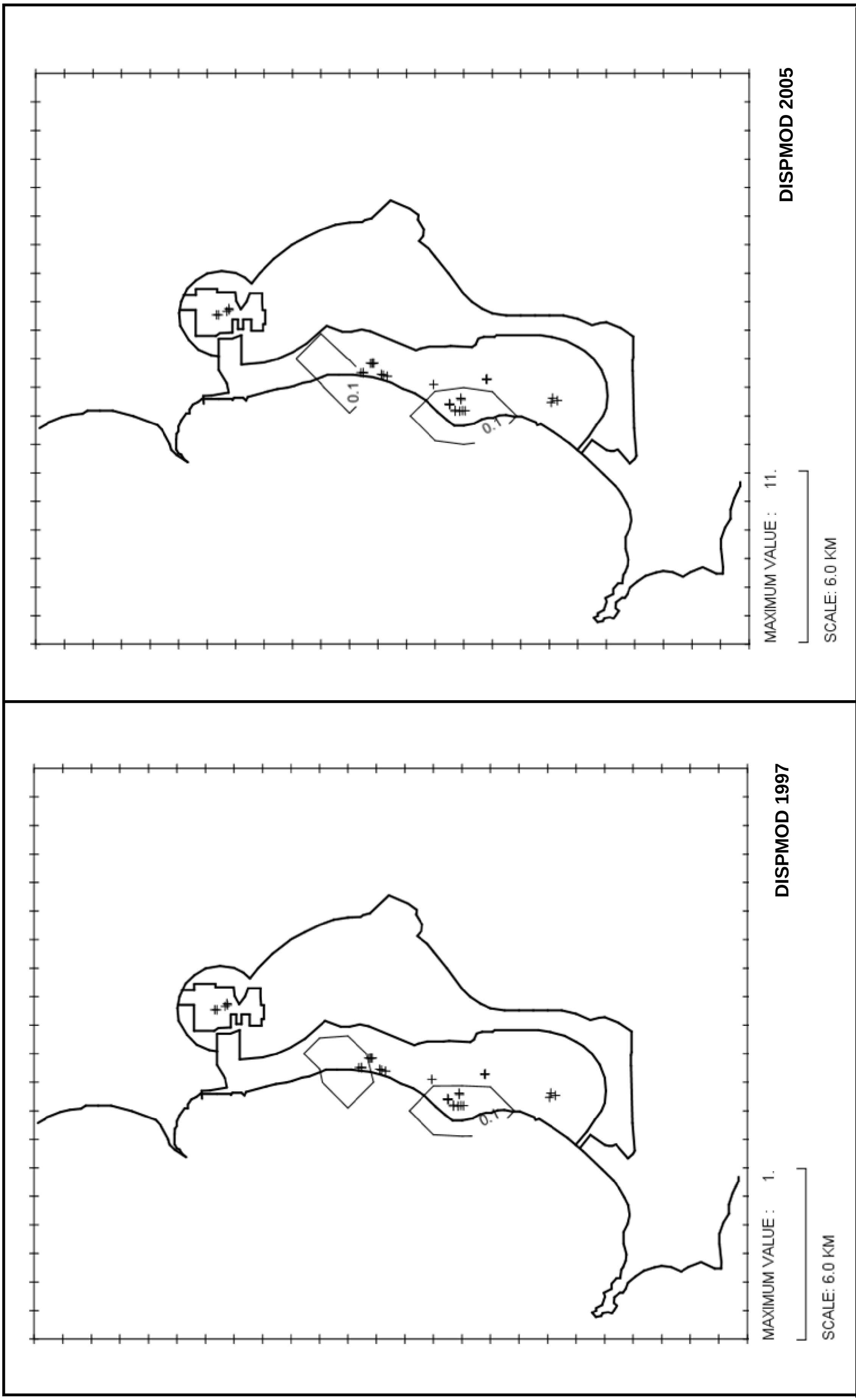


Figure 19. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 700 µg/m³

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

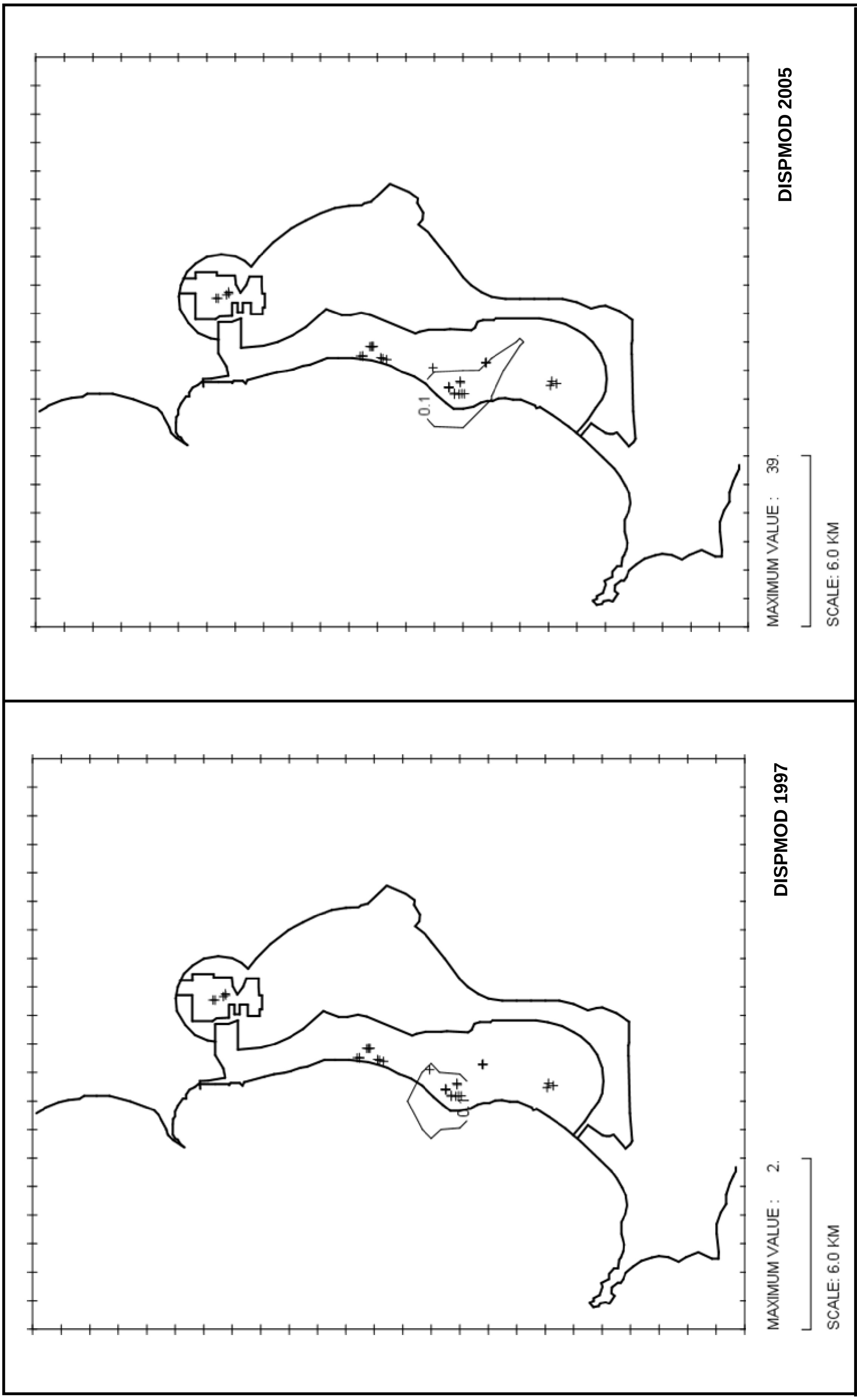


Figure 20. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 700 µg/m^3

(1995 meteorology)

ENVIRON

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

Drawn: BB

Date: 15 April 09

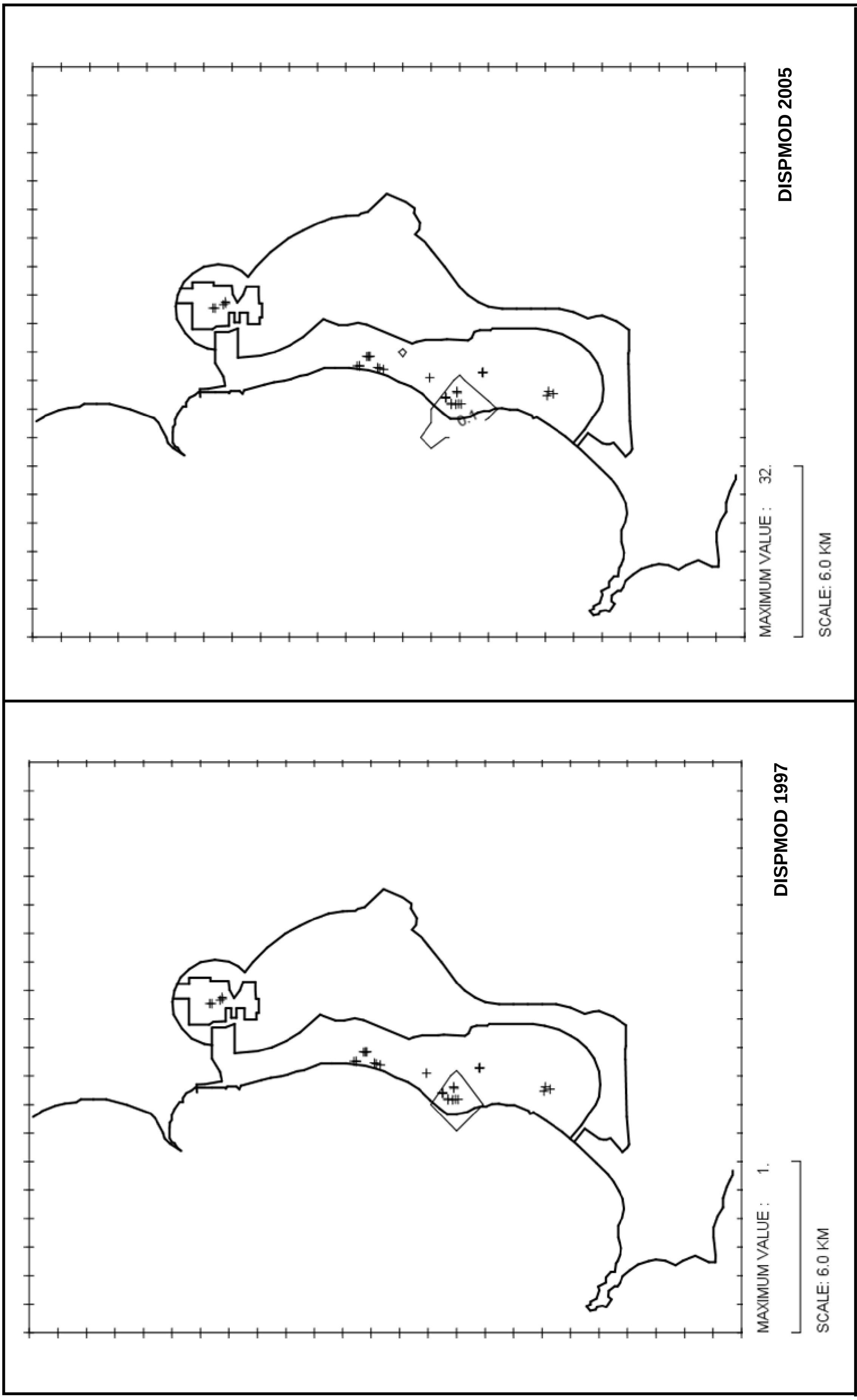


Figure 21. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 700 µg/m³

(1996 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

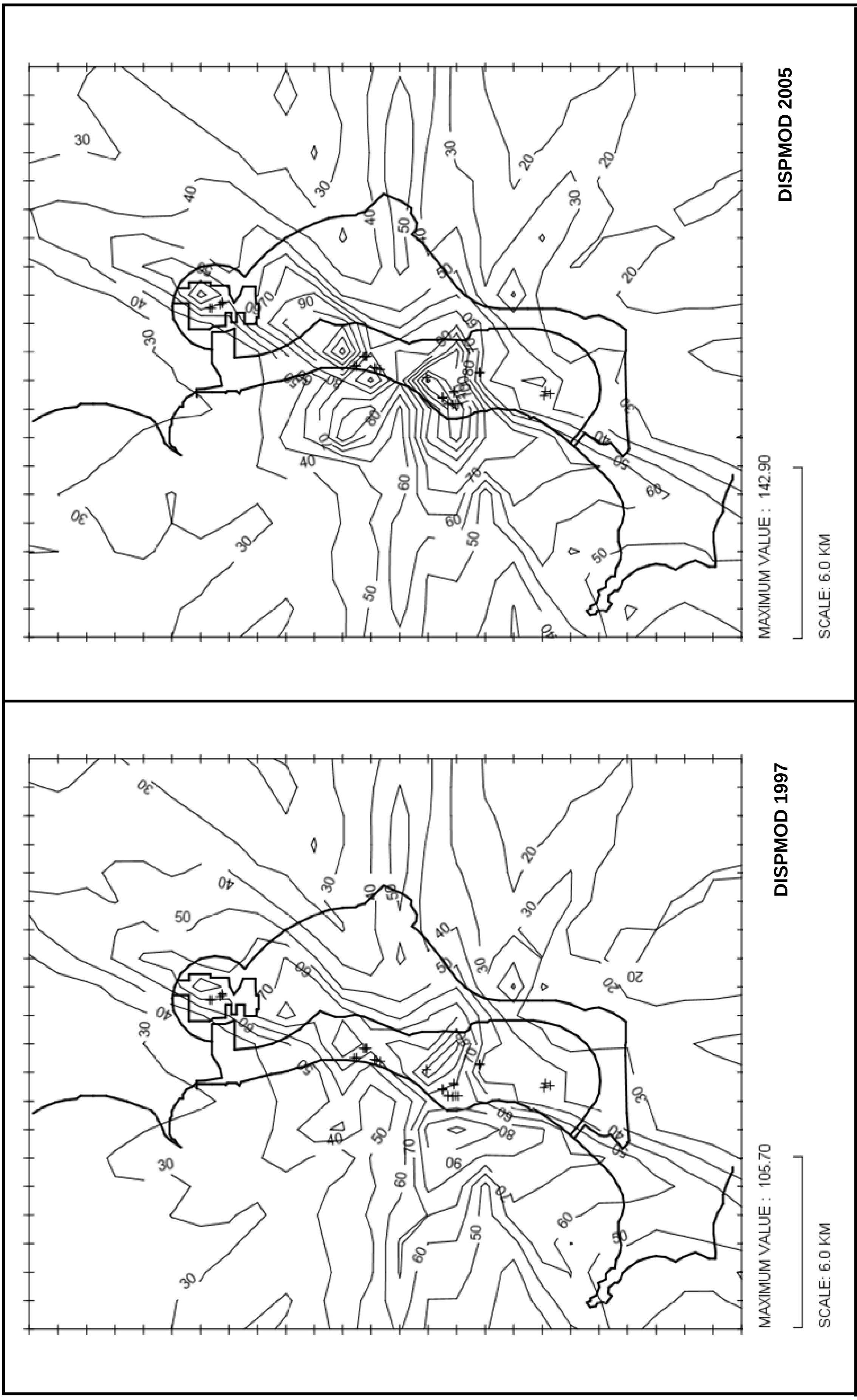


Figure 22. Maximum 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

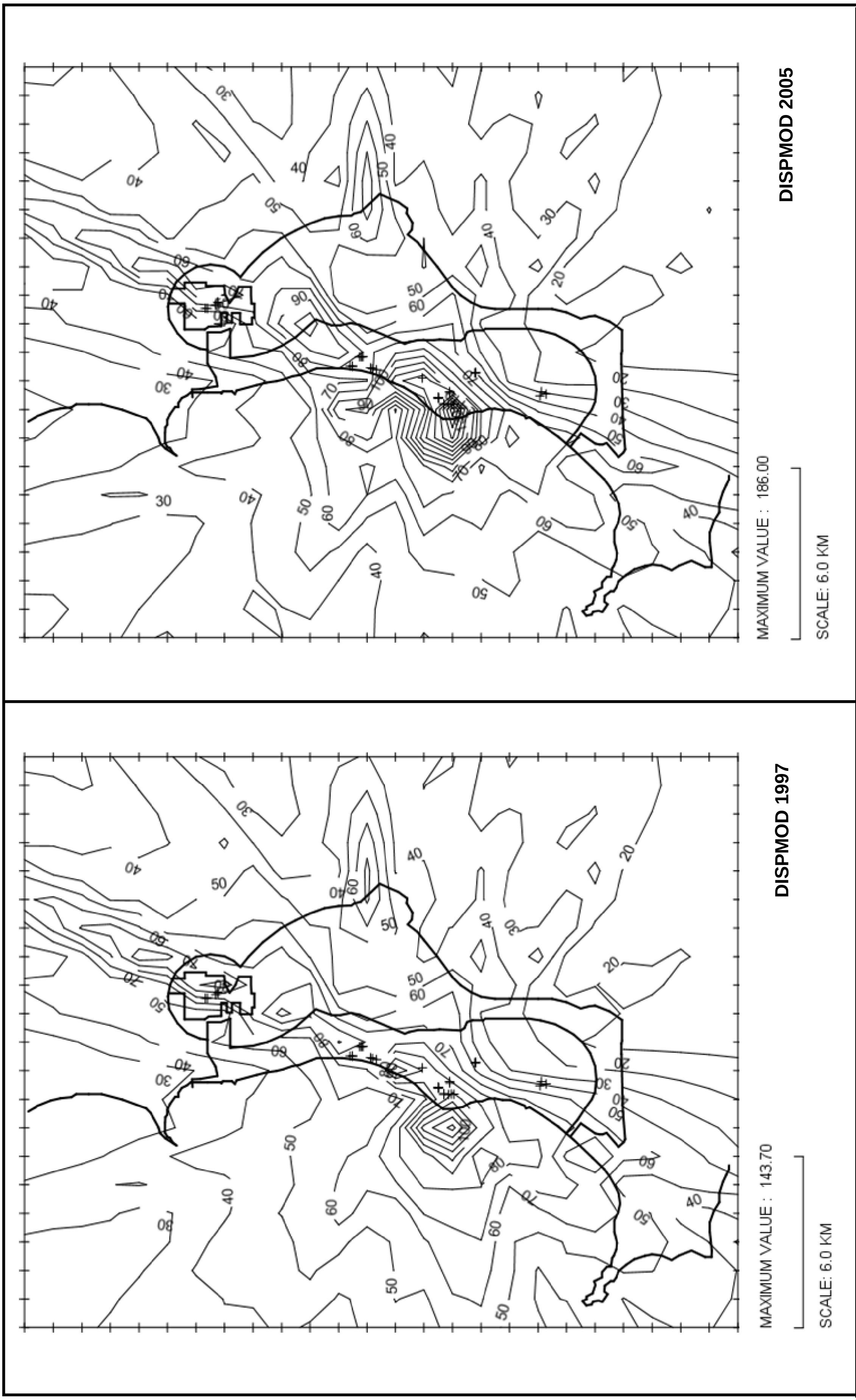


Figure 23. Maximum 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1995 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

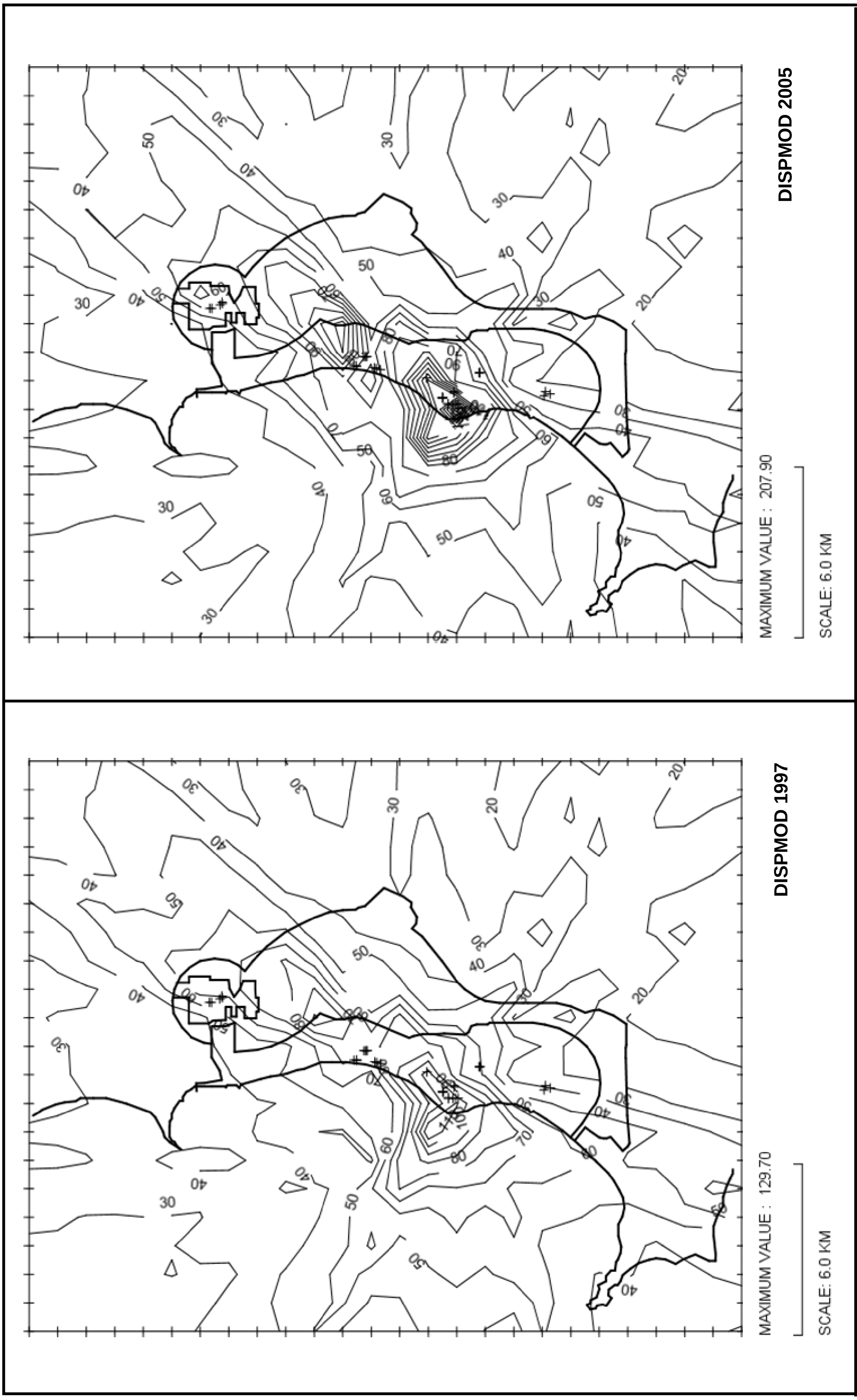


Figure 24. Maximum 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1996 meteorology)

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

ENVIRON

Drawn: BB

Date: 15 April 09

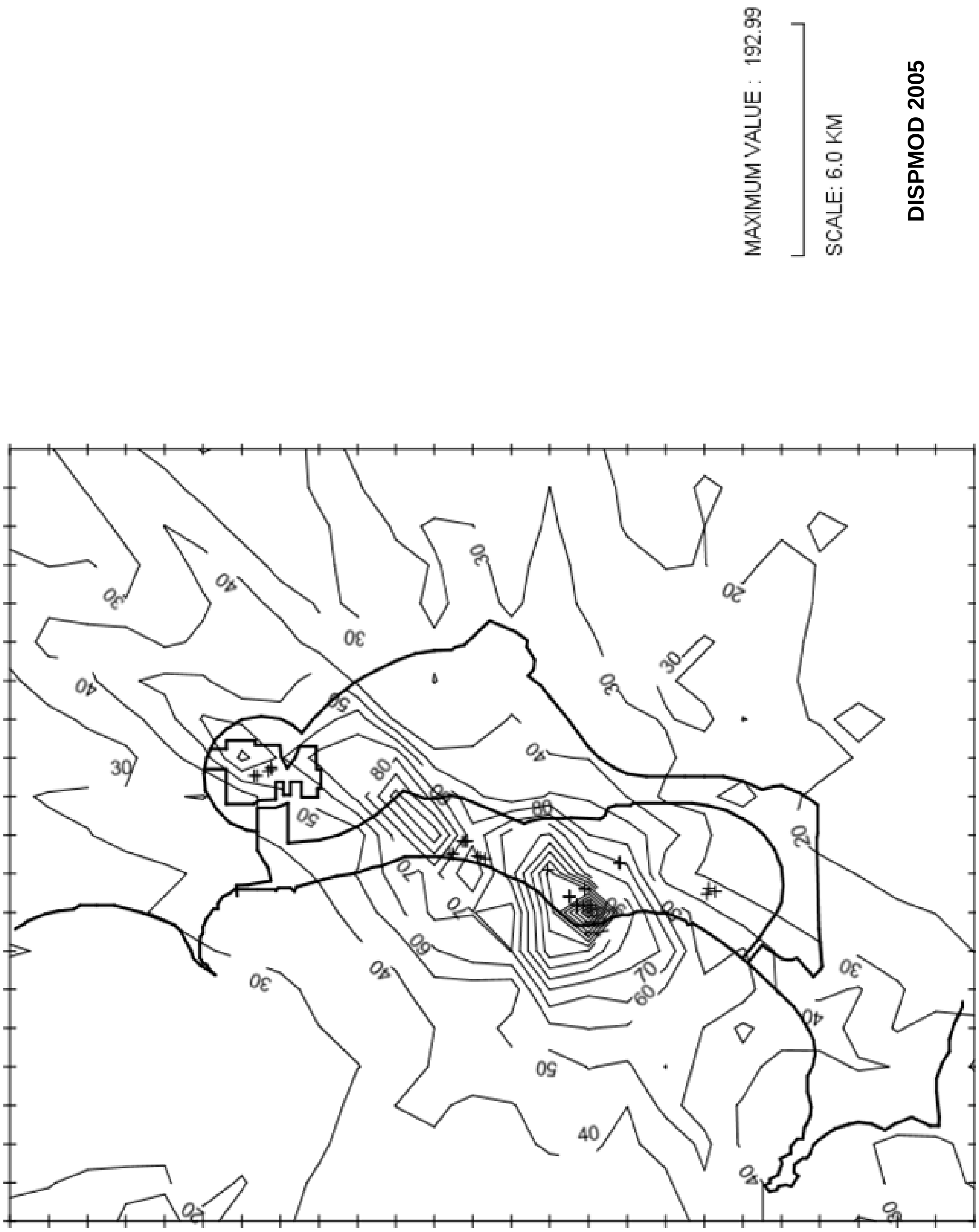


Figure 25. Second Highest 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1996 meteorology)

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

ENVIRON

Drawn: BB

Date: 15 April 09

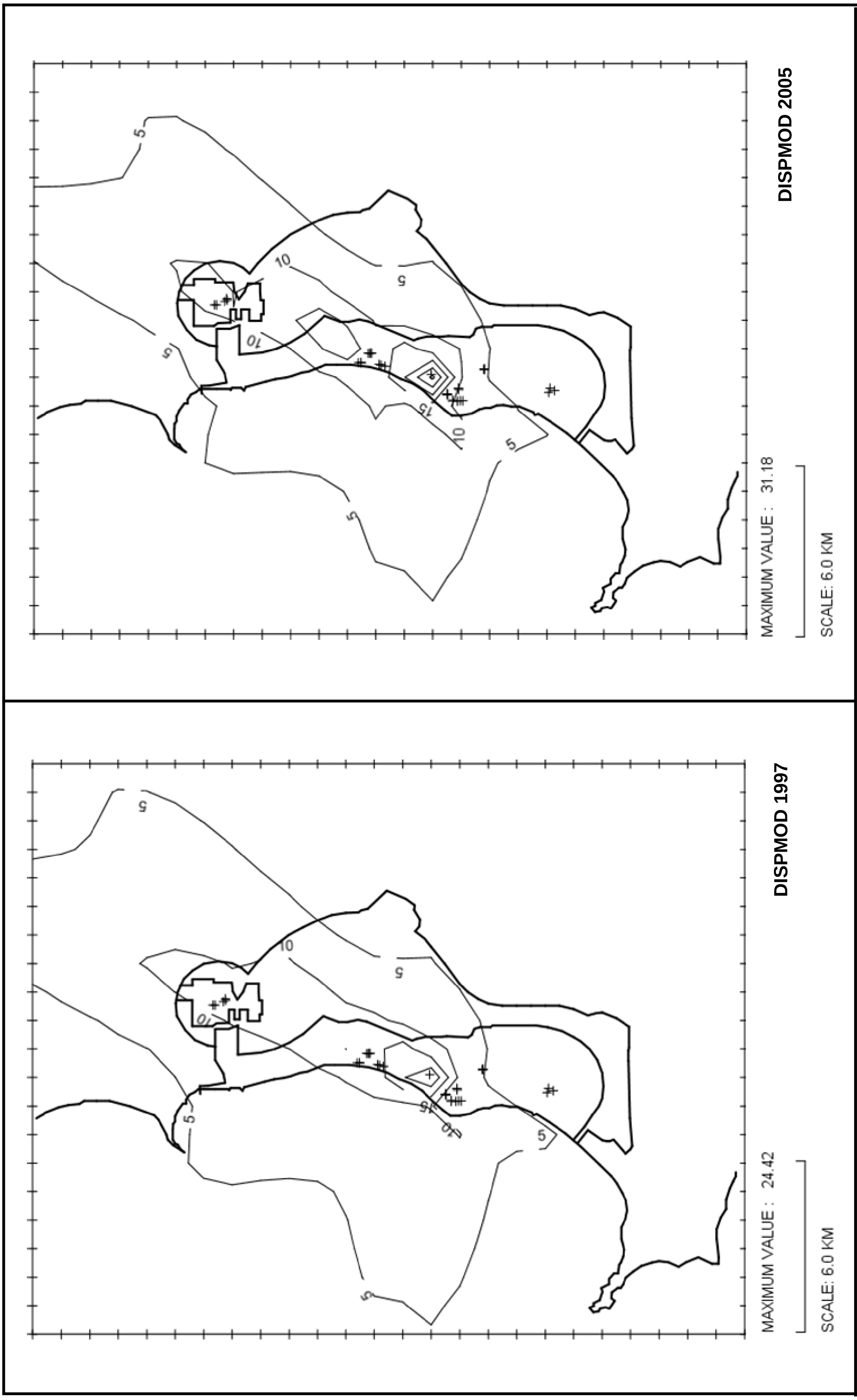


Figure 26. Annual Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

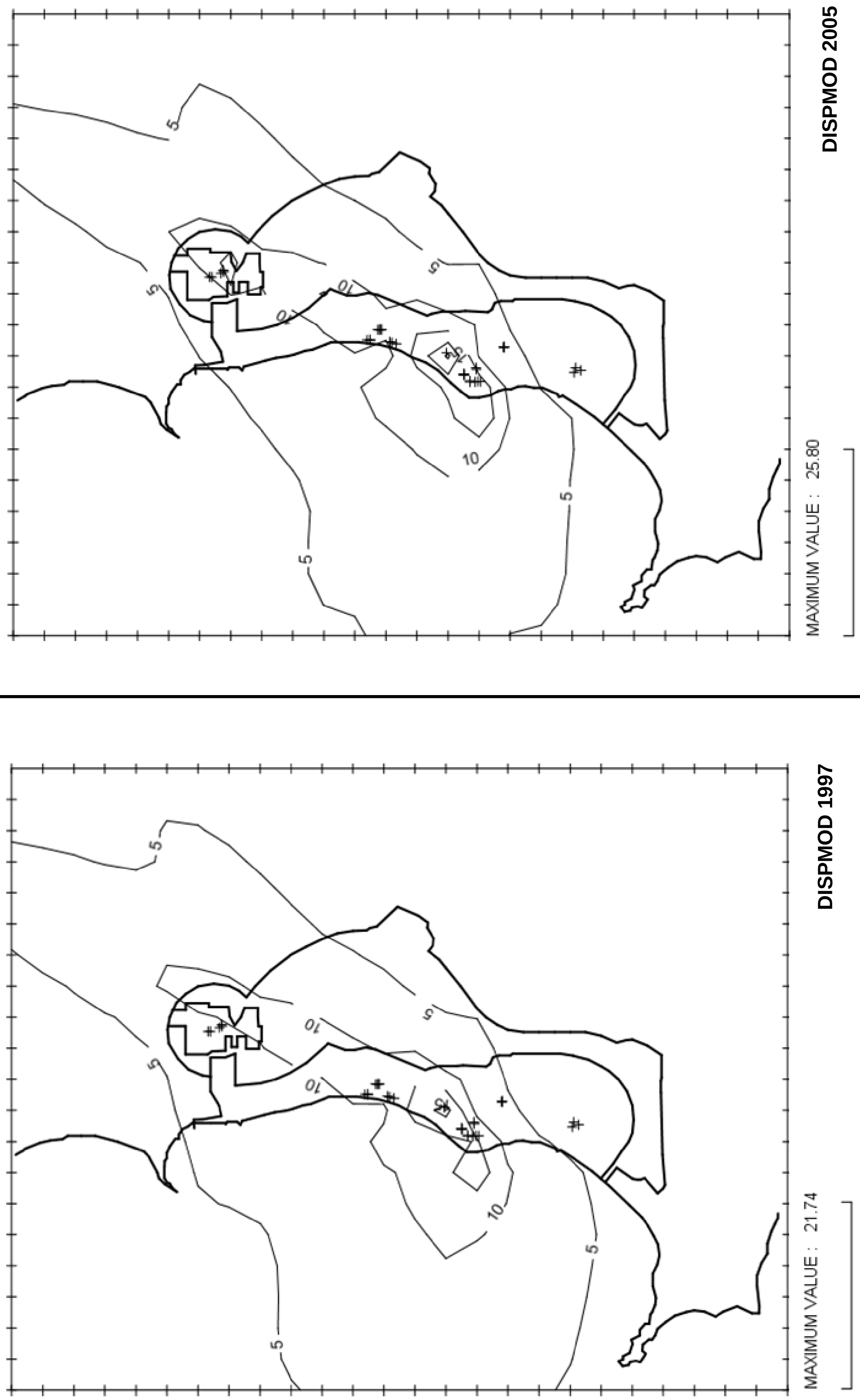


Figure 27. Annual Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1995 meteorology)

Client: Kwinana Industries Council	
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

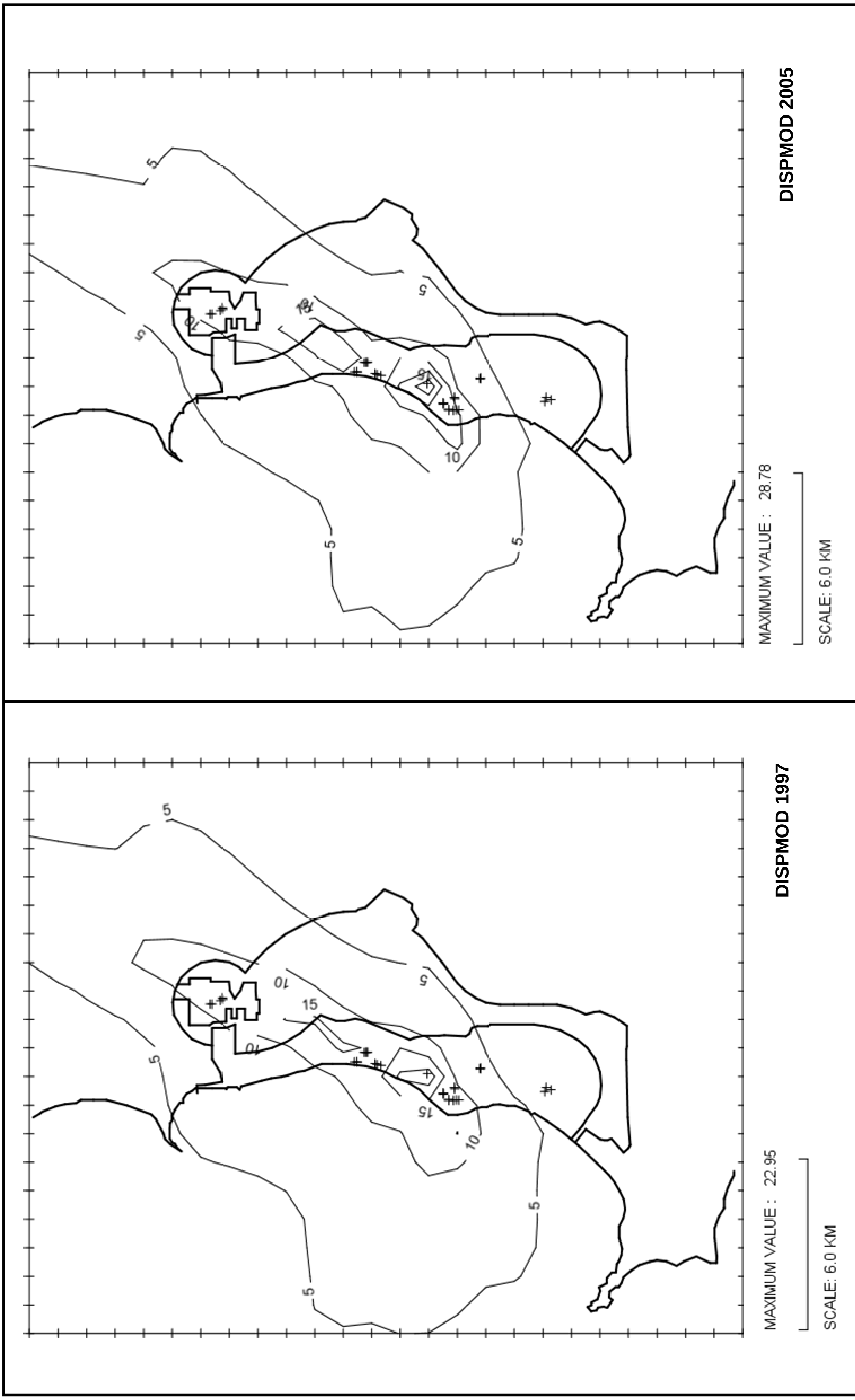


Figure 28. Annual Average Ground Level Concentration of Sulphur Dioxide (µg/m³)

(1996 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

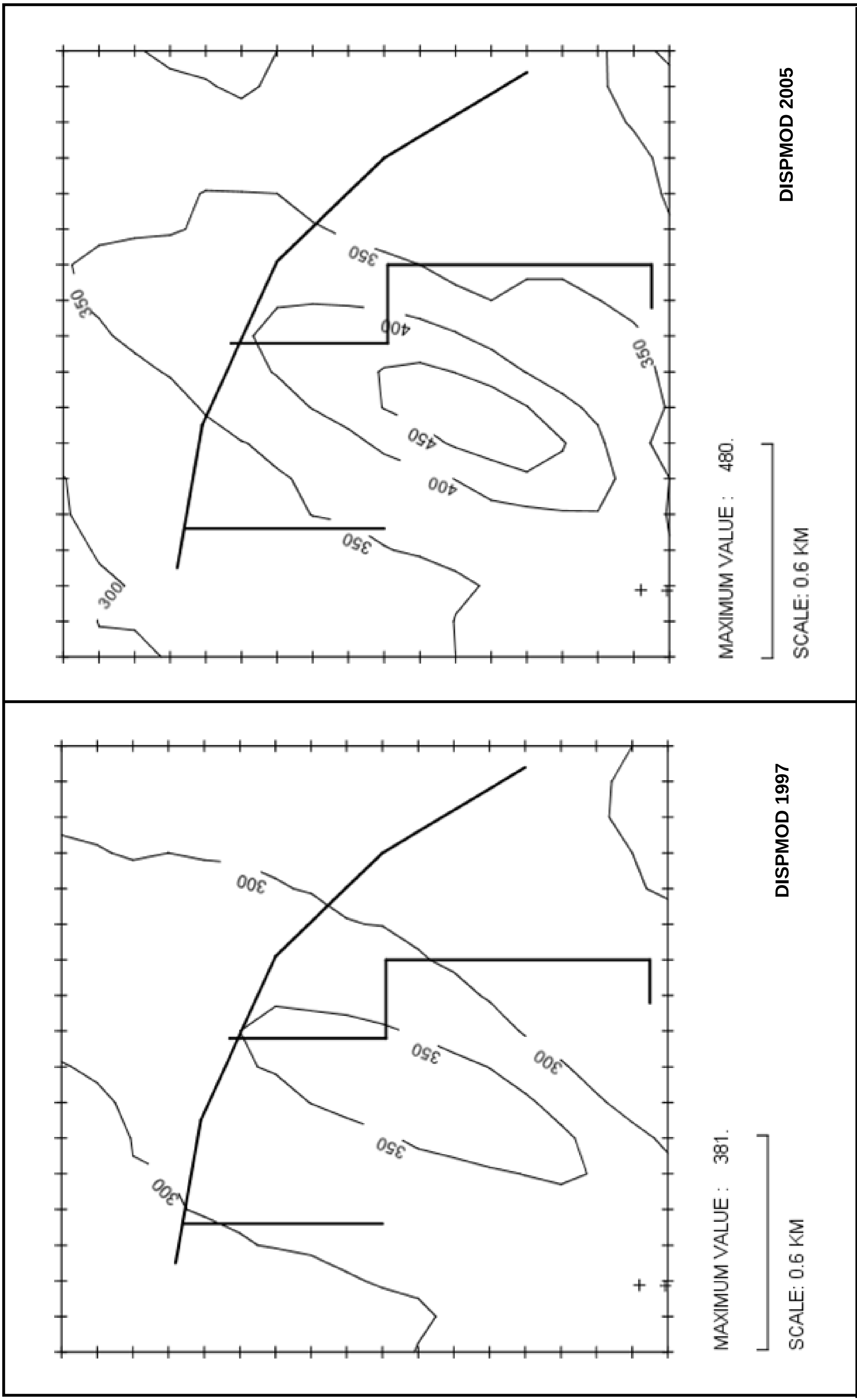


Figure 29. Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Northern Model Domain

(1980 meteorology)

ENVIRON

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

Drawn: BB

Date: 15 April 09

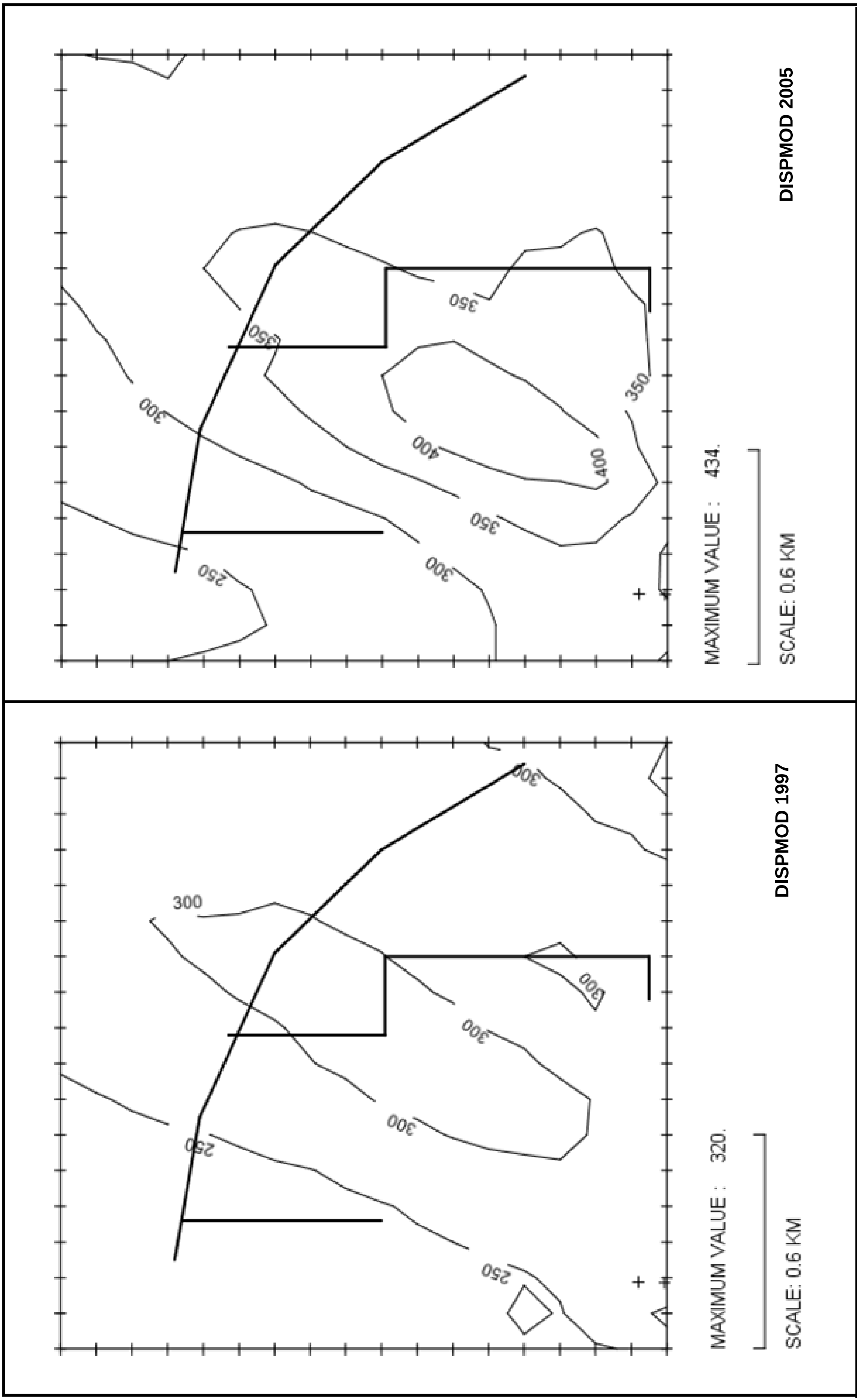


Figure 30. Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Northern Model Domain

(1995 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

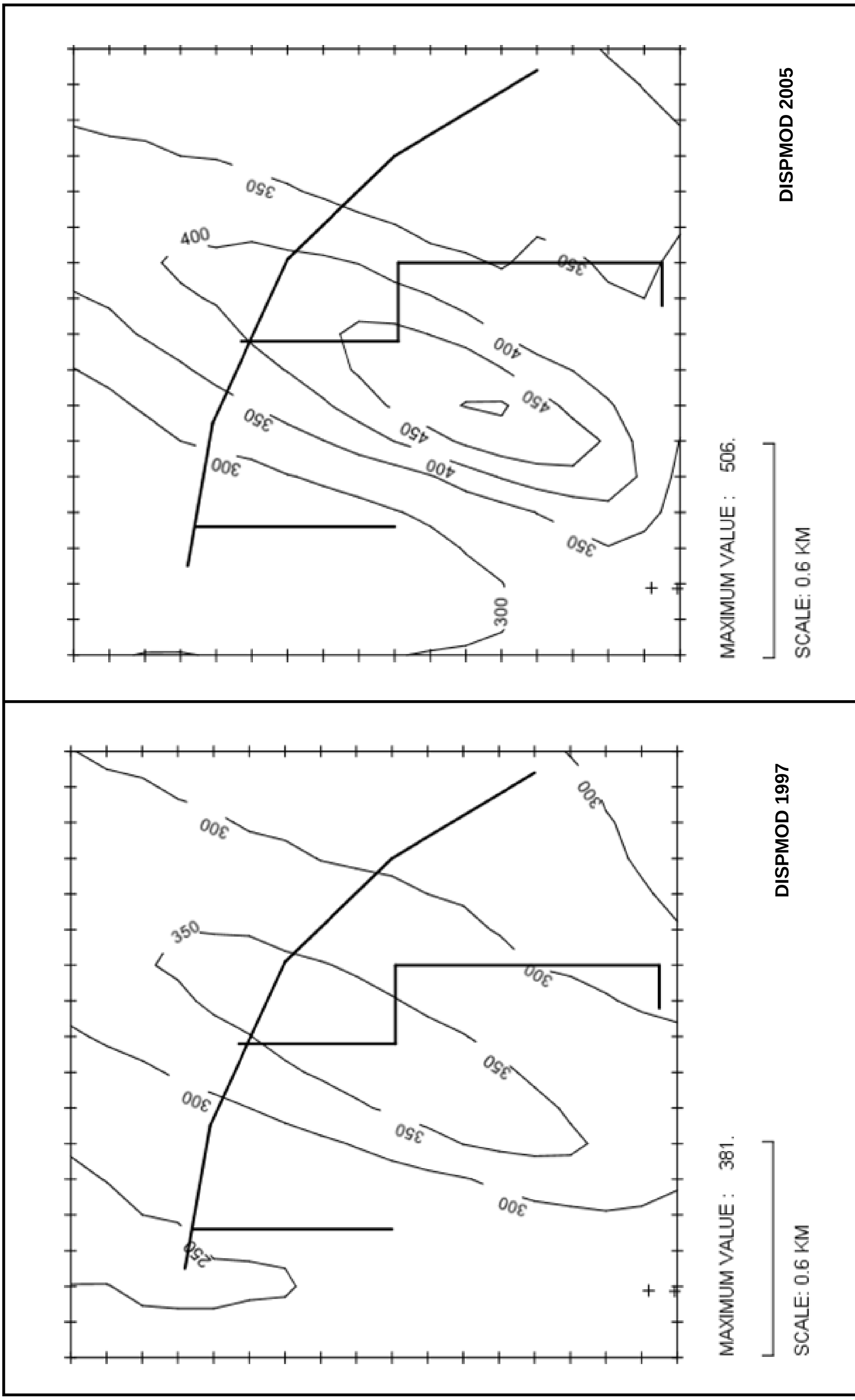


Figure 31. Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Northern Model Domain

(1996 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB
	Date: 15 April 09

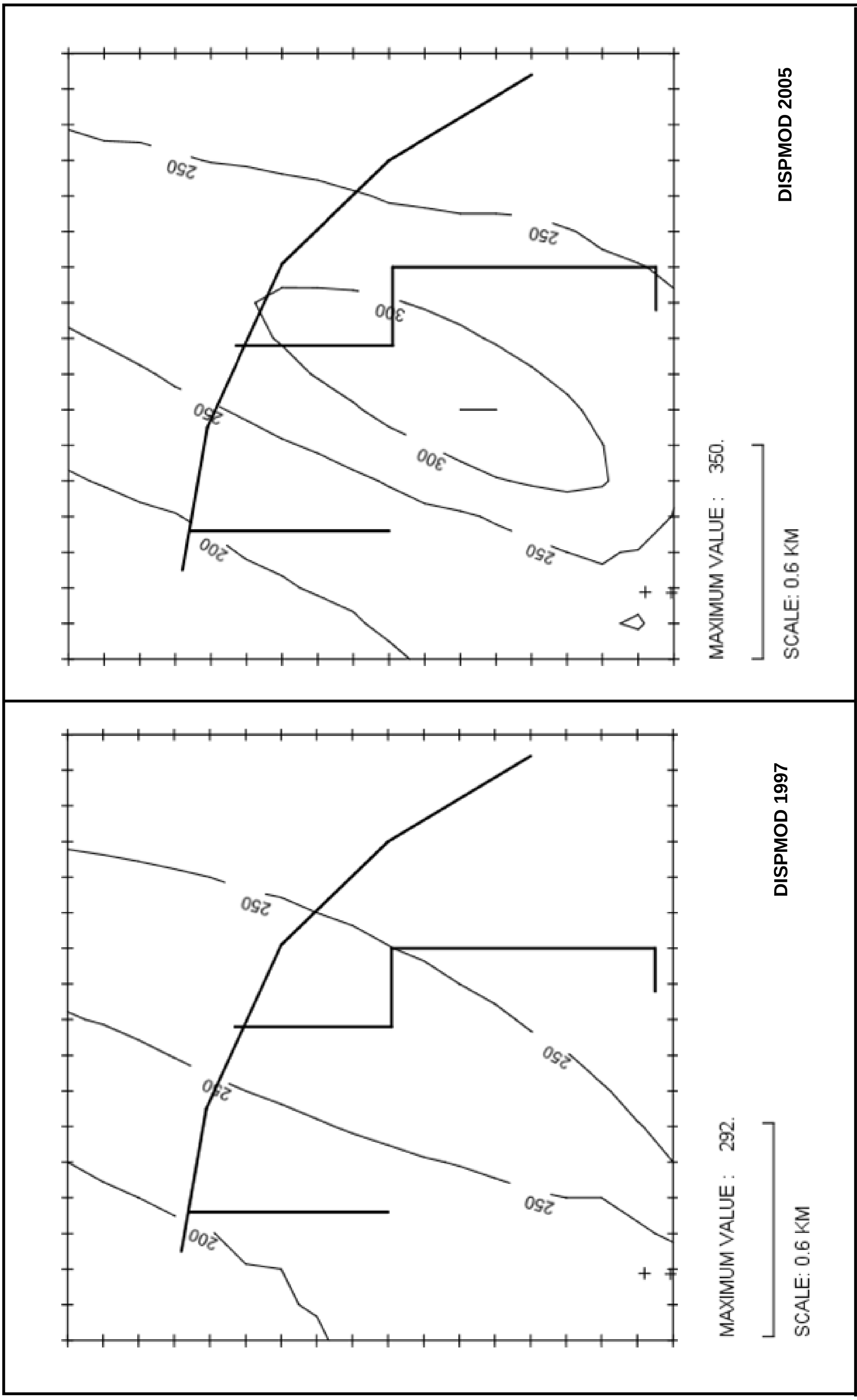


Figure 32. 99.9th Percentile 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m^3) – Northern Model Domain

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB · Date: 15 April 09

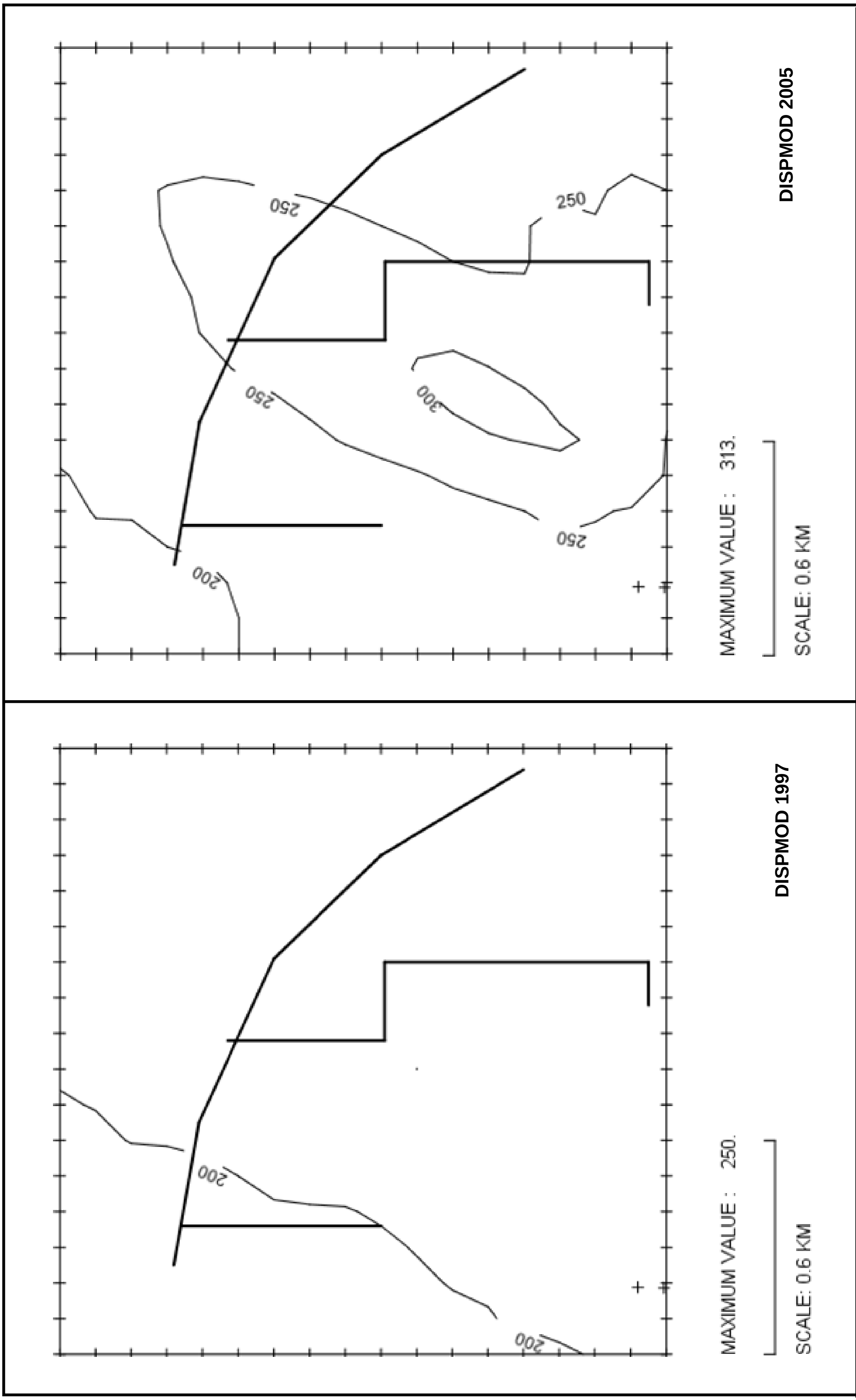


Figure 33. 99.9th Percentile 1-hour Average Ground Level Concentration of Sulphur Dioxide ($\mu g/m^3$) – Northern Model Domain
(1995 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

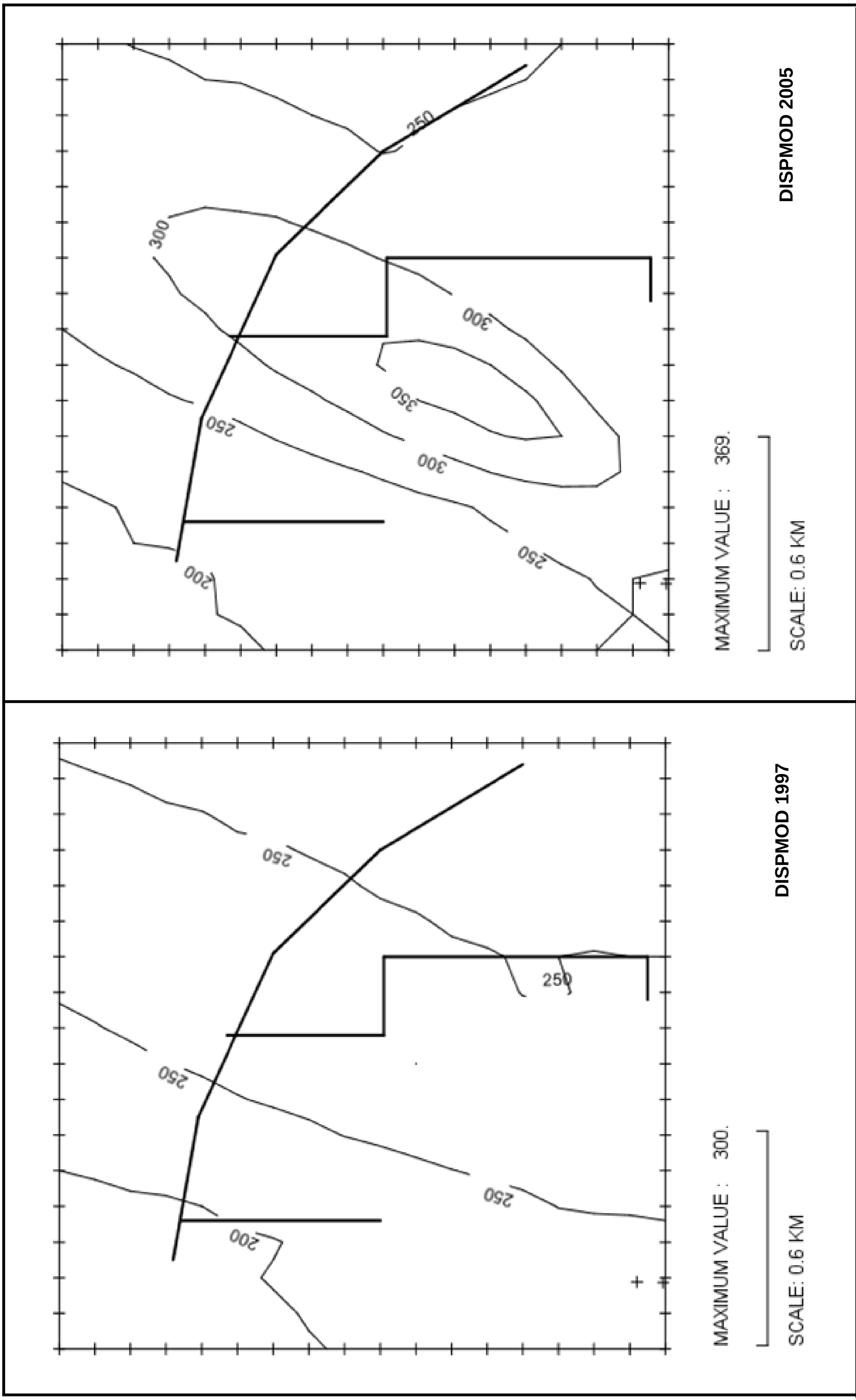


Figure 34. 99.9th Percentile 1-hour Average Ground Level Concentration of Sulphur Dioxide (μg/m³) – Northern Model Domain

(1996 meteorology)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

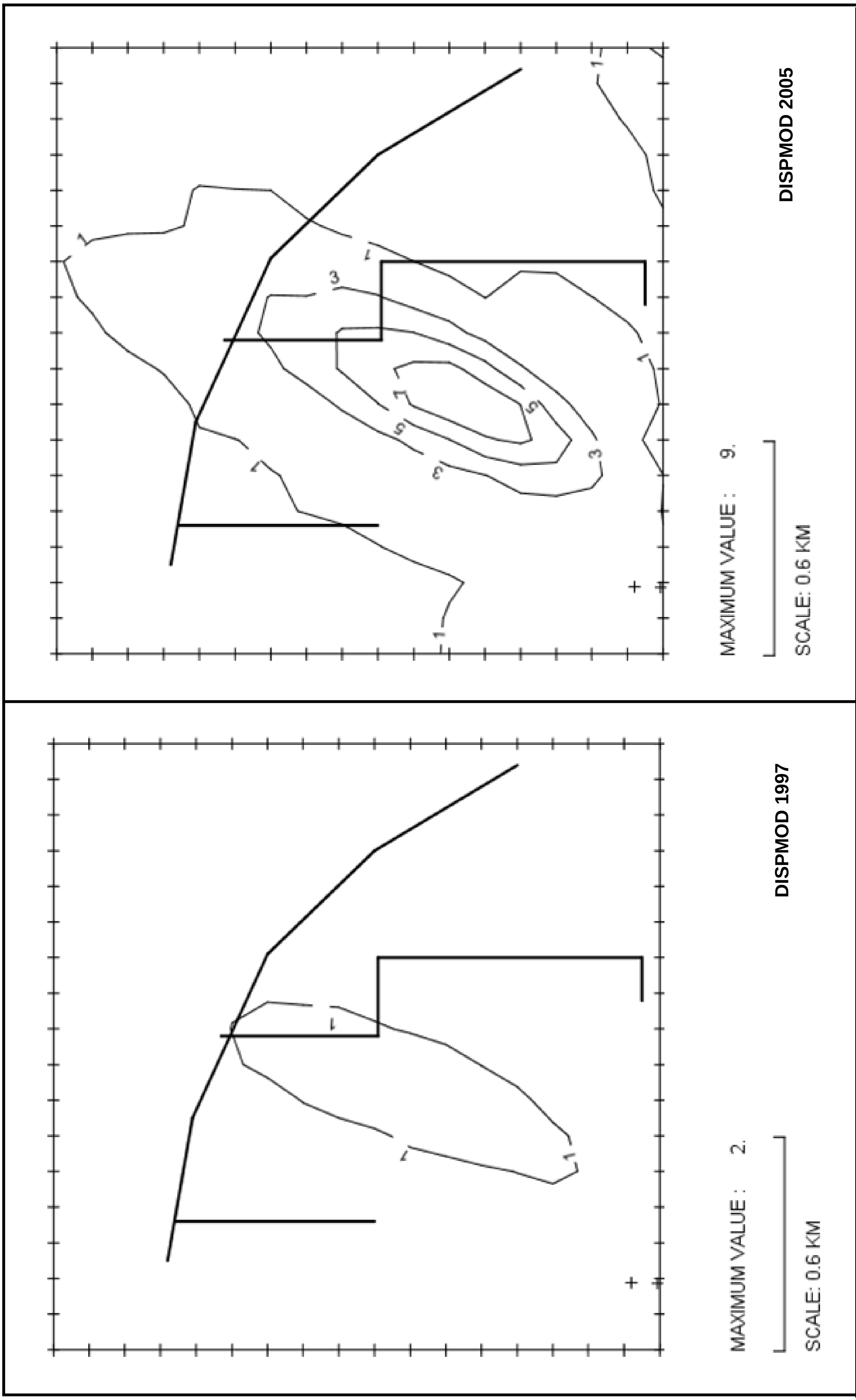


Figure 35. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 350 µg/m³ – Northern Model Domain

(1980 meteorology)

ENVIRON

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

Drawn: BB

Date: 15 April 09

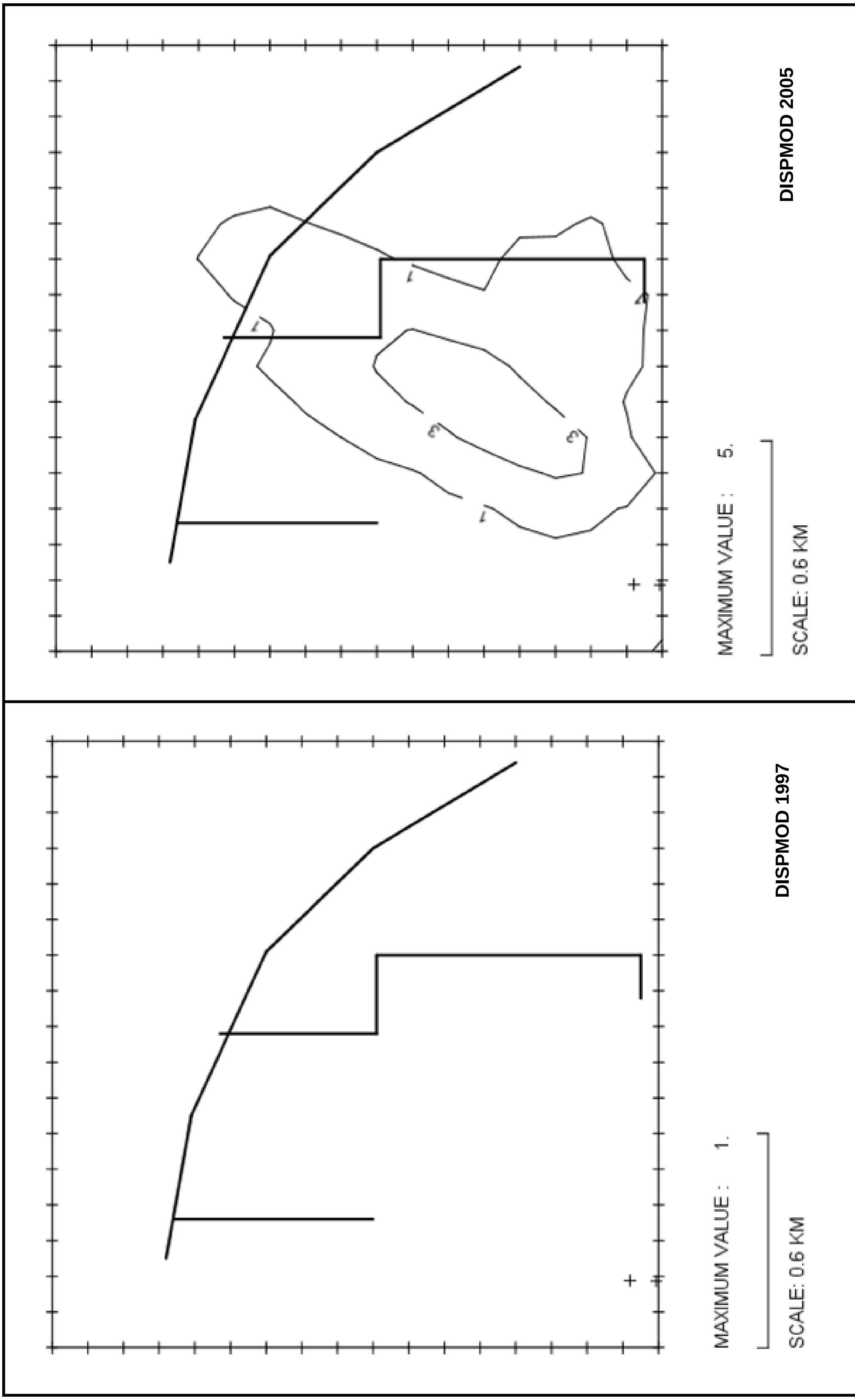


Figure 36. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 350 μg/m³ – Northern Model Domain

(1995 meteorology)

ENVIRON

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

Drawn: BB

Date: 15 April 09

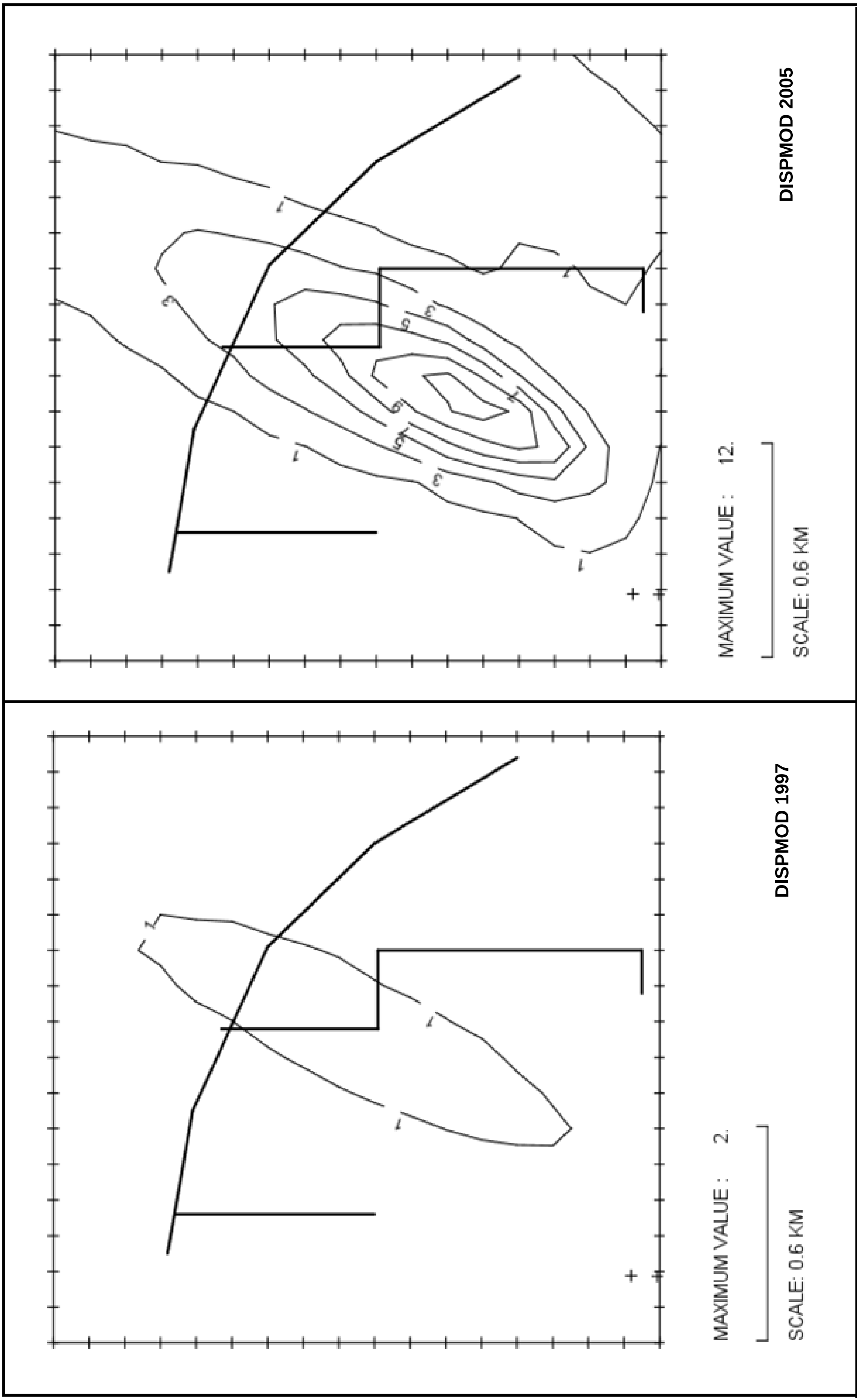


Figure 37. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 350 µg/m³ – Northern Model Domain

(1996 meteorology)

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

Drawn: BB

Date: 15 April 09

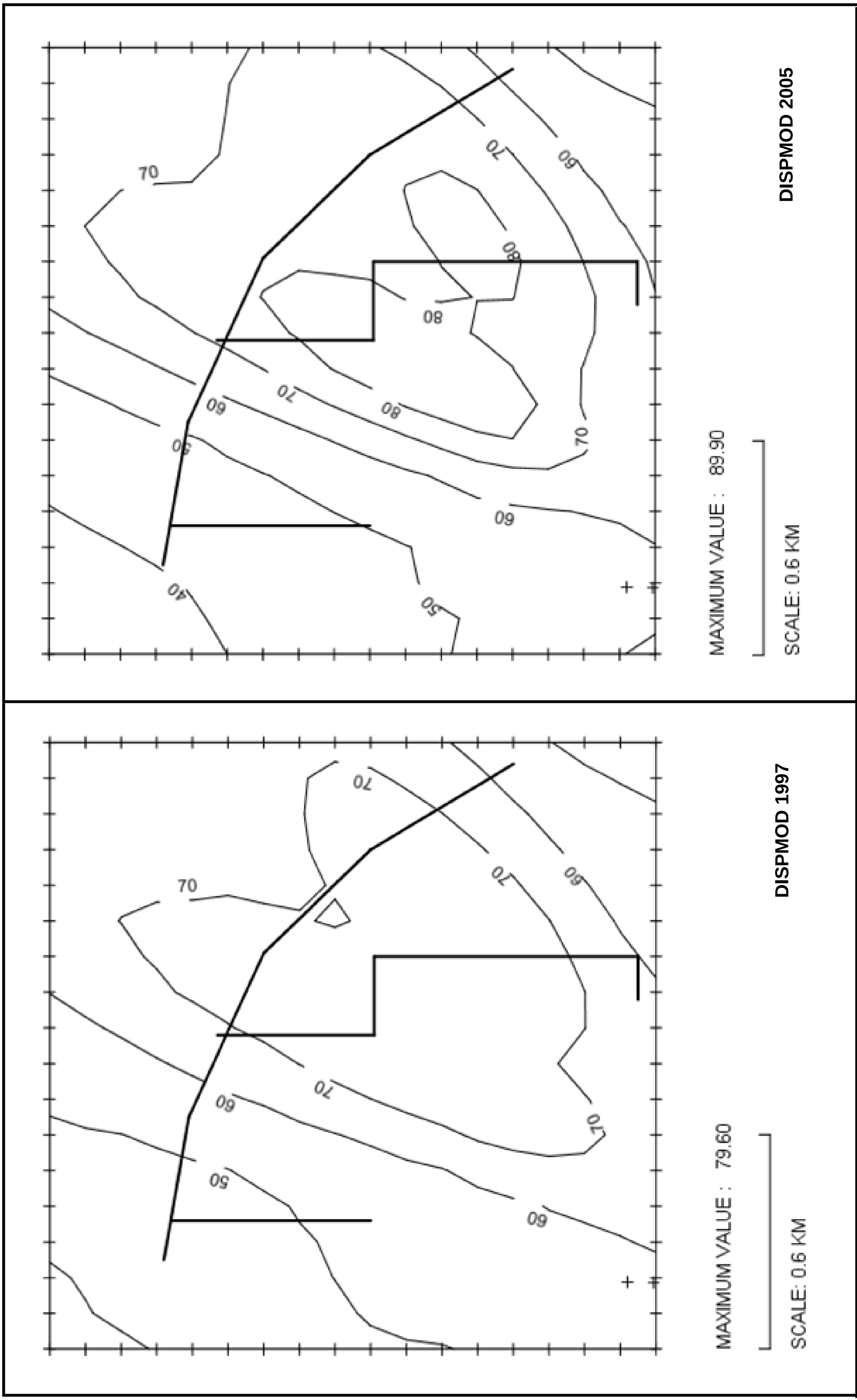


Figure 38. Maximum 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Northern Model Domain

(1980 meteorology)

ENVIRON

Client: Kwinana Industries Council	
Project: EPP SO2 Redetermination	Drawn: BB
	Date: 15 April 09

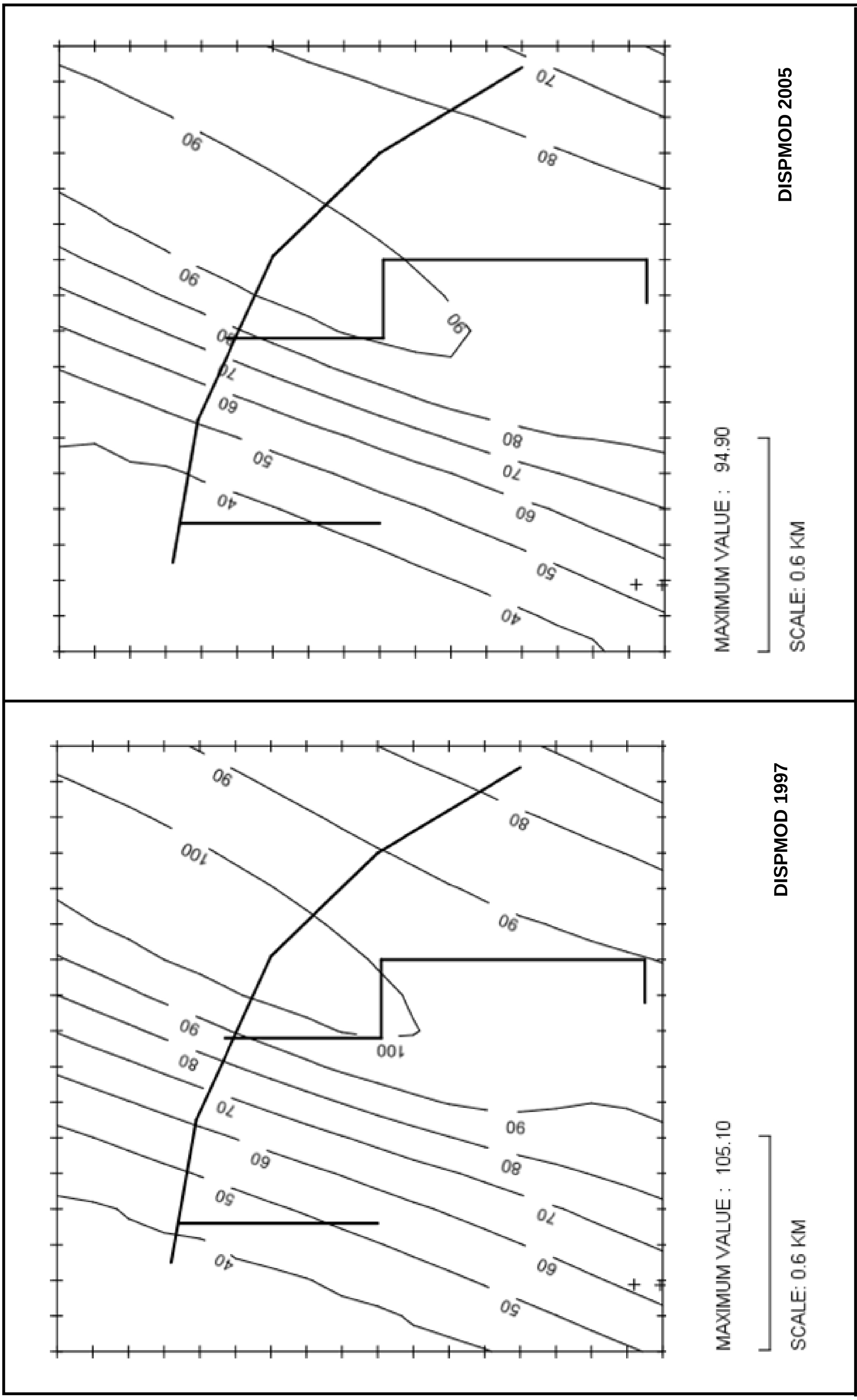


Figure 39. Maximum 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Northern Model Domain

(1995 meteorology)

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

ENVIRON

Drawn: BB

Date: 15 April 09

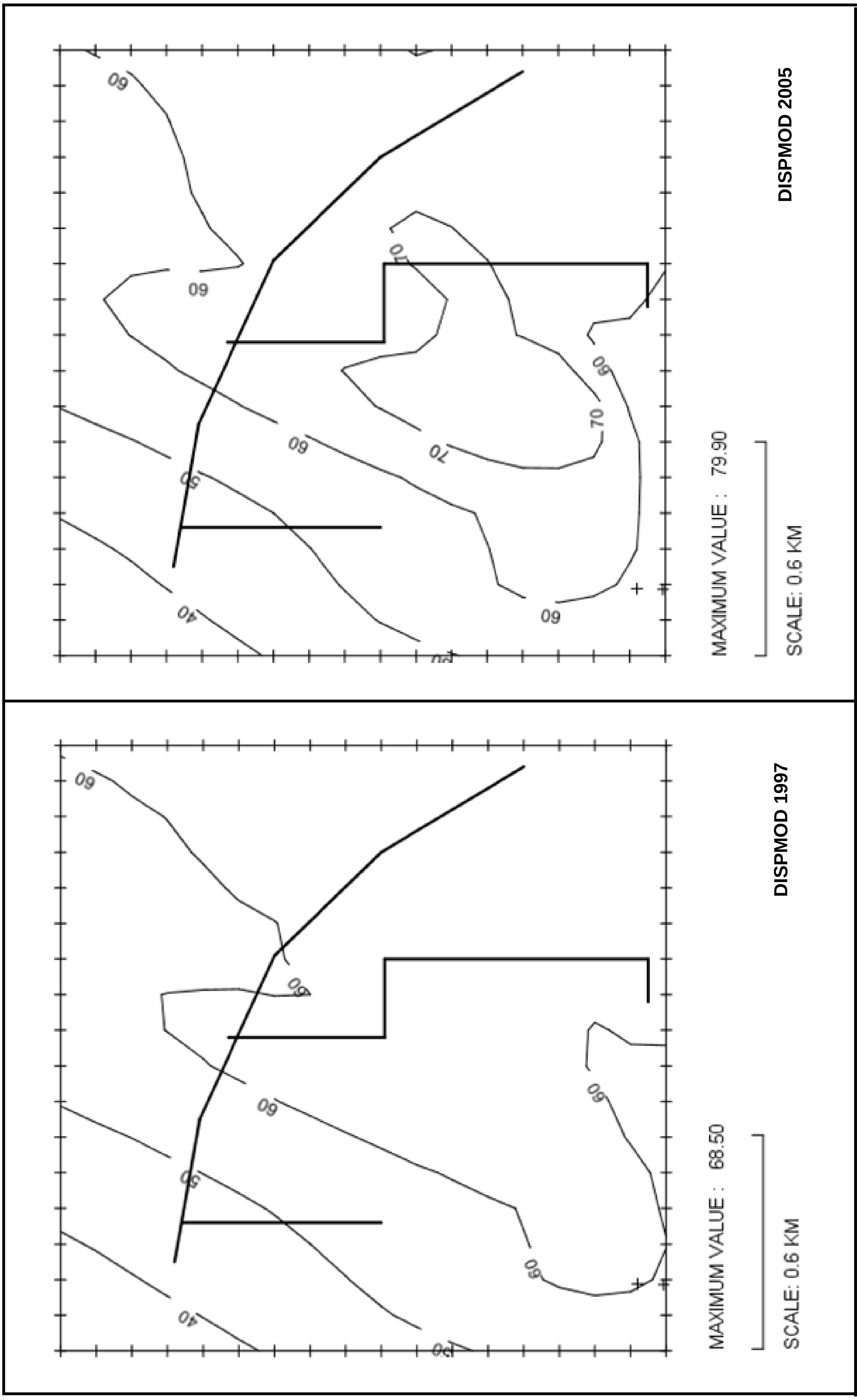


Figure 40. Maximum 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Northern Model Domain

(1996 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

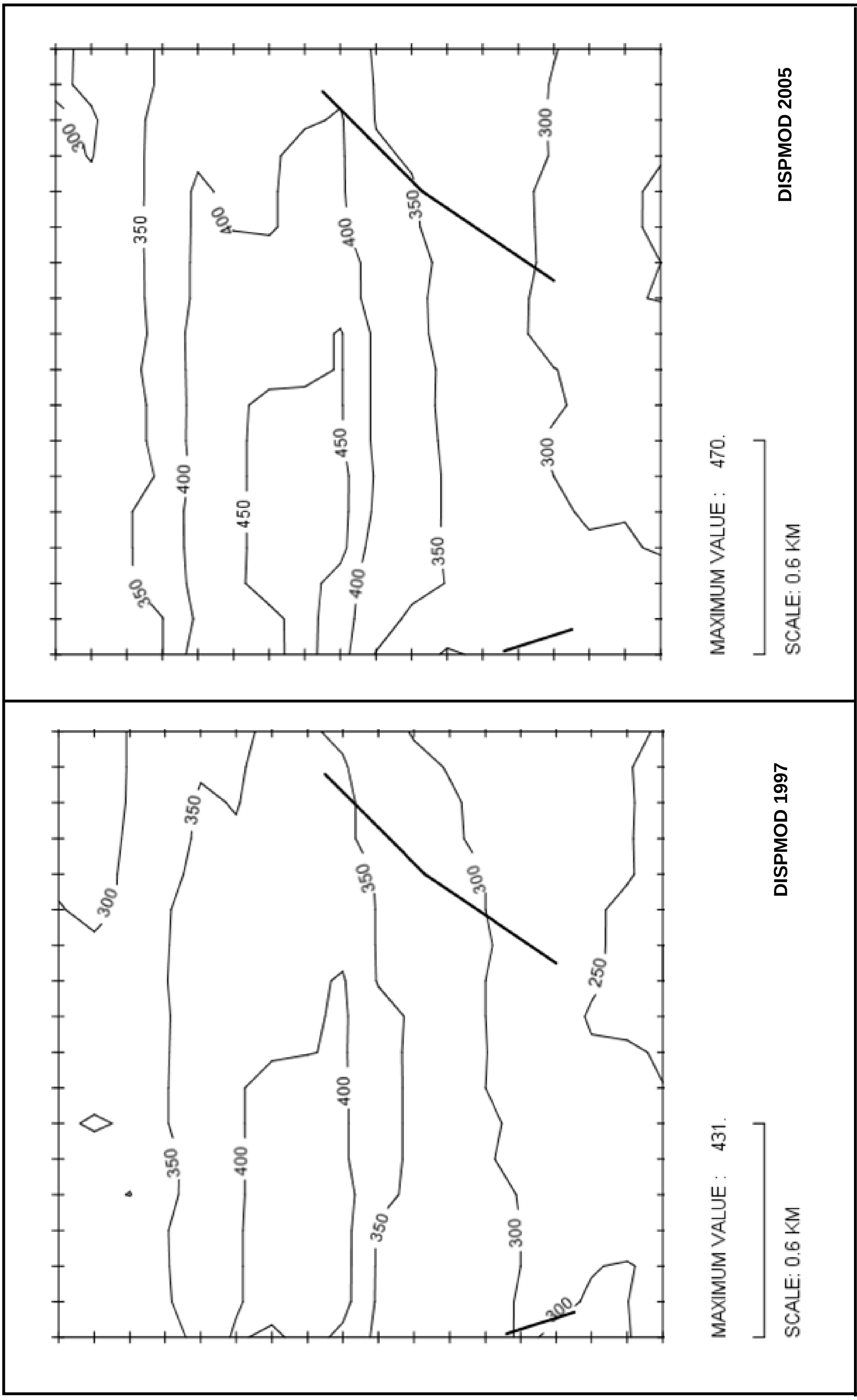


Figure 41. Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Eastern Model Domain

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

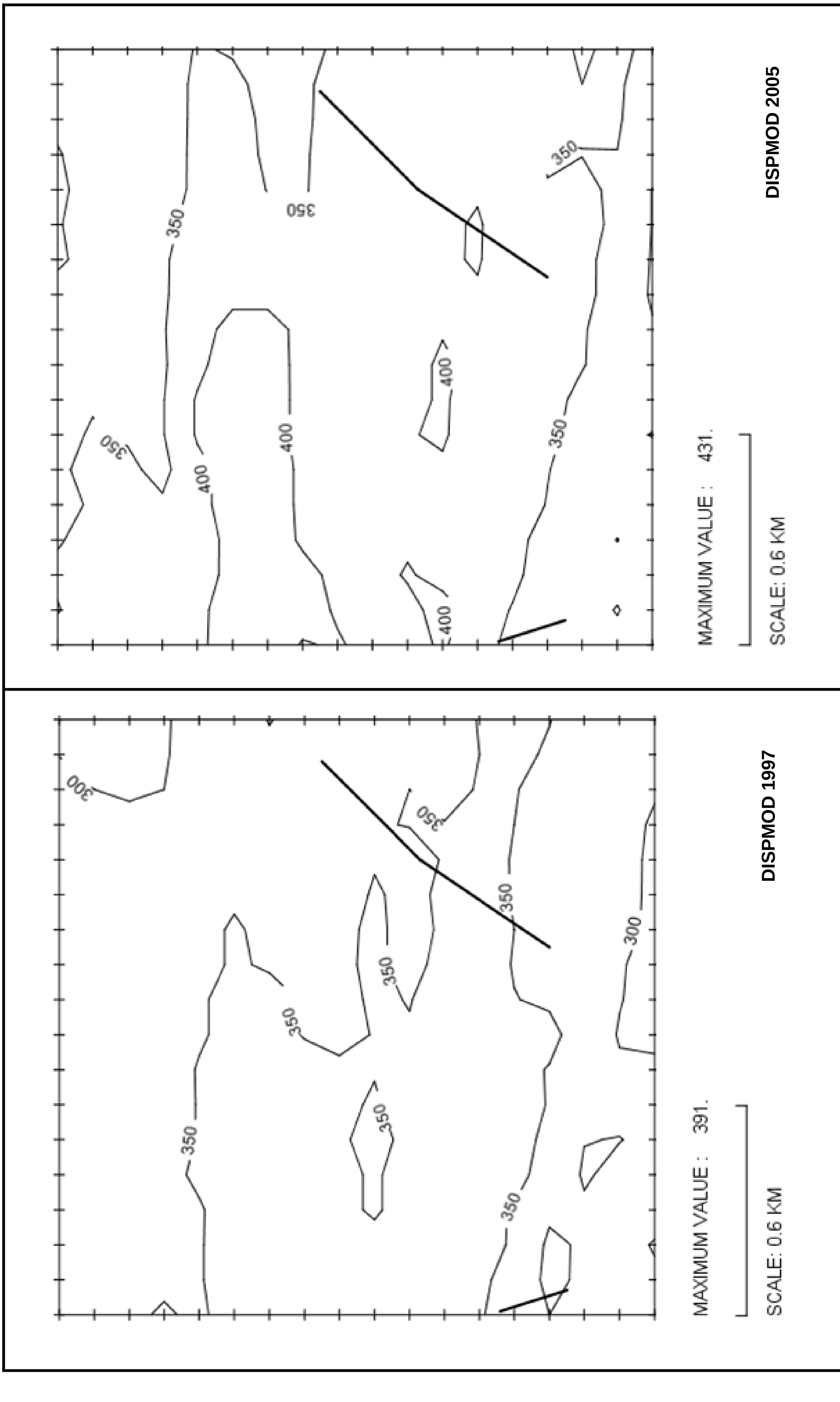


Figure 42. Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Eastern Model Domain

(1995 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

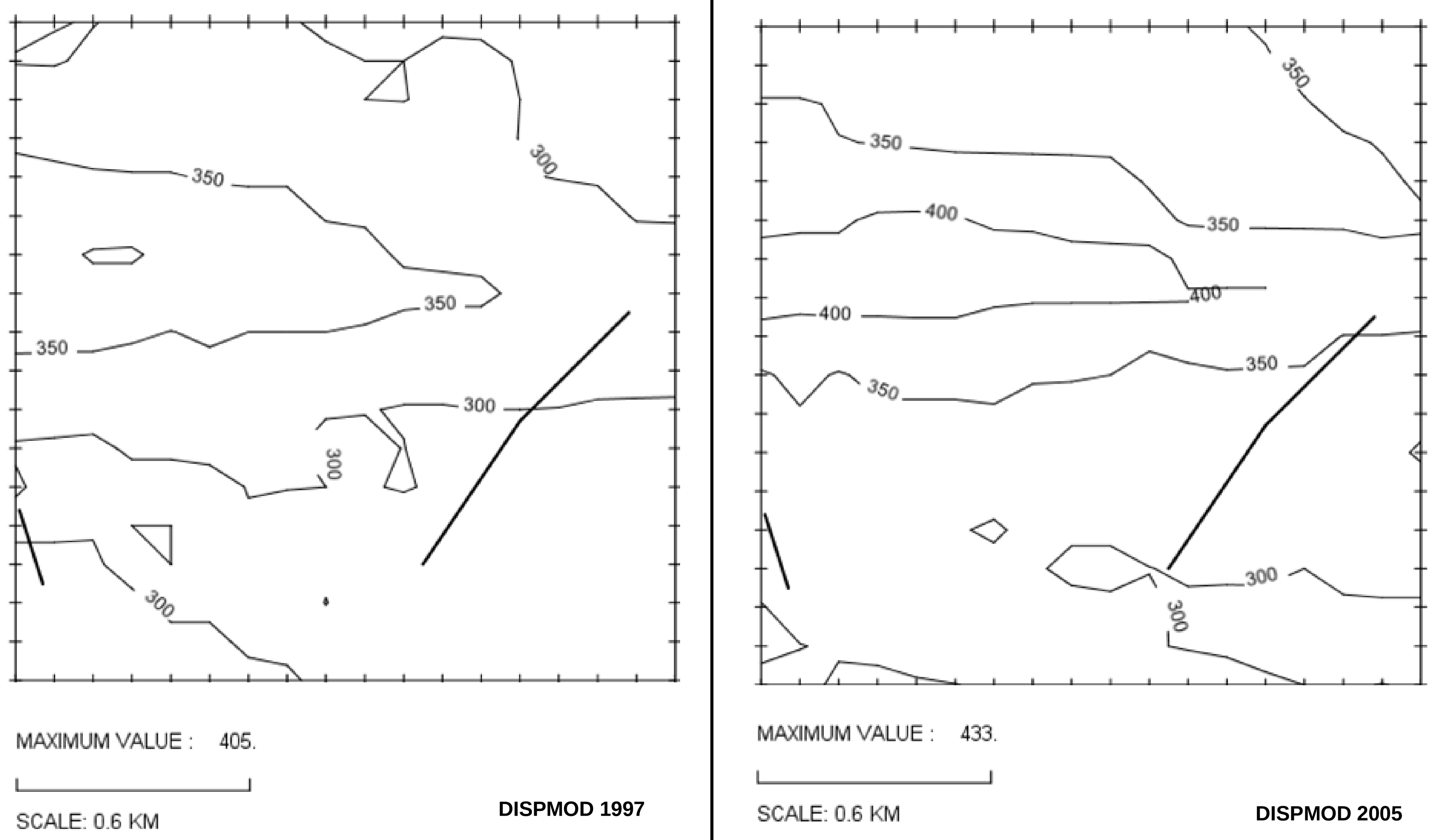


Figure 43. Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide (μg/m³) – Eastern Model Domain

(1996 meteorology)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

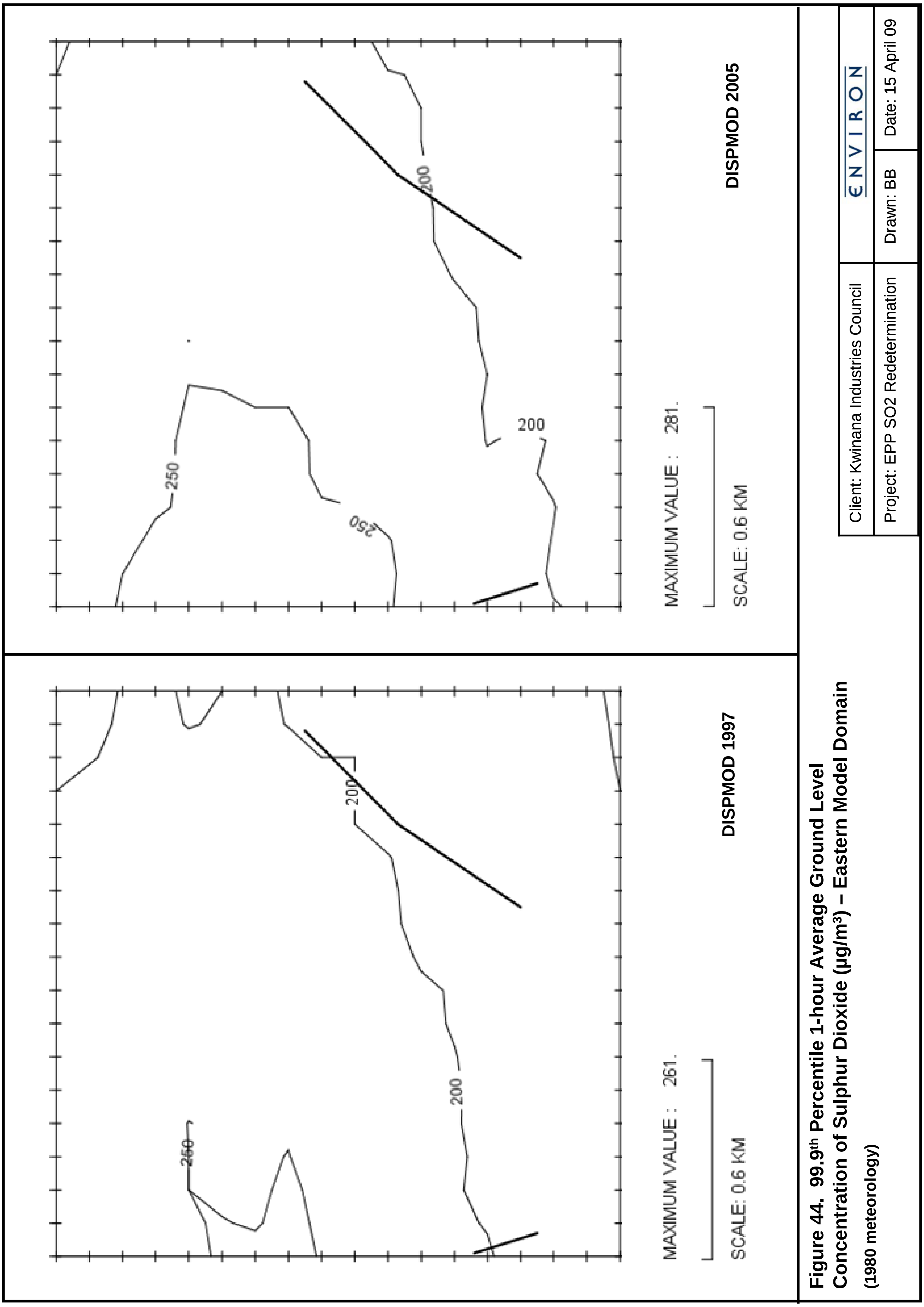


Figure 44. 99.9th Percentile 1-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Eastern Model Domain
(1980 meteorology)

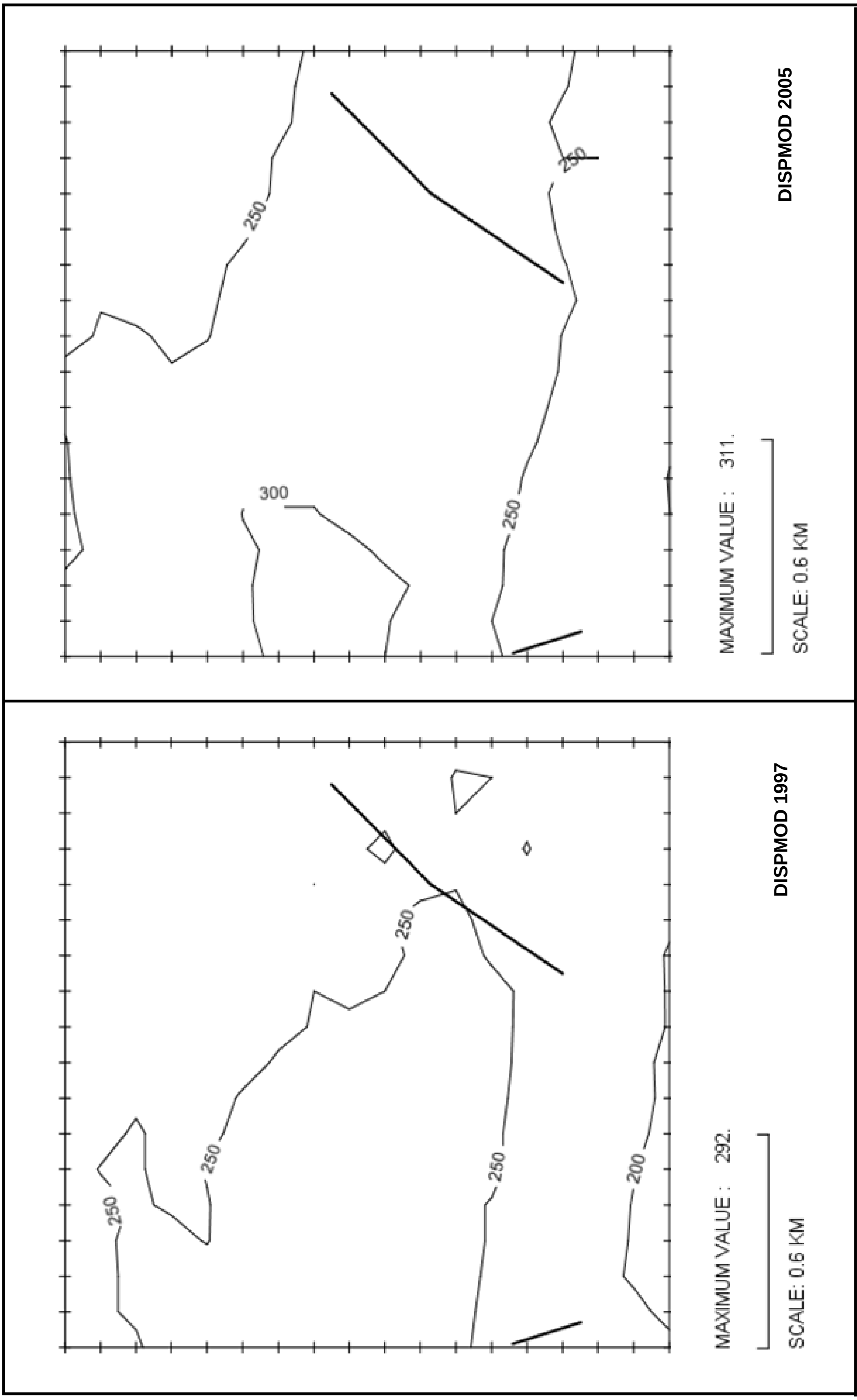


Figure 45. 99.9th Percentile 1-hour Average Ground Level Concentration of Sulphur Dioxide ($\mu g/m^3$) – Eastern Model Domain
(1995 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

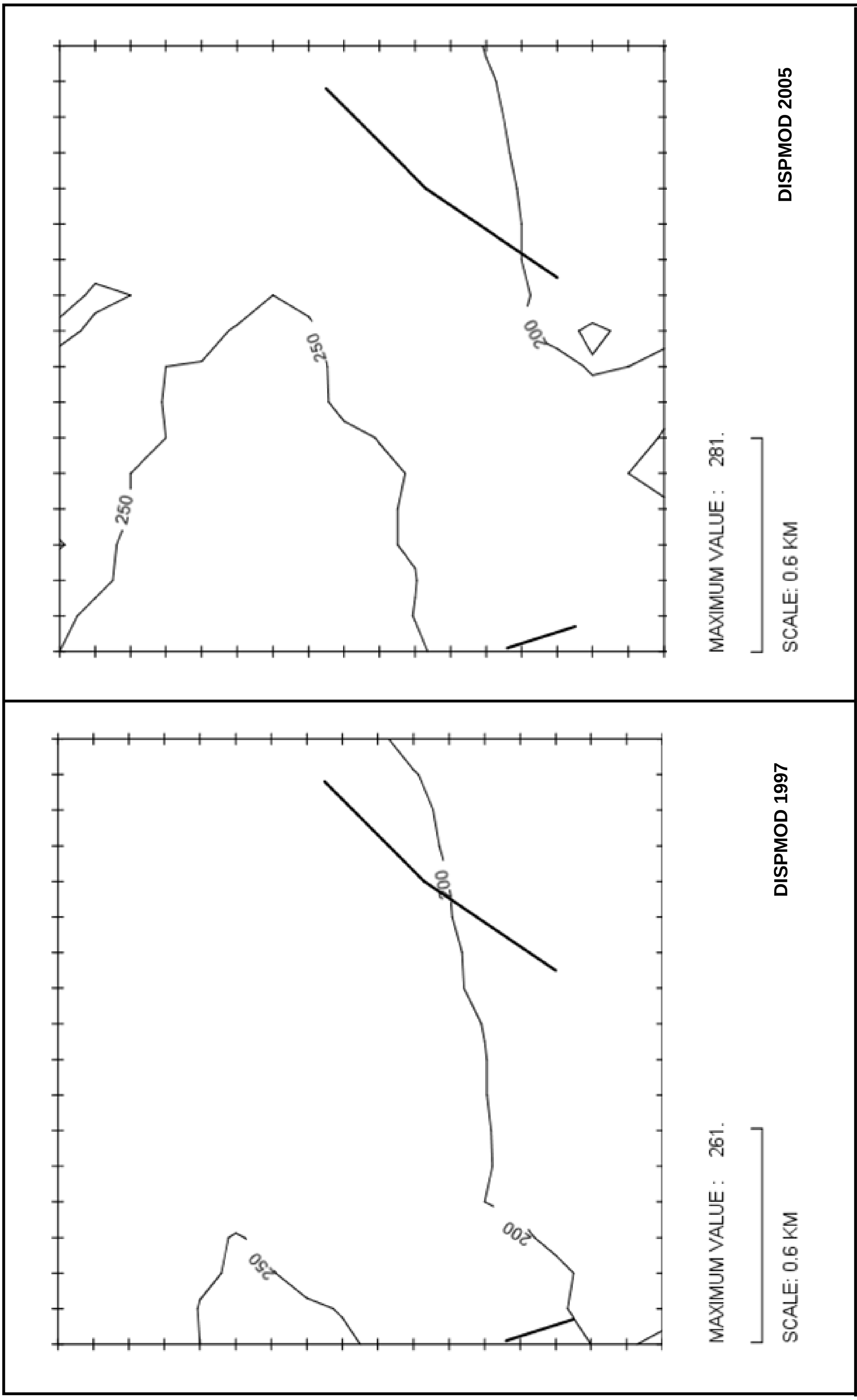


Figure 46. 99.9th Percentile 1-hour Average Ground Level Concentration of Sulphur Dioxide (μg/m³) – Eastern Model Domain

(1996 meteorology)

Client: Kwinana Industries Council	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

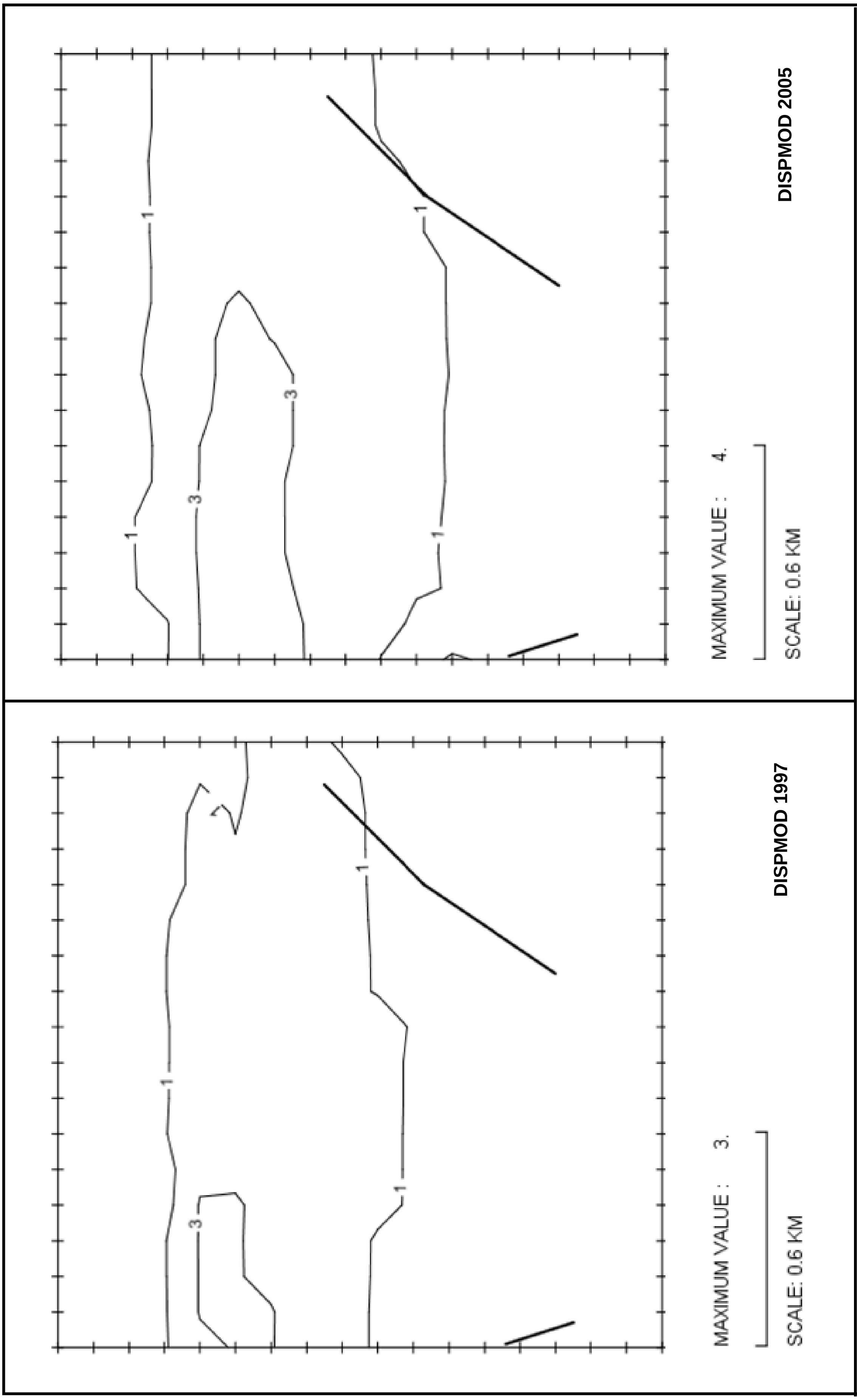


Figure 47. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 350 µg/m³ – Eastern Model Domain

(1980 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

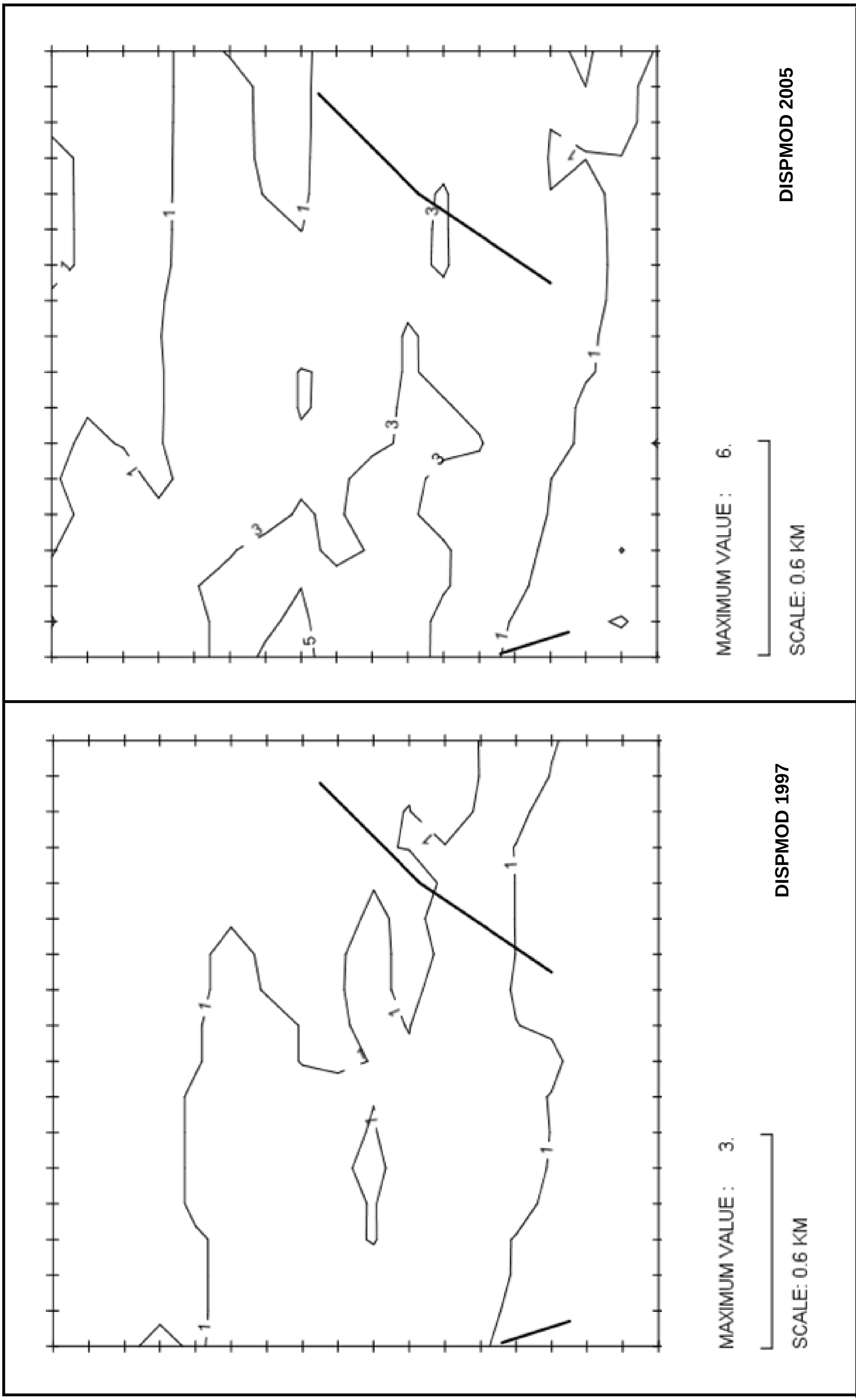


Figure 48. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 350 µg/m^3 – Eastern Model Domain

(1995 meteorology)

ENVIRON

Client: Kwinana Industries Council	
Project: EPP SO2 Redetermination	Drawn: BB
	Date: 15 April 09

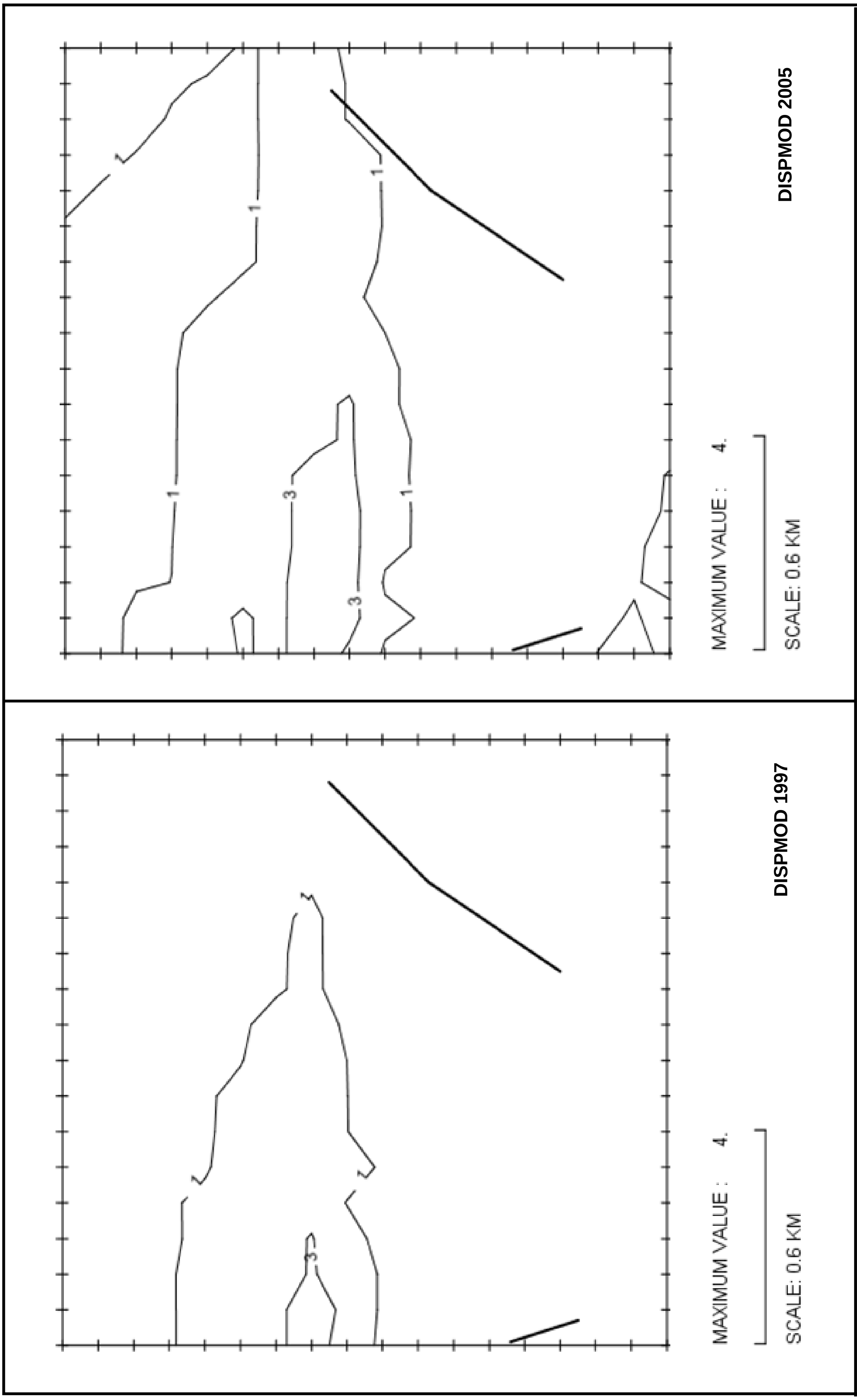


Figure 49. Number of Hours Maximum 1-hour Average Ground Level Concentration of Sulphur Dioxide Exceeds 350 µg/m³ – Eastern Model Domain

(1996 meteorology)

Client: Kwinana Industries Council	ENVIRON
Project: EPP SO2 Redetermination	Drawn: BB / Date: 15 April 09

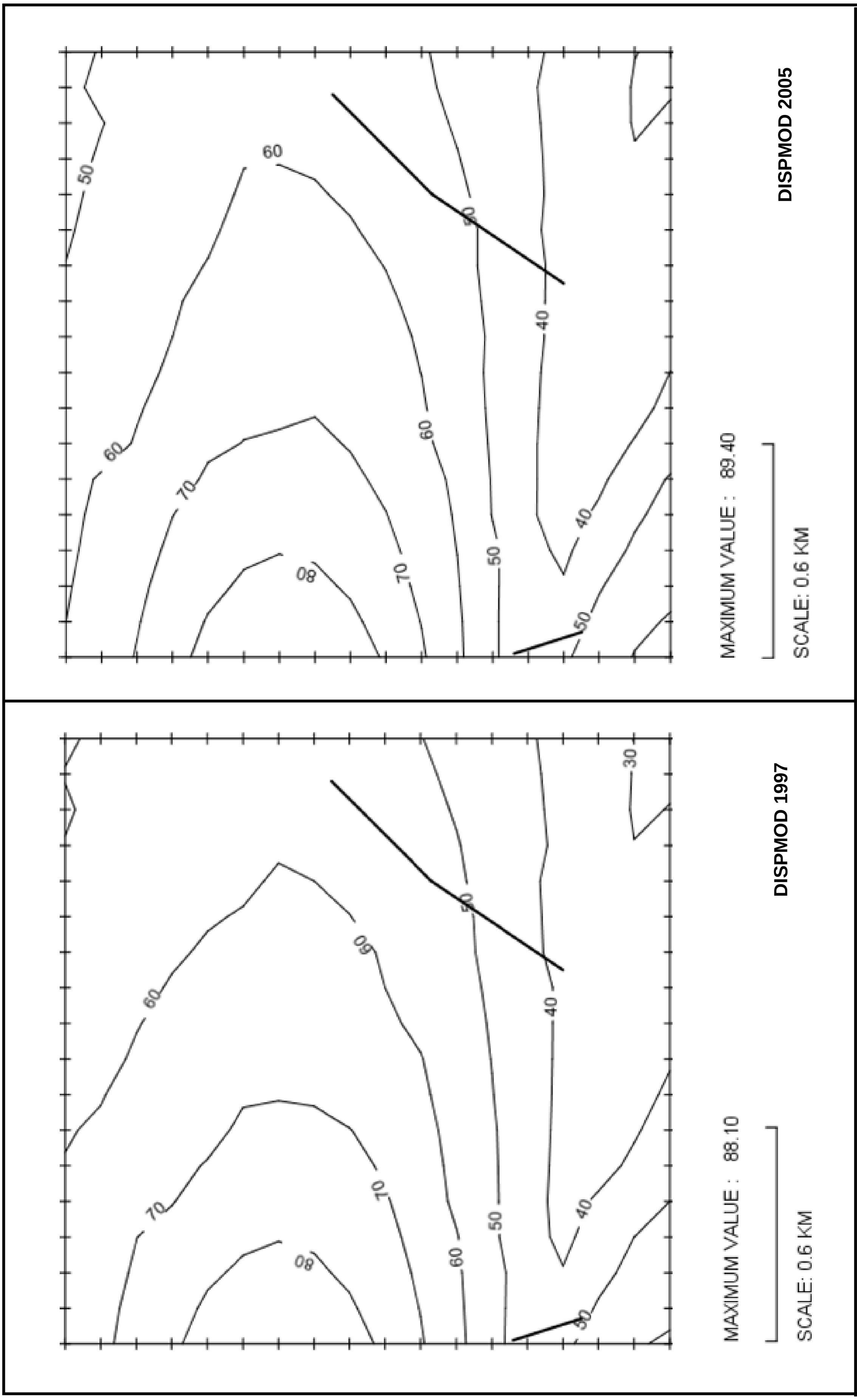


Figure 50. Maximum 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Eastern Model Domain

(1980 meteorology)

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

ENVIRON

Drawn: BB

Date: 15 April 09

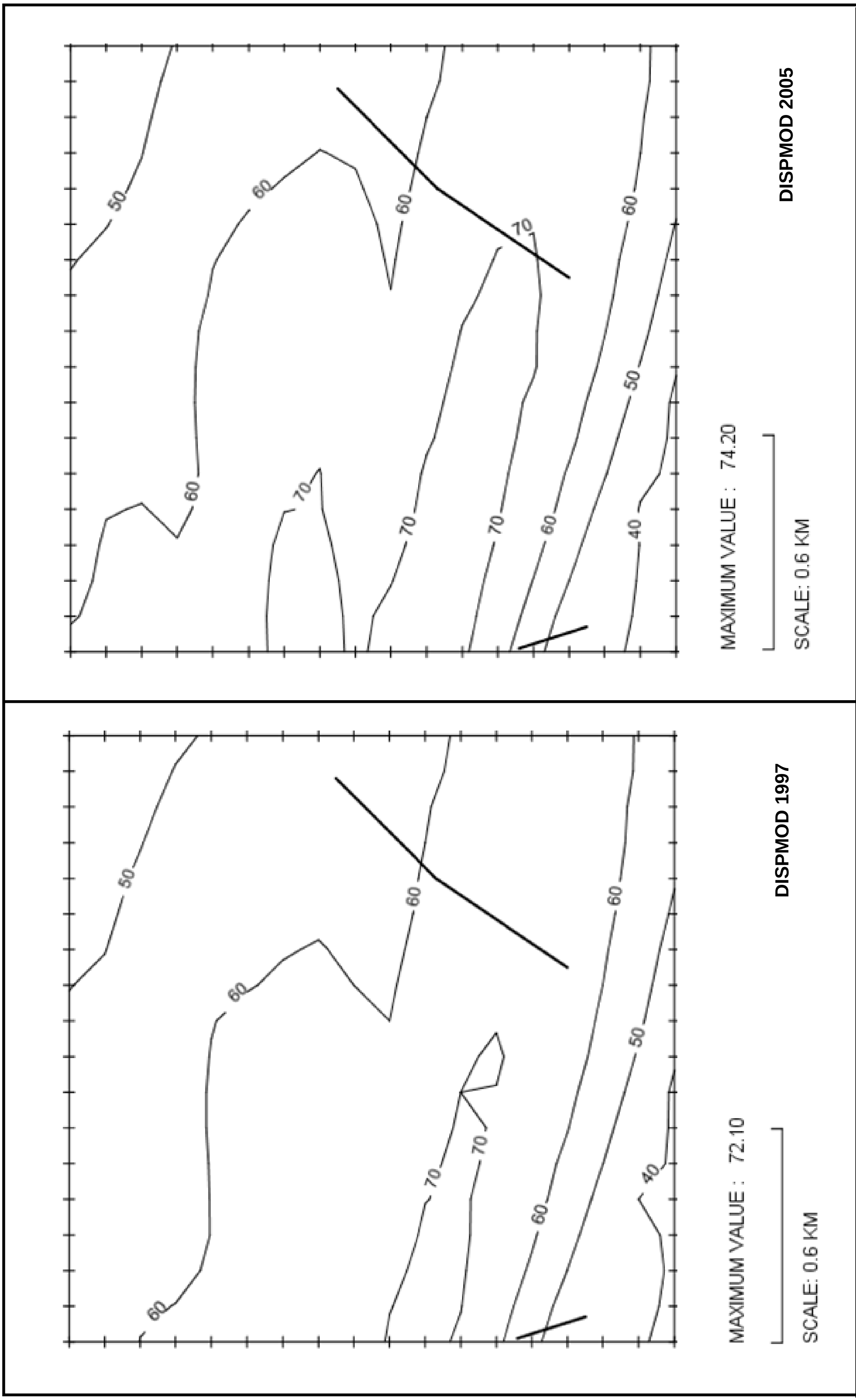


Figure 51. Maximum 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Eastern Model Domain

(1995 meteorology)

Client: Kwinana Industries Council	ENVIRON	
Project: EPP SO2 Redetermination	Drawn: BB	Date: 15 April 09

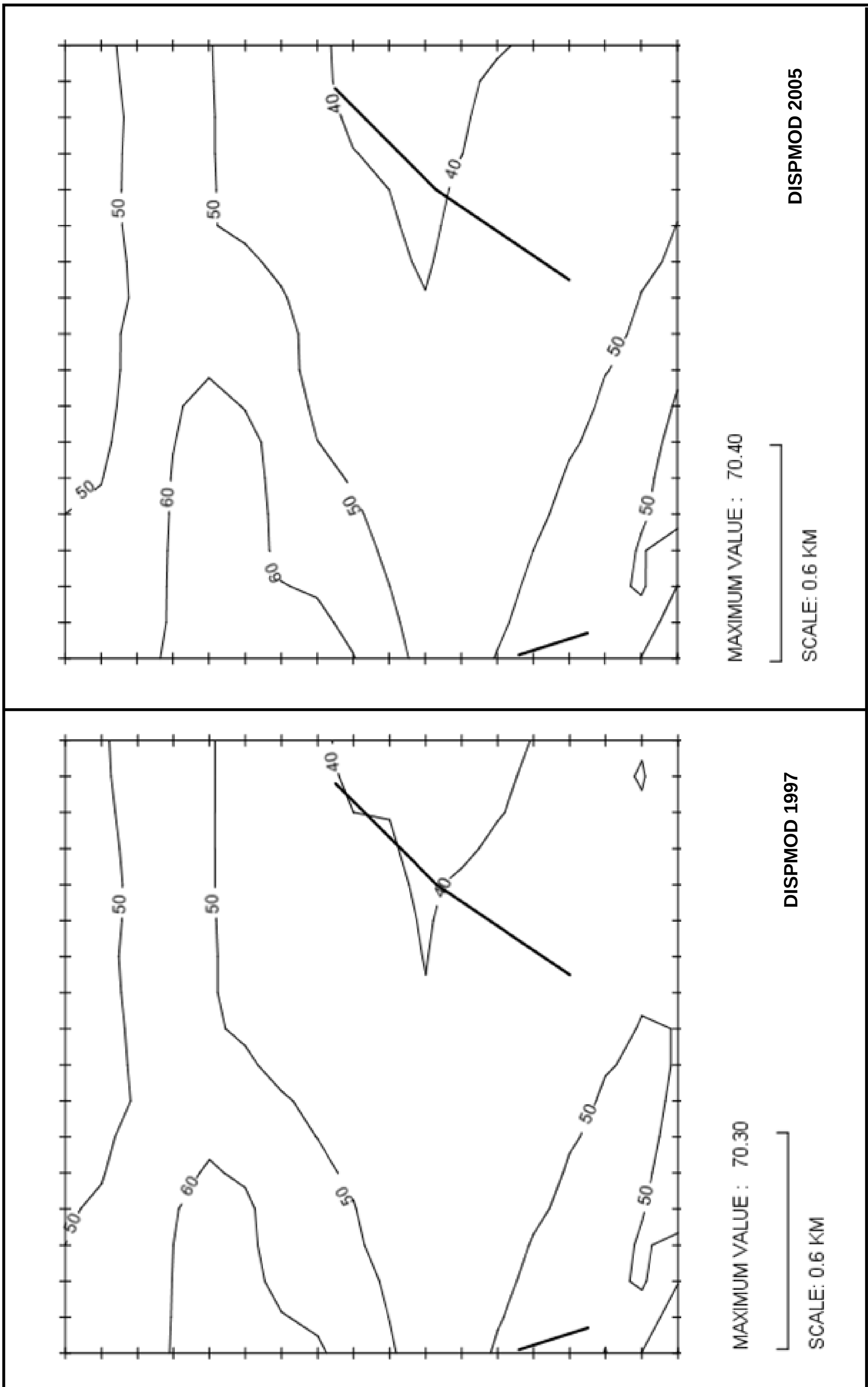


Figure 52. Maximum 24-hour Average Ground Level Concentration of Sulphur Dioxide (µg/m³) – Eastern Model Domain

(1996 meteorology)

Client: Kwinana Industries Council

Project: EPP SO2 Redetermination

ENVIRON

Drawn: BB

Date: 15 April 09

Appendix B Model input files

The files which follow are included in this report as a record of modelling input.

Sample Dispmod Control File

```
KWINANA EPP  - INDUSTRY PROPOSAL DM_R06
  385700. 6433050. 0100. 18 18 0.2833 -32.0 181.7 360.0   3.0  .083  .047  0.25
 01011980 31121980 0000 2400  3  1 77  1.9  2.3
 34 0.00 0350. 0500. 0700. 1000. 0   5000.
  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
  1  1  1  1  1  1  1  1  1  1  1  1
  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22
 23 24 25 26 27 28 29 30 31 32 33 34
  0         ! NUMBER OF STACKS THAT ARE NOT BEING USED
BP VDU 2       48.8 1.50 383170 6434130 0.79 18. 400
BP WEST 10     70.0 4.83 383409 6434491 1.00  0. 395
BP WEST 20     70.0 6.83 383409 6434491 1.00  0. 395
BP WEST 70     70.0 12.7 383409 6434491 1.00  0. 395
BP WEST 200    70.0 21.6 383409 6434491 1.00  0. 395
BP WEST 300    70.0 26.4 383409 6434491 1.00  0. 395
BP CRACKER     80.0 2.85 383185 6434040 1.00  0. 400
BP SRU 1       50.0 0.35 383170 6434300 1.00  0. 425
BP SRU 2       50.0 0.35 383200 6434300 1.00  0. 475
BP THEORETIC   59.2 2.27 383180 6433950 1.00  0. 400
CC KILN 1&2    61.2 2.26 386658 6442312 1.00  0.3000
CC KILN 3      61.6 2.15 386700 6442225 1.00  0.3000
CC KILN 4      80.8 2.15 386755 6442240 1.00  0.3000
CC KILN 5     112.8 2.00 386538 6442680 1.00  0.3000
CC KILN 6     115.5 2.44 386536 6442607 1.00  0.3000
TIWEST BYP 1   27.0 1.20 384280 6433200 1.00  0.1300
TIWEST BYP 2   27.0 1.20 384280 6433200 1.00  0.1300
TIWEST BYP 3   27.0 1.20 384280 6433200 1.00  0.1300
HRSG1A         30.0 3.28 383620 6434098 1.00  0. 800
HRSG1B         30.0 3.28 383568 6434090 1.00  0. 800
KNR SF 123     23.0 1.08 383539 6430718 1.00  0.1025
KNR H2S FLARE  41.5 0.30 383474 6430936 1.00  0. 960
KNR H2S SCRUB  68.7 0.14 383620 6430889 1.00  0.1105
ALC POWERHSE 1 68.6 1.96 384840 6437260 0.54 36. 500
ALC POWERHSE 2 71.6 1.96 384845 6437210 0.54 36. 500
ALC POWERHSE 3 99.7 1.98 384845 6437175 0.52 37. 500
ALC POWERHSE 4108.9 1.98 384845 6437140 0.51 37. 500
ALC CALCINER 1 49.9 3.05 384515 6437510 0.64 28. 250
ALC CALCINER 2 49.9 3.05 384505 6437510 0.64 28. 250
ALC CALCINER 3 37.7 3.05 384510 6437605 0.71 23. 250
SEC STAGE A   114.3 4.27 384425 6436810 1.00  0. 200
SEC STAGE B   137.2 4.27 384450 6436880 1.00  0. 200
SEC STAGE C   189.0 5.33 384390 6436670 1.00  0. 200
HISMELT        65.5 3.30 384100 6435050 1.00  0. 600
0

TITLE
(A)
XREF,YREF,GINT,NUMX,NUMY,DTSL,ALAT,CSTDIR,ZLSB,SGTHSB,SGPHSB,TIBPEN
(2F9.1,F6.1,2I3,F7.4,3F6.1,3F6.0)
IDS,IMS,IYS,IDF,IMF,IYF,IT1,IT2,IAV,IDATAV,IY1,CSIGON,CSIGOF
(2(1X,3I2),2I5,3I3,2F5.1)
**** NOTE - IAV    = MODEL TIME STEP IN MULTIPLES OF 10 MINUTES (EG. 3 = 30 MIN
                     TIMESTEP.
          - IDATAV = INPUT MET DATA AVERAGING TIME IN MULTIPLES OF 10 MINUTES
                     (EG. 3 = 30 MIN INPUT DATA)
**** NOTE - IAV CANNOT BE LESS THAN IDATAV AND IDATAV MUST BE GREATER THAN 0
NUMSCE,QMIN,ALEV1,ALEV2,ALEV3,ALEV4,I
(I3,F5.1,4F6.0,I2)
**** NOTE - POLPOT MODE IS NOW FOR MULTIPLE SOURCES WITH FIXED EMISSIONS.
READ IN THE NUMBER OF STACKS PER SOURCE GROUP
KSCE(I),I=1,NUMSCE
(22I3)
READ IN THE STACK NUMBERS IN THE ORDER OF USE (.IE SOURCE GROUPING)
(ISTNUM(I),I=1,ISTTOT
READ IN THE NUMBER OF STACKS NOT TO BE USED
NSNTUS
```

```
READ IN STACK INFORMATION DATA
C STKHGT - HEIGHT OF STACK
C STKDIA - DIAMETER OF STACK
C STKX   - LATITUDE OF STACK AMG COORDS
C STKY   - LONGITUDE OF STACK AMG COORDS
C TEMSL  - SLOPE OF THE TEMPERATURE LOSS EQUATION FOR STACK
C TEMIN  - INTERCEPT OF THE TEMPERATURE LOSS EQUATION FOR STACK
C TEMSL AND TEMIN ARE USED TO AMKE ALLOWANCE FOR THE TEMPERATURE LOSS OF
C            FLUE GASES IN THE STACK WHEN GAS TEMPERATURES ARE MEASURED AT
C            THE BASE OF THE STACK
C DCOAST - ARRAY DISTANCE (METRES) FROM THE COAST OF EACH SOURCE GROUP
C Q      - SOURCE STRENGTH (KG/S)
C STKVOL - SOURCE VOLUME (M**3/S) AT STACK TEMP (IE. GAS FLOW RATE)
C STKRHO - EMISSION DENSITY (KG/M**3) AT STACK TEMP
C IBUILD - BUILDING EFFECTS FOR THIS SOURCE (1=YES, 0=NO)
C HBSTK  - HEIGHT OF BUILDING
C WBSTK  - WIDTH OF BUILDING
STKHGT(K),STKDIA(K),STKX(K),STKY(K),DCOAST(K),Q(K),STKVOL(K),STKRHO(K),
IBUILD(K),HBSTK(K),WBSTK(K)
(14X,F5.1,F5.2,F7.0,F8.0,F5.2,F4.0,F6.0,3F8.0,I2,2F4.0)
*** NOTE- WITH BUILDING EFFECTS IT IS ASSUMED THAT THE LAST SOURCE IN THE
          SOURCE GROUP HAS THE BUILDING DIMENSIONS. THIS LAST SOURCE ALSO
          CONTAINS THE LOGICAL (IBUILD) WHICH DETERMINE WHETHER BUILDING
          EFFECTS ARE TO BE USED.
```

Sample Dispmod Response File

```
dispmod.ctl
z.out
y            ! plume spread in s.b. due to self gen turb?
y            ! use new PDF model for TIBL fumigation?
N            ! account for wind shear in TIBL PDF fumigation?
y            ! use numerical method to calculate TIBL height
95.              ! Tibl integration distance
y                ! use coastal AMG file
kwinana.coa
Y            ! use pdf for convective dispersion within TIBL & PBL?
N            ! account for wind shear within the TIBL?
N            ! use stability classes? - not with PDF
N            ! plume centreline mode?
4            ! option for lapse rate determination
Y            ! apply seasonal variation to lapse rates?
N            ! use measured sigma theta?
n                ! mixing into TIBL sharper than SGPHI?
y            ! if direction meander sigma greater, use it
n            ! info to screen on big timestep concs?
2            ! plume penetration: 1 ISC, 2 Manins, 3 Ausplume, 4 Aermod (Berkowicz)
n            ! include invers temp jump in pot temp lapse rate for pentration?
y                ! write all concs to disk for post-processing?
HVMET80_150503.DAT
pmkwin.dat
dm62Z3.emi
w_veer.dat
```

Dispmod emissions file (nominal emissions for 1-hour modelling)

```
RUN06 INDUSTRY PROPOSAL - AVERAGE EMISSION RATES OF ALL CASES
Name                  Q        V      Rho   Nd   Nh Int
BP VDU 2          .0248      7.5     .700             1
BP WEST 10        .0050     10.0     .600             1
BP WEST 20        .0100     20.0     .600             1
BP WEST 70        .1800     70.0     .600             1
BP WEST 200       .2800    200.0     .600             1
BP WEST 300       .8600    300.0     .600             1
BP CRACKER        .2000     90.0     .590             1
BP SRU 1          .0293      4.8     .390             1
BP SRU 2          .0371      5.1     .390             1
BP THEORETIC      .1403    16.78     .700             1
CC KILN 1&2       .0240     29.6     .640             1
CC KILN 3         .0350     77.8     .740             1
CC KILN 4         .0350     93.5     .730             1
CC KILN 5         .0120    116.0     .710             1
CC KILN 6        .00044    113.7     .910             1
TIWEST BYP 1      .005       5.9     .347             1
TIWEST BYP 2      .0850     28.5     .347             1
TIWEST BYP 3      .1550     49.1     .347             1
HRSG1A            .0100    173.7     .827             1
HRSG1B            .0100    173.7     .827             1
KNR SF 123        .0020      6.9     .500             1
KNR H2S PLANT     .0070      1.4     .280             1
KNR H2S SCRUB     .0095      0.3     .280             1
ALC POWERHSE 1  .00050      55.1     .735             1
ALC POWERHSE 2  .00055      56.8     .767             1
ALC POWERHSE 3  .00055      65.8     .735             1
ALC POWERHSE 4  .00055      66.2     .731             1
ALC CALCINER 1  .00167      58.1     .614             1
ALC CALCINER 2  .00167      66.8     .614             1
ALC CALCINER 3  .00167      73.9     .614             1
SEC STAGE A       .3400    356.0     .823             0
SEC STAGE B       .0000    354.0     .805             0
SEC STAGE C       .3500    374.0     .840             0
HISMELT           .0350    130.0    1.070             0
```

Probabilistic emissions file for post-processing 1-hour modelled concentrations

```
Run_06 Emissions for industry upset cases

columns are Q (kg/s), V(m**3/s), rho(kg/m**3)

No. industries  8


Industry No.  3  No. cases  10  No. stacks 10

Case 1 Normal 200-300  probability 0.56929
BP VDU 2         .00490      7.5     .700   1
BP WEST 10       .00000     10.0     .600   1
BP WEST 20       .01000     20.0     .600   1
BP WEST 70       .00000     70.0     .600   1
BP WEST 200      .00000    200.0     .600   1
BP WEST 300      .00000    300.0     .600   1
BP CRACKER       .21500     90.0     .590   1
BP SRU 1         .03040      4.8     .390   1
BP SRU 2         .03710      5.1     .390   1
```

```
BP THEORETIC     .00260    16.8    .700   1

Case 2  Normal 150-200 probability 0.20000
BP VDU 2         .00330     7.5    .700   1
BP WEST 10       .00500    10.0    .600   1
BP WEST 20       .00000    20.0    .600   1
BP WEST 70       .00000    70.0    .600   1
BP WEST 200      .00000   200.0    .600   1
BP WEST 300      .00000   300.0    .600   1
BP CRACKER       .14000    90.0    .590   1
BP SRU 1         .02250     4.8    .390   1
BP SRU 2         .02750     5.1    .390   1
BP THEORETIC     .00180    16.8    .700   1

Case 3  RCU&SRU SD     probability 0.10959
BP VDU 2         .01300     7.5    .700   1
BP WEST 10       .00000    10.0    .600   1
BP WEST 20       .00000    20.0    .600   1
BP WEST 70       .00000    70.0    .600   1
BP WEST 200      .28000   200.0    .600   1
BP WEST 300      .00000   300.0    .600   1
BP CRACKER       .00000    90.0    .590   1
BP SRU 1         .00000     4.8    .390   1
BP SRU 2         .00000     5.1    .390   1
BP THEORETIC     .00700    16.8    .700   1

Case 4  Normal <150    probability 0.10000
BP VDU 2         .00330     7.5    .700   1
BP WEST 10       .00500    10.0    .600   1
BP WEST 20       .00000    20.0    .600   1
BP WEST 70       .00000    70.0    .600   1
BP WEST 200      .00000   200.0    .600   1
BP WEST 300      .00000   300.0    .600   1
BP CRACKER       .10000    90.0    .590   1
BP SRU 1         .01800     4.8    .390   1
BP SRU 2         .02200     5.1    .390   1
BP THEORETIC     .00180    16.8    .700   1

Case 5  High RCU feed  probability 0.00936
BP VDU 2         .00330     7.5    .700   1
BP WEST 10       .00000    10.0    .600   1
BP WEST 20       .01000    20.0    .600   1
BP WEST 70       .00000    70.0    .600   1
BP WEST 200      .00000   200.0    .600   1
BP WEST 300      .00000   300.0    .600   1
BP CRACKER       .25000    90.0    .590   1
BP SRU 1         .03825     4.8    .390   1
BP SRU 2         .04675     5.1    .390   1
BP THEORETIC     .00180    16.8    .700   1

Case 6  Flare/Low feed probability 0.00342
BP VDU 2         .00330     7.5    .700   1
BP WEST 10       .00000    10.0    .600   1
BP WEST 20       .00000    20.0    .600   1
BP WEST 70       .18000    70.0    .600   1
BP WEST 200      .00000   200.0    .600   1
BP WEST 300      .00000   300.0    .600   1
BP CRACKER       .10000    90.0    .590   1
BP SRU 1         .02925     4.8    .390   1
BP SRU 2         .03575     5.1    .390   1
BP THEORETIC     .00180    16.8    .700   1
```

Case 7 Flar/High feed probability 0.00285

BP VDU 2	.00330	7.5	.700	1
BP WEST 10	.00000	10.0	.600	1
BP WEST 20	.00000	20.0	.600	1
BP WEST 70	.13000	70.0	.600	1
BP WEST 200	.00000	200.0	.600	1
BP WEST 300	.00000	300.0	.600	1
BP CRACKER	.20000	90.0	.590	1
BP SRU 1	.02925	4.8	.390	1
BP SRU 2	.03575	5.1	.390	1
BP THEORETIC	.00180	16.8	.700	1

Case 8 SRUtp/low feed probability 0.00263

BP VDU 2	.00330	7.5	.700	1
BP WEST 10	.00000	10.0	.600	1
BP WEST 20	.00000	20.0	.600	1
BP WEST 70	.00000	70.0	.600	1
BP WEST 200	.00000	200.0	.600	1
BP WEST 300	.86000	300.0	.600	1
BP CRACKER	.10000	90.0	.590	1
BP SRU 1	.01575	4.8	.390	1
BP SRU 2	.01925	5.1	.390	1
BP THEORETIC	.00180	16.8	.700	1

Case 9 SRUtp/Highfeed probability 0.00228

BP VDU 2	.00330	7.5	.700	1
BP WEST 10	.00000	10.0	.600	1
BP WEST 20	.00000	20.0	.600	1
BP WEST 70	.00000	70.0	.600	1
BP WEST 200	.00000	200.0	.600	1
BP WEST 300	.73000	300.0	.600	1
BP CRACKER	.20000	90.0	.590	1
BP SRU 1	.02925	4.8	.390	1
BP SRU 2	.03575	5.1	.390	1
BP THEORETIC	.00180	16.8	.700	1

Case 10 Furnace upset probability 0.00057

BP VDU 2	.02480	7.5	.700	1
BP WEST 10	.00500	10.0	.600	1
BP WEST 20	.00000	20.0	.600	1
BP WEST 70	.00000	70.0	.600	1
BP WEST 200	.00000	200.0	.600	1
BP WEST 300	.00000	300.0	.600	1
BP CRACKER	.16000	90.0	.590	1
BP SRU 1	.03150	4.8	.390	1
BP SRU 2	.03850	5.1	.390	1
BP THEORETIC	.14030	16.8	.700	1

Industry No. 8 No. cases 4 No. stacks 5

Case 1 normal probability 0.50000

CC KILN 1&2	.00675	29.6	.640	1
CC KILN 3	.00987	77.8	.740	1
CC KILN 4	.00987	93.5	.730	1
CC KILN 5	.00339	116.0	.710	1
CC KILN 6	.00012	113.7	.910	1

Case 2 normal 1 probability 0.40000

CC KILN 1&2	.01800	29.6	.640	1

```
CC KILN 3       .02632    77.8    .740   1
CC KILN 4       .02632    93.5    .730   1
CC KILN 5       .00904   116.0    .710   1
CC KILN 6       .00032   113.7    .910   1

Case 3  Upset 1         probability 0.09000
CC KILN 1&2     .06800    29.6    .640   1
CC KILN 3       .02632    77.8    .740   1
CC KILN 4       .02632    93.5    .730   1
CC KILN 5       .00904   116.0    .710   1
CC KILN 6       .00032   113.7    .910   1

Case 4  Upset 2         probability 0.01000
CC KILN 1&2     .11800    29.6    .640   1
CC KILN 3       .02632    77.8    .740   1
CC KILN 4       .02632    93.5    .730   1
CC KILN 5       .00904   116.0    .710   1
CC KILN 6       .00032   113.7    .910   1


Industry No.  4  No. cases   3  No. stacks  3

Case 1  normal          probability 0.80000
TIWEST BYP 1     .005      5.9    .347   1
TIWEST BYP 2     .0000    28.5    .347   1
TIWEST BYP 3     .0000    49.1    .347   1

Case 2                  probability 0.18000
TIWEST BYP 1     .0000     5.9    .347   1
TIWEST BYP 2     .0850    28.5    .347   1
TIWEST BYP 3     .0000    49.1    .347   1

Case 3                  probability 0.02000
TIWEST BYP 1     .0000     5.9    .347   1
TIWEST BYP 2     .0000    28.5    .347   1
TIWEST BYP 3     .1550    49.1    .347   1


Industry No.  9  No. cases   2  No. stacks  2

Case 1  normal          probability 0.99000
HRSG1A           .0100   173.7    .827   1
HRSG1B           .0100   173.7    .827   1

Case 2                  probability 0.01000
HRSG1A           .0250   173.7    .827   1
HRSG1B           .0250   173.7    .827   1


Industry No.  6  No. cases   3  No. stacks  3

Case 1  normal          probability 0.98500
KNR SF 123       .0020     6.9    .500   1
KNR H2S PLANT    .0000     1.4    .280   1
KNR H2S SCRUB    .0000     0.3    .280   1

Case 2  scrubber upset probability 0.01200
KNR SF 123       .0020     6.9    .500   1
KNR H2S FLARE    .0000     1.4    .280   1
KNR H2S SCRUB    .0095     0.3    .280   1
```

```
Case 3  plant upset     probability 0.00300
KNR SF 123       .0020     6.9    .500   1
KNR H2S FLARE    .0070     1.4    .280   1
KNR H2S SCRUB    .0000     0.3    .280   1


Industry No.  2  No. cases   3  No. stacks  7

Case 1  normal          probability 0.50000
ALC POWERHSE 1  .00055    55.1    .735   1
ALC POWERHSE 2  .00055    56.8    .767   1
ALC POWERHSE 3  .00055    65.8    .735   1
ALC POWERHSE 4  .00055    66.2    .731   1
ALC CALCINER 1  .00067    58.1    .614   1
ALC CALCINER 2  .00067    66.8    .614   1
ALC CALCINER 3  .00067    73.9    .614   1

Case 2  oil test        probability 0.40000
ALC POWERHSE 1  .00055    55.1    .735   1
ALC POWERHSE 2  .00055    56.8    .767   1
ALC POWERHSE 3  .00055    65.8    .735   1
ALC POWERHSE 4  .00055    66.2    .731   1
ALC CALCINER 1  .00167    58.1    .614   1
ALC CALCINER 2  .00167    66.8    .614   1
ALC CALCINER 3  .00167    73.9    .614   1

Case 3  gas outage      probability 0.10000
ALC POWERHSE 1  .00055    55.1    .735   1
ALC POWERHSE 2  .00055    56.8    .767   1
ALC POWERHSE 3  .00055    65.8    .735   1
ALC POWERHSE 4  .00055    66.2    .731   1
ALC CALCINER 1  .00467    58.1    .614   1
ALC CALCINER 2  .00467    66.8    .614   1
ALC CALCINER 3  .00467    73.9    .614   1



Industry No.  1  No. cases   1  No. stacks  3

Case 1  normal          probability 1.00000
SEC STAGE 1      .3400    356.    .823   0
SEC STAGE 2      .0000    354.    .805   0
SEC STAGE 3      .3500    374.    .840   0


Industry No.  5  No. cases   1  No. stacks  1

Case 1  normal          probability 1.00000
HISMELT          .0350    130.    1.07   0
```

Dispmod emissions file for modelling 24-hour average concentrations

```
RUN06 INDUSTRY PROPOSAL - AVERAGE EMISSION RATES OF ALL CASES
Name                Q       V     Rho  Nd  Nh Int
BP VDU 2         .0049    7.5    .700          0
BP WEST 10       .0000   10.0    .600          0
BP WEST 20       .0100   20.0    .600          0
BP WEST 70       .0000   70.0    .600          0
BP WEST 200      .0000  200.0    .600          0
BP WEST 300      .0000  300.0    .600          0
BP CRACKER       .2150   90.0    .590          0
BP SRU 1         .0304    4.8    .390          0
BP SRU 2         .0371    5.1    .390          0
BP THEORETIC     .0026  16.78    .700          0
CC KILN 1&2     .01800   29.6    .640          0
CC KILN 3       .02632   77.8    .740          0
CC KILN 4       .02632   93.5    .730          0
CC KILN 5       .00904  116.0    .710          0
CC KILN 6       .00032  113.7    .910          0
TIWEST BYP 1     .005     5.9    .347          0
TIWEST BYP 2     .0000   28.5    .347          0
TIWEST BYP 3     .0000   49.1    .347          0
HRSG1A           .0100  173.7    .827          0
HRSG1B           .0100  173.7    .827          0
KNR SF 123       .0020    6.9    .500          0
KNR H2S PLANT    .0000    1.4    .280          0
KNR H2S SCRUB    .0000    0.3    .280          0
ALC POWERHSE 1  .00050   55.1    .735          0
ALC POWERHSE 2  .00055   56.8    .767          0
ALC POWERHSE 3  .00055   65.8    .735          0
ALC POWERHSE 4  .00055   66.2    .731          0
ALC CALCINER 1  .00167   58.1    .614          0
ALC CALCINER 2  .00167   66.8    .614          0
ALC CALCINER 3  .00167   73.9    .614          0
SEC STAGE A      .3400  356.0    .823          0
SEC STAGE B      .0000  354.0    .805          0
SEC STAGE C      .3500  374.0    .840          0
HISMELT          .0350  130.0   1.070          0
```

Sample Dispmod Control File

```
KWINANA EPP  - INDUSTRY PROPOSAL DM_R06
  385700. 6433050. 0100. 18 18 0.2833 -32.0 181.7 360.0   3.0  .083  .047  0.25
 01011980 31121980 0000 2400  3  1 77  1.9  2.3
 34 0.00 0350. 0500. 0700. 1000. 0   5000.
  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
  1  1  1  1  1  1  1  1  1  1  1  1
  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22
 23 24 25 26 27 28 29 30 31 32 33 34
  0         ! NUMBER OF STACKS THAT ARE NOT BEING USED
BP VDU 2       48.8 1.50 383170 6434130 0.79 18. 400
BP WEST 10     70.0 4.83 383409 6434491 1.00  0. 395
BP WEST 20     70.0 6.83 383409 6434491 1.00  0. 395
BP WEST 70     70.0 12.7 383409 6434491 1.00  0. 395
BP WEST 200    70.0 21.6 383409 6434491 1.00  0. 395
BP WEST 300    70.0 26.4 383409 6434491 1.00  0. 395
BP CRACKER     80.0 2.85 383185 6434040 1.00  0. 400
BP SRU 1       50.0 0.35 383170 6434300 1.00  0. 425
BP SRU 2       50.0 0.35 383200 6434300 1.00  0. 475
BP THEORETIC   59.2 2.27 383180 6433950 1.00  0. 400
CC KILN 1&2    61.2 2.26 386658 6442312 1.00  0.3000
CC KILN 3      61.6 2.15 386700 6442225 1.00  0.3000
CC KILN 4      80.8 2.15 386755 6442240 1.00  0.3000
CC KILN 5     112.8 2.00 386538 6442680 1.00  0.3000
CC KILN 6     115.5 2.44 386536 6442607 1.00  0.3000
TIWEST BYP 1   27.0 1.20 384280 6433200 1.00  0.1300
TIWEST BYP 2   27.0 1.20 384280 6433200 1.00  0.1300
TIWEST BYP 3   27.0 1.20 384280 6433200 1.00  0.1300
HRSG1A         30.0 3.28 383620 6434098 1.00  0. 800
HRSG1B         30.0 3.28 383568 6434090 1.00  0. 800
KNR SF 123     23.0 1.08 383539 6430718 1.00  0.1025
KNR H2S FLARE  41.5 0.30 383474 6430936 1.00  0. 960
KNR H2S SCRUB  68.7 0.14 383620 6430889 1.00  0.1105
ALC POWERHSE 1 68.6 1.96 384840 6437260 0.54 36. 500
ALC POWERHSE 2 71.6 1.96 384845 6437210 0.54 36. 500
ALC POWERHSE 3 99.7 1.98 384845 6437175 0.52 37. 500
ALC POWERHSE 4108.9 1.98 384845 6437140 0.51 37. 500
ALC CALCINER 1 49.9 3.05 384515 6437510 0.64 28. 250
ALC CALCINER 2 49.9 3.05 384505 6437510 0.64 28. 250
ALC CALCINER 3 37.7 3.05 384510 6437605 0.71 23. 250
SEC STAGE A   114.3 4.27 384425 6436810 1.00  0. 200
SEC STAGE B   137.2 4.27 384450 6436880 1.00  0. 200
SEC STAGE C   189.0 5.33 384390 6436670 1.00  0. 200
HISMELT        65.5 3.30 384100 6435050 1.00  0. 600
0

TITLE
(A)
XREF,YREF,GINT,NUMX,NUMY,DTSL,ALAT,CSTDIR,ZLSB,SGTHSB,SGPHSB,TIBPEN
(2F9.1,F6.1,2I3,F7.4,3F6.1,3F6.0)
IDS,IMS,IYS,IDF,IMF,IYF,IT1,IT2,IAV,IDATAV,IY1,CSIGON,CSIGOF
(2(1X,3I2),2I5,3I3,2F5.1)
**** NOTE - IAV    = MODEL TIME STEP IN MULTIPLES OF 10 MINUTES (EG. 3 = 30 MIN
                     TIMESTEP.
          - IDATAV = INPUT MET DATA AVERAGING TIME IN MULTIPLES OF 10 MINUTES
                     (EG. 3 = 30 MIN INPUT DATA)
**** NOTE - IAV CANNOT BE LESS THAN IDATAV AND IDATAV MUST BE GREATER THAN 0
NUMSCE,QMIN,ALEV1,ALEV2,ALEV3,ALEV4,I
(I3,F5.1,4F6.0,I2)
**** NOTE - POLPOT MODE IS NOW FOR MULTIPLE SOURCES WITH FIXED EMISSIONS.
READ IN THE NUMBER OF STACKS PER SOURCE GROUP
KSCE(I),I=1,NUMSCE
(22I3)
READ IN THE STACK NUMBERS IN THE ORDER OF USE (.IE SOURCE GROUPING)
(ISTNUM(I),I=1,ISTTOT
READ IN THE NUMBER OF STACKS NOT TO BE USED
NSNTUS
READ IN STACK INFORMATION DATA
C STKHGT - HEIGHT OF STACK
C STKDIA - DIAMETER OF STACK
C STKX   - LATITUDE OF STACK AMG COORDS
C STKY   - LONGITUDE OF STACK AMG COORDS
C TEMSL  - SLOPE OF THE TEMPERATURE LOSS EQUATION FOR STACK
```

```
C TEMIN  - INTERCEPT OF THE TEMPERATURE LOSS EQUATION FOR STACK
C TEMSL AND TEMIN ARE USED TO AMKE ALLOWANCE FOR THE TEMPERATURE LOSS OF
C            FLUE GASES IN THE STACK WHEN GAS TEMPERATURES ARE MEASURED AT
C            THE BASE OF THE STACK
C DCOAST - ARRAY DISTANCE (METRES) FROM THE COAST OF EACH SOURCE GROUP
C Q      - SOURCE STRENGTH (KG/S)
C STKVOL - SOURCE VOLUME (M**3/S) AT STACK TEMP (IE. GAS FLOW RATE)
C STKRHO - EMISSION DENSITY (KG/M**3) AT STACK TEMP
C IBUILD - BUILDING EFFECTS FOR THIS SOURCE (1=YES, 0=NO)
C HBSTK  - HEIGHT OF BUILDING
C WBSTK  - WIDTH OF BUILDING
STKHGT(K),STKDIA(K),STKX(K),STKY(K),DCOAST(K),Q(K),STKVOL(K),STKRHO(K),
IBUILD(K),HBSTK(K),WBSTK(K)
(14X,F5.1,F5.2,F7.0,F8.0,F5.2,F4.0,F6.0,3F8.0,I2,2F4.0)
*** NOTE- WITH BUILDING EFFECTS IT IS ASSUMED THAT THE LAST SOURCE IN THE
          SOURCE GROUP HAS THE BUILDING DIMENSIONS. THIS LAST SOURCE ALSO
          CONTAINS THE LOGICAL (IBUILD) WHICH DETERMINE WHETHER BUILDING
          EFFECTS ARE TO BE USED.
```

Sample Dispmod Response File

```
dispmod.ctl
z.out
y           ! plume spread in s.b. due to self gen turb?
y           ! use new PDF model for TIBL fumigation?
N           ! account for wind shear in TIBL PDF fumigation?
y           ! use numerical method to calculate TIBL height
95.             ! Tibl integration distance
y               ! use coastal AMG file
kwinana.coa
Y           ! use pdf for convective dispersion within TIBL & PBL?
N           ! account for wind shear within the TIBL?
N           ! use stability classes? - not with PDF
N           ! plume centreline mode?
4           ! option for lapse rate determination
Y           ! apply seasonal variation to lapse rates?
N           ! use measured sigma theta?
n               ! mixing into TIBL sharper than SGPHI?
y           ! if direction meander sigma greater, use it
n           ! info to screen on big timestep concs?
2           ! plume penetration: 1 ISC, 2 Manins, 3 Ausplume, 4 Aermod (Berkowicz)
n           ! include invers temp jump in pot temp lapse rate for pentration?
y               ! write all concs to disk for post-processing?
HVMET80_150503.DAT
pmkwin.dat
dm62Z3.emi
w_veer.dat
```

Dispmod emissions file (nominal emissions for 1-hour modelling)

RUN06 INDUSTRY PROPOSAL - AVERAGE EMISSION RATES OF ALL CASES

Name	Q	V	Rho	Nd	Nh	Int
BP VDU 2	.0248	7.5	.700			1
BP WEST 10	.0050	10.0	.600			1
BP WEST 20	.0100	20.0	.600			1
BP WEST 70	.1800	70.0	.600			1
BP WEST 200	.2800	200.0	.600			1
BP WEST 300	.8600	300.0	.600			1
BP CRACKER	.2000	90.0	.590			1
BP SRU 1	.0293	4.8	.390			1
BP SRU 2	.0371	5.1	.390			1
BP THEORETIC	.1403	16.78	.700			1
CC KILN 1&2	.0240	29.6	.640			1
CC KILN 3	.0350	77.8	.740			1
CC KILN 4	.0350	93.5	.730			1
CC KILN 5	.0120	116.0	.710			1
CC KILN 6	.00044	113.7	.910			1
TIWEST BYP 1	.005	5.9	.347			1
TIWEST BYP 2	.0850	28.5	.347			1
TIWEST BYP 3	.1550	49.1	.347			1
HRSG1A	.0100	173.7	.827			1
HRSG1B	.0100	173.7	.827			1
KNR SF 123	.0020	6.9	.500			1
KNR H2S PLANT	.0070	1.4	.280			1
KNR H2S SCRUB	.0095	0.3	.280			1
ALC POWERHSE 1	.00050	55.1	.735			1
ALC POWERHSE 2	.00055	56.8	.767			1
ALC POWERHSE 3	.00055	65.8	.735			1
ALC POWERHSE 4	.00055	66.2	.731			1
ALC CALCINER 1	.00167	58.1	.614			1
ALC CALCINER 2	.00167	66.8	.614			1
ALC CALCINER 3	.00167	73.9	.614			1
SEC STAGE A	.3400	356.0	.823			0
SEC STAGE B	.0000	354.0	.805			0
SEC STAGE C	.3500	374.0	.840			0
HISMELT	.0350	130.0	1.070			0

Probabilistic emissions file for post-processing 1-hour modelled concentrations

```
Run_06 Emissions for industry upset cases

columns are Q (kg/s), V(m**3/s), rho(kg/m**3)

No. industries  8


Industry No.  3  No. cases  10  No. stacks 10

Case 1 Normal 200-300  probability 0.56929
BP VDU 2         .00490     7.5    .700   1
BP WEST 10       .00000    10.0    .600   1
BP WEST 20       .01000    20.0    .600   1
BP WEST 70       .00000    70.0    .600   1
BP WEST 200      .00000   200.0    .600   1
BP WEST 300      .00000   300.0    .600   1
BP CRACKER       .21500    90.0    .590   1
BP SRU 1         .03040     4.8    .390   1
BP SRU 2         .03710     5.1    .390   1
BP THEORETIC     .00260    16.8    .700   1

Case 2  Normal 150-200 probability 0.20000
BP VDU 2         .00330     7.5    .700   1
BP WEST 10       .00500    10.0    .600   1
BP WEST 20       .00000    20.0    .600   1
BP WEST 70       .00000    70.0    .600   1
BP WEST 200      .00000   200.0    .600   1
BP WEST 300      .00000   300.0    .600   1
BP CRACKER       .14000    90.0    .590   1
BP SRU 1         .02250     4.8    .390   1
BP SRU 2         .02750     5.1    .390   1
BP THEORETIC     .00180    16.8    .700   1

Case 3  RCU&SRU SD     probability 0.10959
BP VDU 2         .01300     7.5    .700   1
BP WEST 10       .00000    10.0    .600   1
BP WEST 20       .00000    20.0    .600   1
BP WEST 70       .00000    70.0    .600   1
BP WEST 200      .28000   200.0    .600   1
BP WEST 300      .00000   300.0    .600   1
BP CRACKER       .00000    90.0    .590   1
BP SRU 1         .00000     4.8    .390   1
BP SRU 2         .00000     5.1    .390   1
BP THEORETIC     .00700    16.8    .700   1

Case 4  Normal <150    probability 0.10000
BP VDU 2         .00330     7.5    .700   1
BP WEST 10       .00500    10.0    .600   1
BP WEST 20       .00000    20.0    .600   1
BP WEST 70       .00000    70.0    .600   1
BP WEST 200      .00000   200.0    .600   1
BP WEST 300      .00000   300.0    .600   1
BP CRACKER       .10000    90.0    .590   1
BP SRU 1         .01800     4.8    .390   1
BP SRU 2         .02200     5.1    .390   1
BP THEORETIC     .00180    16.8    .700   1

Case 5  High RCU feed  probability 0.00936
BP VDU 2         .00330     7.5    .700   1
```

```
BP WEST 10      .00000    10.0    .600   1
BP WEST 20      .01000    20.0    .600   1
BP WEST 70      .00000    70.0    .600   1
BP WEST 200     .00000   200.0    .600   1
BP WEST 300     .00000   300.0    .600   1
BP CRACKER      .25000    90.0    .590   1
BP SRU 1        .03825     4.8    .390   1
BP SRU 2        .04675     5.1    .390   1
BP THEORETIC    .00180    16.8    .700   1

Case 6  Flare/Low feed probability 0.00342
BP VDU 2        .00330     7.5    .700   1
BP WEST 10      .00000    10.0    .600   1
BP WEST 20      .00000    20.0    .600   1
BP WEST 70      .18000    70.0    .600   1
BP WEST 200     .00000   200.0    .600   1
BP WEST 300     .00000   300.0    .600   1
BP CRACKER      .10000    90.0    .590   1
BP SRU 1        .02925     4.8    .390   1
BP SRU 2        .03575     5.1    .390   1
BP THEORETIC    .00180    16.8    .700   1

Case 7  Flar/High feed probability 0.00285
BP VDU 2        .00330     7.5    .700   1
BP WEST 10      .00000    10.0    .600   1
BP WEST 20      .00000    20.0    .600   1
BP WEST 70      .13000    70.0    .600   1
BP WEST 200     .00000   200.0    .600   1
BP WEST 300     .00000   300.0    .600   1
BP CRACKER      .20000    90.0    .590   1
BP SRU 1        .02925     4.8    .390   1
BP SRU 2        .03575     5.1    .390   1
BP THEORETIC    .00180    16.8    .700   1

Case 8  SRUtp/low feed probability 0.00263
BP VDU 2        .00330     7.5    .700   1
BP WEST 10      .00000    10.0    .600   1
BP WEST 20      .00000    20.0    .600   1
BP WEST 70      .00000    70.0    .600   1
BP WEST 200     .00000   200.0    .600   1
BP WEST 300     .86000   300.0    .600   1
BP CRACKER      .10000    90.0    .590   1
BP SRU 1        .01575     4.8    .390   1
BP SRU 2        .01925     5.1    .390   1
BP THEORETIC    .00180    16.8    .700   1

Case 9  SRUtp/Highfeed probability 0.00228
BP VDU 2        .00330     7.5    .700   1
BP WEST 10      .00000    10.0    .600   1
BP WEST 20      .00000    20.0    .600   1
BP WEST 70      .00000    70.0    .600   1
BP WEST 200     .00000   200.0    .600   1
BP WEST 300     .73000   300.0    .600   1
BP CRACKER      .20000    90.0    .590   1
BP SRU 1        .02925     4.8    .390   1
BP SRU 2        .03575     5.1    .390   1
BP THEORETIC    .00180    16.8    .700   1

Case 10 Furnace upset  probability 0.00057
BP VDU 2        .02480     7.5    .700   1
BP WEST 10      .00500    10.0    .600   1
```

```
BP WEST 20      .00000    20.0    .600   1
BP WEST 70      .00000    70.0    .600   1
BP WEST 200     .00000   200.0    .600   1
BP WEST 300     .00000   300.0    .600   1
BP CRACKER      .16000    90.0    .590   1
BP SRU 1        .03150     4.8    .390   1
BP SRU 2        .03850     5.1    .390   1
BP THEORETIC    .14030    16.8    .700   1


Industry No.  8  No. cases   4  No. stacks  5

Case 1  normal         probability 0.50000
CC KILN 1&2     .00675    29.6    .640   1
CC KILN 3       .00987    77.8    .740   1
CC KILN 4       .00987    93.5    .730   1
CC KILN 5       .00339   116.0    .710   1
CC KILN 6       .00012   113.7    .910   1

Case 2  normal 1       probability 0.40000
CC KILN 1&2     .01800    29.6    .640   1
CC KILN 3       .02632    77.8    .740   1
CC KILN 4       .02632    93.5    .730   1
CC KILN 5       .00904   116.0    .710   1
CC KILN 6       .00032   113.7    .910   1

Case 3  Upset 1        probability 0.09000
CC KILN 1&2     .06800    29.6    .640   1
CC KILN 3       .02632    77.8    .740   1
CC KILN 4       .02632    93.5    .730   1
CC KILN 5       .00904   116.0    .710   1
CC KILN 6       .00032   113.7    .910   1

Case 4  Upset 2        probability 0.01000
CC KILN 1&2     .11800    29.6    .640   1
CC KILN 3       .02632    77.8    .740   1
CC KILN 4       .02632    93.5    .730   1
CC KILN 5       .00904   116.0    .710   1
CC KILN 6       .00032   113.7    .910   1


Industry No.  4  No. cases   3  No. stacks  3

Case 1  normal         probability 0.80000
TIWEST BYP 1     .005      5.9    .347   1
TIWEST BYP 2     .0000    28.5    .347   1
TIWEST BYP 3     .0000    49.1    .347   1

Case 2                 probability 0.18000
TIWEST BYP 1     .0000     5.9    .347   1
TIWEST BYP 2     .0850    28.5    .347   1
TIWEST BYP 3     .0000    49.1    .347   1

Case 3                 probability 0.02000
TIWEST BYP 1     .0000     5.9    .347   1
TIWEST BYP 2     .0000    28.5    .347   1
TIWEST BYP 3     .1550    49.1    .347   1


Industry No.  9  No. cases   2  No. stacks  2
```

```
Case 1  normal          probability 0.99000
HRSG1A           .0100   173.7    .827   1
HRSG1B           .0100   173.7    .827   1

Case 2                  probability 0.01000
HRSG1A           .0250   173.7    .827   1
HRSG1B           .0250   173.7    .827   1


Industry No.  6  No. cases   3  No. stacks  3

Case 1  normal          probability 0.98500
KNR SF 123       .0020     6.9    .500   1
KNR H2S PLANT    .0000     1.4    .280   1
KNR H2S SCRUB    .0000     0.3    .280   1

Case 2  scrubber upset probability 0.01200
KNR SF 123       .0020     6.9    .500   1
KNR H2S FLARE    .0000     1.4    .280   1
KNR H2S SCRUB    .0095     0.3    .280   1

Case 3  plant upset     probability 0.00300
KNR SF 123       .0020     6.9    .500   1
KNR H2S FLARE    .0070     1.4    .280   1
KNR H2S SCRUB    .0000     0.3    .280   1


Industry No.  2  No. cases   3  No. stacks  7

Case 1  normal          probability 0.50000
ALC POWERHSE 1  .00055    55.1    .735   1
ALC POWERHSE 2  .00055    56.8    .767   1
ALC POWERHSE 3  .00055    65.8    .735   1
ALC POWERHSE 4  .00055    66.2    .731   1
ALC CALCINER 1  .00067    58.1    .614   1
ALC CALCINER 2  .00067    66.8    .614   1
ALC CALCINER 3  .00067    73.9    .614   1

Case 2  oil test        probability 0.40000
ALC POWERHSE 1  .00055    55.1    .735   1
ALC POWERHSE 2  .00055    56.8    .767   1
ALC POWERHSE 3  .00055    65.8    .735   1
ALC POWERHSE 4  .00055    66.2    .731   1
ALC CALCINER 1  .00167    58.1    .614   1
ALC CALCINER 2  .00167    66.8    .614   1
ALC CALCINER 3  .00167    73.9    .614   1

Case 3  gas outage      probability 0.10000
ALC POWERHSE 1  .00055    55.1    .735   1
ALC POWERHSE 2  .00055    56.8    .767   1
ALC POWERHSE 3  .00055    65.8    .735   1
ALC POWERHSE 4  .00055    66.2    .731   1
ALC CALCINER 1  .00467    58.1    .614   1
ALC CALCINER 2  .00467    66.8    .614   1
ALC CALCINER 3  .00467    73.9    .614   1


Industry No.  1  No. cases   1  No. stacks  3

Case 1  normal          probability 1.00000
SEC STAGE 1      .3400    356.    .823   0
```

```
SEC STAGE 2       .0000    354.    .805   0
SEC STAGE 3       .3500    374.    .840   0


Industry No.  5  No. cases   1  No. stacks  1

Case 1  normal         probability 1.00000
HISMELT           .0350    130.    1.07   0
```

Dispmod emissions file for modelling 24-hour average concentrations

```
RUN06 INDUSTRY PROPOSAL - AVERAGE EMISSION RATES OF ALL CASES
Name                  Q        V      Rho  Nd  Nh Int
BP VDU 2          .0049      7.5     .700            0
BP WEST 10        .0000     10.0     .600            0
BP WEST 20        .0100     20.0     .600            0
BP WEST 70        .0000     70.0     .600            0
BP WEST 200       .0000    200.0     .600            0
BP WEST 300       .0000    300.0     .600            0
BP CRACKER        .2150     90.0     .590            0
BP SRU 1          .0304      4.8     .390            0
BP SRU 2          .0371      5.1     .390            0
BP THEORETIC      .0026    16.78     .700            0
CC KILN 1&2      .01800     29.6     .640            0
CC KILN 3        .02632     77.8     .740            0
CC KILN 4        .02632     93.5     .730            0
CC KILN 5        .00904    116.0     .710            0
CC KILN 6        .00032    113.7     .910            0
TIWEST BYP 1      .005       5.9     .347            0
TIWEST BYP 2      .0000     28.5     .347            0
TIWEST BYP 3      .0000     49.1     .347            0
HRSG1A            .0100    173.7     .827            0
HRSG1B            .0100    173.7     .827            0
KNR SF 123        .0020      6.9     .500            0
KNR H2S PLANT     .0000      1.4     .280            0
KNR H2S SCRUB     .0000      0.3     .280            0
ALC POWERHSE 1  .00050      55.1     .735            0
ALC POWERHSE 2  .00055      56.8     .767            0
ALC POWERHSE 3  .00055      65.8     .735            0
ALC POWERHSE 4  .00055      66.2     .731            0
ALC CALCINER 1  .00167      58.1     .614            0
ALC CALCINER 2  .00167      66.8     .614            0
ALC CALCINER 3  .00167      73.9     .614            0
SEC STAGE A       .3400    356.0     .823            0
SEC STAGE B       .0000    354.0     .805            0
SEC STAGE C       .3500    374.0     .840            0
HISMELT           .0350    130.0    1.070            0
```