DATA BOOK 3

QUESTIONNAIRE OF INTERVIEW SURVEY ON MEZZE-RAZY & KAFAR SOUSEH-LAWAN

QUESTIONNAIRE

Sample :	
District :	
Neighborhood :	
Data	

SURVEY
ON
INDIVIDUAL RESERVOIR
AT
PILOT DMA AREA

This questionnaire is prepared by the JICA Study Team (the Japan International Cooperation Agency) in cooperation with DAWSSA (the Damascus City Water Supply and Sewerage Authority) to upgrade the water service level in Damascus City. Results of survey are key information to formulate a DMA plan. Your cooperation would be most grateful.

Questionnaire on Individual Reservoir at Pilot DMA Area

Q1. Please select the type of building for questionnaire from the following:

1) House (≦ 2 stories) 2) House (≧3 stories)

3) Apartment/Condominium 4) Private Office Building

5) Hotel 6) Government Office Building

7) Hospital 8) School

Q2. Family Size (persons): Total_____Adult_____Children_____

Q3. Size of the building type except house and apartment/condominium (number):

1) Private Office : Workers_____

2) Hotel : Rooms_____ Beds_____

3) Government Office : Workers_____

4) Hospital : Workers_____ Beds_____

5) School : Workers_____ Students_____

Q4. Do you have any vehicles in your house/building?

1) Yes (How many : _____units)

2) No

Q5. Do you have any water storage device (reservoir) in your house/building?

1) Yes 2) No

Q6. What is the capacity of the water storage device?

1) ≦0.5 m^3 2) 1.0 m^3

3) more than 1.0 m^3 (Approximately_____m^3)

Q7. What season do you use the water storage device in a year?

1) All the year

2) If not all the year, when ? from_____to_____

Q8. How frequent do you fill water up the water storage device in a day?

1) One time per day 2) Two times per day

3) Three times or more (Approximately_____times per day)

Q9. When do you fill water up the water storage device in a day?

1) Day time (from_____to_____)

2) Night time (from_____to_____)

Q10. How do you control filling water up the water storage device?

1) Automatic control

2) Hand-operated control

3) Without any control

Questionnaire

استبيان

رقم العينة	Sample No.	:
الحي	District	:
المنطقة	Neighbourhood	:
التاريخ	Date	:

Survey of Environmental Conditions in Mezze- Razy / Kafar Souseh -Lawan Area, Damascus, SYRIA

DAWSSA (Damascus City Water Supply and Sewerage Authority) in cooperation with JICA (the Japan International Cooperation Agency) is developing new water supply system in Mezze- Razy / Kafar Souseh -Lawan area . This questionnaire was prepared by the JICA/DAWASSA Study Team to obtain information necessary to develop the system. Your cooperation would be most grateful.

احصائية الظروف البيئية في منطقة المزة - رازي / كفرسوسة - اللوان دمشق سوريا .

مؤسسة المياه والصرف الصحي بدمشق بالتعاون مع جيكا (وكالة التعاون الدولي اليابانية) ينفذ نظام المياه في منطقة مزة -- الرازي / كفرسوسة اللوان . أعد هذا الاستبيان من قبل جيكا / مؤسسة المياه والصرف الصحي للحصول على المعلومات اللازمة لتنمية هذا النظام . إننا نشكركم جزيل الشكر لتعاونكم معنا .

Q1. Status of interviewee

السؤال ١ : معلومات عن الشخص الذي تمت مقابلته

age/sex الجنس/ العمر	years old العمر	Male/Female انثى / ذكر
family size (persons) عدد أفراد العائلة	total عدد	(adult بالغين | /children) أطفال /
total houshold income مجموع الدخل العائلي	1)1000-3000 S.L./month 2)3000-5000 S.L./month 3)5000-10000 S.L./month 4)10000-25000 S.L./month 5)25000-50000 S.L./month 6)50000 or more S.L./month	١٠٠٠-٣٠٠٠ ل.س /شهر ٣٠٠٠-٥٠٠٠ ل.س /شهر ٥٠٠٠-١٠٠٠٠ ل.س /شهر ١٠٠٠٠-٢٥٠٠٠ ل.س /شهر ٢٥٠٠٠-٥٠٠٠٠ ل.س/شهر ٥٠٠٠٠ فمافوق ل.س /شهر
Occupation of the main income العمل ومصدر الدخل الرئيسي	1) Public sector wage labor 2) Private sector wage labor 3) Agriculture wage labor 4) Business / commercial self- empoyed 5)Agriculture self- employed 6) Other	عمل مأجور في القطاع العام عمل مأجور في القطاع الخاص عمل مأجور في القطاع الزراعي عمل حر خاص عمل حر بالزراعة أخرى
possession ممتلكات	1) land (approx. m2) 2) house (rooms) 3) electric laundry machine 4) refrigerator 5)automobile 6)TV 7)private bath 8) flush toilet	أرض (تقريب م٢) منزل (غرفة) غسالة كهربائية براد سيارة تلفزيون حمام خاص توالیت

Q2. How much water do you use a day?

السؤال ٢ : ماهي كمية المياه المستخدمة في اليوم الواحد ؟

1) less than average (about 160 litter/day/person) ١) أقل من المتوسط (١٦٠ لتر /يوم/شخص)

2) slightly less than average (about 170 litter/day/person) ٢) (١٧٠ لتر/يوم/شخص)

3) average (about 180 litter/day/person) ٣) المتوسط (١٨٠ لتر/يوم/شخص)

4) slightly above average (about 190 litter/day/person) ٤) (١٩٠ لتر/يوم/شخص)

5) more than average (over 200 litter/day/person) ٥) أكثر من المتوسط (٢٠٠ لتر فوق /يوم/شخص)

Q3. Source of water

السؤال ٣: مصدر المياه

source المصدر	drinking & cooking الشرب والطبخ	laundering غسيل	bathing الاستحمام	toilet المرحاض	Agriculture الزراعة	other أخرى
total (litter/day/person) المجموع (لتر/يوم/شخص)						
DAWASSA, individual house connection (litter/day/person) وصلة خاصة منزلية						
DAWASSA, shared house connection (litter/day/person) وصلة مشتركة						
bottled water (litter/day/person) مياه بالعبوات						
private spring or well (litter/day/person) بئر خاص						
communal spring or well (litter/day/person) بئر مشترك						
other ( ) ( ) أخرى						

Q4. Are you satisfied with your water ?

السؤال ٤ : هل أنت مكتف بالماء ؟

1) Yes نعم 2)No لا

If "No" , please give the main reason . إذا كان الجواب "لا" ماهو السبب الرئيسي

3)poor water quality نوعية الماء رديئة 4) low pressure ضغط الماء المنخفض

5) insufficient quantity الكمية غير كافية 6)expensive التسعيرة مرتفعة

7) other ( ) ( ) أخرى

Q5. Do you want to use more water ?

السؤال ٥: هل تريد كمية أكبر من الماء ؟

1) Yes نعم 2)No لا

If "Yes" what prevent you from using more water ? إذا كان الجواب "نعم" ما الذي يمنعك من استخدام ماء بكمية أكبر ؟

3) too expensive السعر الغالي

4) lack of water resource in the area نقص مصادر المياه

5)other ( ) ( ) أخرى

Q6. Have you got any of the following water - borne diseases in the past 5 years ? (multiple answer)

السؤال ٦: هل لديك مرض ناشيء عن المياه خلال السنوات الخمس الماضية ؟

1) typhoid/typhus/paratyphoid (times/ 5 years) ١) باراتيفويد /تيفوس / تيفويد (مرة /٥ سنوات)

2) cholera (times/ 5 years) ٢) كوليرا (مرة /٥ سنوات)

3) dysentery (times/ 5 years) ٣) ديزنتري (مرة /٥ سنوات)

4) others (name of disease , times /5 years)

٤)أخرى (اسم المرض ، مرة /٥ سنوات)

Q7. How often do you get diarrhea from drinking low quality water ?

السؤال ٧ :كم مرة تصاب بالاسهال من شرب ماء سيء النوعية ؟

1) none كلا 2) once/month مرة /شهر 3) 2-3 time/month ٢-٣ مرة/ شهر

4) 3-5 times/month ٣-٥ مرة /شهر

5) more than 5 time/month أكثر من ٥ مرات /شهر

Q8. Where does your wastewater go ? السؤال ٨: أين تصرف المياه المستهلكة ؟

1) to public sewer system ١) نظام صرفي عام

2) to septic tank ٢)جورة صحية

3) to ditch / creek ٣)حفرة /جدول

4) other ( ) (٤)أخرى (

Q9. Where does your garbage go ? السؤال ٩: أين تصرف القمامة ؟

1) regulary collected by the city (time /week) ١) يجمع بانتظام من الدولة

2)regularly collected by private collector (time/week) ٢) يجمع بانتظام بطريق خاص

3) bury or incinerate ٣) تحرق / تدفن

4) other ( ) (٤) أخرى (

Q10. Where does your human waste go? السؤال ١٠ : أين تصرف الفضلات الانسانية ؟

1) to public sewer system ١) نظام صرفي عام

2) to septic tank ٢)جورة صحية

3) regulary collected by the city (time /week) ٣) يجمع بانتظام من الدولة (مرة /أسبوع)

4)regularly collected by private company (time/week) ٤) يجمع بانتظام بطريق خاص (مرة /أسبوع)

5) used for agriculture ٥) تستعمل للزراعة

6) other ( ) (٦) أخرى (

Q11. What is the most serious environmental problem in your neighborhood?

السؤال ١١ : ماهي أخطر مشكلة بيئية في حيزك ؟

1) air pollution تلوث الهواء 2) lack of clean , safe drinking water نقص مياه نظيفة صالحة للشرب

3) polluted river نهر ملوث 4) noise ضجيج 5)odor روائح

6) filthy environment due to lack of wast control تلوث البيئة بسبب نقص تنظيم التخلص من الفضلات

7) other ( ) (أخرى (

Q12. On average , how much tariff do you pay for the following public utilities ?

السؤال ١٢: بالمتوسط ، كم تدفع للخدمات العامة التالية ؟

1) water supply	S.L./ month	ل.س/شهر	١) الماء
2) sewerage	S.L./ month	ل.س/شهر	٢) النظام الصرفي
3) electricity	S.L./ month	ل.س/ شهر	٣) الكهرباء

Q13. How is your house connected to the public (DAWSSA) water supply system ?

السؤال ١٣: كيف يتصل منزلك إلى نظام توصيل المياه العام ؟

1) not connected ١) غير موصل

2) official individual house connection ٢) توصيلة خاصة

3) private pipe with valve ٣) أنبوب خاص مع صمام

4) private pipe without valve ٤) أنبوب خاص بدون صمام

5) private pump with booster pump ٥) أنبوب خاص مع مضخة

6) other ( ) ( ) ٦) أخرى

Q14 . If new public water supply system is installed in your area , how much tariff can you afford to pay per month for the service ?, Similarly, how much tariff can you afford to pay for sewerage and electricity for better service ?

السؤال ١٤: إذا ركب نظام توصيل عام في منطقتك ، كم أنت مستعد أن تدفع لهذه الخدمة بالشهر ، وكم أنت مستعد أن تدفع بالشهر للنظام الصرفي والكهرباء ؟

1) water supply	S.L./ month	ل.س/شهر	١) الماء
2) sewerage	S.L./ month	ل.س/شهر	٢) النظام الصرفي
3) electricity	S.L./ month	ل.س/ شهر	٣) الكهرباء

Q15. To install new water supply system in your area, water mains have to be placed under roads. This work, which involves digging , may affect your daily activities. Do you have any concern ?

السؤال ١٥: لتركيب نظام توصيل ماء في منطقتك ، ستوضع أنابيب مياه تحت الشوارع ، هذا العمل سيتطلب حفر الذي قد يؤثر على نشاطاتك اليومية . ما الذي سيزعجك من التالي :

1) no concern ١) كلا

2) the area becomes noisy. ٢) المنطقة فيها ضجيج

3) the area becomes dusty . ٣) المنطقة فيها غبار

4) the traffic jam makes commuting difficult ٤) ازدحام الشوارع بسبب سد الطرق

5) your customers cannot come to your shop because of the construction work ٥) تعطيل عملك لأن الزبائن لن تصل إلى المحل

6)other ( ) ( ) ٦) أخرى

Q16. Please select the type of building for questionnaire from the following :

السؤال ١٦: إذا سمحت اختار نوع البناء من التالي :

1) House (≦ 2 stories) ١) منزل (≦٢ طابق) 2) House (≧ 3 stories) ٢)منزل (≧٣طوابق)

3) Apartment / Condominium ٣) شقة 4) Private Office Building ٤) بناء عمل خاص

5)Hotel ٥) فندق 6) Government Office Building ٦) بناء عمل حكومي

7) Hospital ٧) مشفى 8) School ٨) مدرسة

Q17. Do you have any water storage device (reservoir) in your house / building?

السؤال ١٧ : هل لديك مستودع تخزين ماء في منزلك ؟

1) Yes نعم 2) No لا

Q18. What is the capacity of the water storage device ?

السؤال ١٨: كم سعة مستودع تخزين المياه ؟

1) ≦0.5 m3 ١) ≦٠,٥ م٣ 2)1.0 m3 ٢) ١ م٣

3) more than 1.0 m3 (Approximately m3) ٣) أكثر من ١م٣ (تقريبا" م٣)

Q19. What season do you use the water storage device in a year ?

السؤال :١٩ في أي فصل تستخدم مستودع تخزين المياه خلال السنة ؟

1) All the year ١) كل السنة

2) If not all the year , When ? from to ٢) إذا كان الجواب لا لكل السنة ، متى ؟ من إلى

Q20 . How frequent do you fill water up the water storage device in a day ?

السؤال ٢٠: كم مرة تملأ مستودع تخزين المياه باليوم ؟

1) One time per day ١) مرة باليوم 2) Two times per day ٢) مرتين باليوم

3)three times or more (Approximately times per day) ٣) ٣ مرات أو أكثر (تقريبا" مرة / يوم)

Q21. When do you fill water up the water storage device in a day ?

السؤال ٢١: متى تملأ مستودع تخزين المياه باليوم ؟

1) Day time (from to)

١) أثناء النهار (من إلى)

2) Night time (from to)

٢) أثناء الليل (من إلى)

Q22. How do you control filling water up the water storage device ?

السؤال ٢٢: ماهي الطريقة التي تستخدمها للتحكم بملىء مستودع تخزين المياه ؟

1) Automatic control ١) أتوماتيكيا"

2) Hand- operated control ٢) يدويا"

3) Without any control ٣) بلا تحكم

Thank you very much for answering the questionnaire . نشكركم على اجابتكم عن الاستبيان

DATA BOOK 4

WATER QUALITY AND ENVIRONMENT DATA

4-a

RESULTS OF PESTICIDE ANALYSIS

July 10, 1997

Itaru Okuda, Ph.D.

1. Summary

Three groundwater samples from Oumawiyin wellfield were analyzed for aldrin, dieldrin, heptachlor, fenitrothion, and carbofuran. No pesticide was found from any samples examined this time beyond the concentration detectable with the method given herein. This report was prepared based on the report submitted by IET (Analysis ID IET 97-5001).

2. Sampling

Location :	Oumawiyin wells # 1, 4, and 13
Date :	May 27 - 28, 1997
Size:	> 1 L/sample

3. Analytical Institute

Institute :	Institute of Environmental Toxicology (IET) 2-772 Suzuki-cho, Kodaira, Tokyo (Anal. ID IET 97-5001)

4. Reagents and Instruments

acetone, ethyl acetate, diethylether, dichloromethane, hexane :	all residual pesticide analysis grade
other reagents :	reagent grade
florigil minicolumn :	Sep-Pak (Waters)
florigil :	60-100 mesh (Kanto Chemical), activated over night at 120℃
aldrin standard :	purity 100 % (Wako Chemical)
dieldrin standard :	purity 99.2 % (Wako Chemical)
heptachlor standard :	purity 98 % (Wako Chemical)
fenitrothion standard :	purity 99.3 % (Wako Chemical)
carbofuran standard :	purity 99.5 % (Wako Chemical)
gas chromatograph :	GC-14B, ECD (Shimazu) HP 5890 Series II, NPD (Hewlett Packard)
data processing :	C-R4A, C-R7A (Shimazu)

5. Operational Conditions of GC

5.1 aldrin, dieldrin, heptachlor (GC-14B, ECD)

column :	DB-5 (J&W), 0.53 mm i.d., 15 m long, 1.5 μm thick
temp. :	column 120 ℃ (1 min.) - 10 ℃/min. gradient - 230℃ injector port 250℃ detector 280℃
gas flow rate :	carrier (He) 30 kg/cm^3, make up (N_2) 30 kg/cm^3

// 8

sensitivity : range 10^1, current 0.5
attenuation : 2^5
chart speed : 5 mm/min
retention time : heptachlor 7.4 min.
aldrin 8.0 min.
dieldrin 10.4 min.

5.2 fenitrothion, carbofuran (HP5890 Series II, NPD)

column : DB-5 (J&W), 0.53 mm i.d., 15 m long, 1.5 μm thick
temp. : column 150 ℃ (1 min.) - 10 ℃/min gradient - 225℃
injector port 250℃
detector 280℃
gas flow rate : carrier (He) 15 mL/min., H_2 3 mL/min., air 91 mL/min.
sensitivity : range 10^0
attenuation : 2^6 (0 to 6 min.), 2^7 (6 to 8.5 min.)
chart speed : 5 mm/min
retention time : carbofuran 4.8 min.
fenitrothion 6.7 min.

6. Quantification

Dissolve standard pesticide reagents in acetone such that the concentrations of the stock solutions are 500 mg/L or 200 mg/L. Dilute the stock solutions with acetone to make a series of mixtures of standard solutions : 0.0045 to 0.018 mg/L for aldrin, dieldrin and heptachlor, and 0.015 to 0.3 mg/L for fenitrothion and carbofuran. Inject 2 μL of the standard mixture into GC. From the linear relationship between the concentrations and peak areas, create standard curves.

7. Sample Preparations

7.1 Extraction

Take 300 mL of the sample water into a 500 mL separatory funnel, and add 15 g of NaCl, and 100 mL of dichlormethane. Shake 5 min., and separate out the dichloromethane phase. Add 100 mL of dichlormethane to the aqueous phase again, and repeat the extraction. Add 0.5 mL of 2 % diethylene glycol / acetone solution to the dichlormethane phase. Concentrate the extractant under vacuum, in const. temp. bath (< 40 ℃), and remove the solvent by using nitrogen gas.

7.2 Clean-up 1

Attach a florigil column to a 10 mL syringe, and rinse the column with 10 mL of hexane. Dissolve the extractant in 5 mL of hexane, and inject into the minicolumn: repeat again. Rinse the container with 30 mL of hexane/ethyl acetate mixture (8:2 v/v solution) to completely dissolve the extractant, and pass it through the minicolumn. Add 0.5 mL of 2 % ethylene glycol /acetone solution to the eluent. Concentrate the extractant under vacuum, in const. temp. bath (< 40 ℃), and remove the solvent by using nitrogen gas.

7.3 Quantification of fenitrothion and carbofuran

Dissolve the extractant in aliquot of acetone, and inject 2 μL of this solution into the GC-NPD. Calculate the concentration from the peak area - concentration curve.

7.4 Clean-up

After the analysis of fenitrothion and carbofuran, concentrate the solution under vacuum, in constant temp. bath (< 40 ℃), and remove the solvent by using nitrogen gas. Pack a clean-up column with 12 g of florigil using hexane. Dissolve the extractant by using 5 mL of hexane / diethylether solution (96:4 v/v), and flow it through the column. Repeat this again. Rinse the container once again using 90 mL of hexane / diethylether solution (96:4 v/v), and pass the solution through the column. Retain the eluent for heptachlor and aldrin analysis. Pass 120 mL of hexane / diethylether mixture (85:15, v/v) through the column, and retain the eluent for dieldrin analysis. Concentrate both eluents separately under vacuum in constant temp. bath (< 40 ℃), and remove the solvent by using nitrogen gas.

7.5 Quantification of aldrin, dieldrin, and heptachlor

Dissolve the extractant in aliquot of acetone, and inject 2 μL into the GC-ECD. Calculate the concentration from the peak area - concentration curve.

8. Detection Limit

Table Detection limit of analytical methods.

chemical	min. detectable mass (ng)	sample vol. (mL)	final volume (mL)	injection volume (μL)	detection limit (μg/L)
aldrin	0.0009	300	20	2	0.03
dieldrin	0.0009	300	20	2	0.03
heptachlor	0.0009	300	20	2	0.03
fenitrothion	0.03	300	2	2	0.1
carbofuran	0.03	300	2	2	0.1

9. Recovery

Table Results of recovery tests (in duplicate)

chemical	added conc. (μ g/L)	recovery (%)	ave. recovery (%)
aldrin	1.5	90, 87	88
dieldrin	1.5	94, 94	94
heptachlor	1.5	76, 74	75
fenitrothion	5	100, 97	98
carbofuran	5	93, 92	92

10. Results

Table Results of pesticide analysis

chemical	detection limit	Well #1	Well #4	Well #13
aldrin	0.03 ppb	N.D.	N.D.	N.D.
dieldrin	0.03 ppb	N.D.	N.D.	N.D.
heptachlor	0.03 ppb	N.D.	N.D.	N.D.
fenitrothion	0.1 ppb	N.D.	N.D.	N.D.
carbofuran	0.1 ppb	N.D.	N.D.	N.D.

N.D.: below detection limit

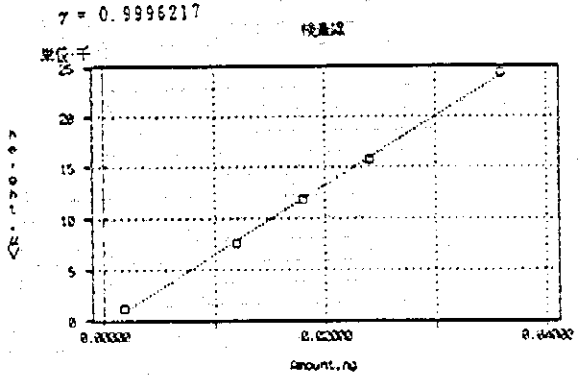
No pesticide was found from any samples examined this time beyond the concentration detectable with the method given herein.

Attachments :
- Fig.1 Standard curves
- Fig.2 Chromatograms of standard pesticides
- Fig.3 Recovery Studies
- Fig.4 Chromatograms of the samples

Fig.1 Standard curves

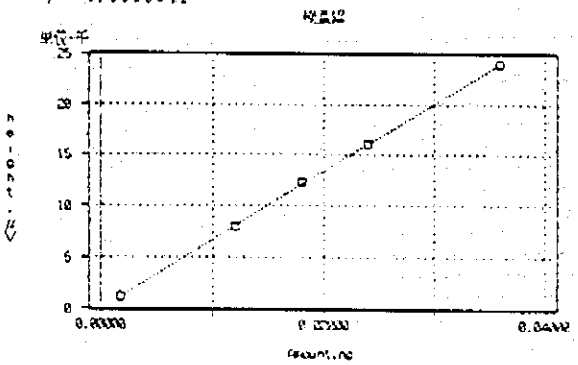
検量線 1997/06/17
アルドリン aldrin

Y=aX+b
a= 678684.69
b= -318.8509
r = 0.9996217



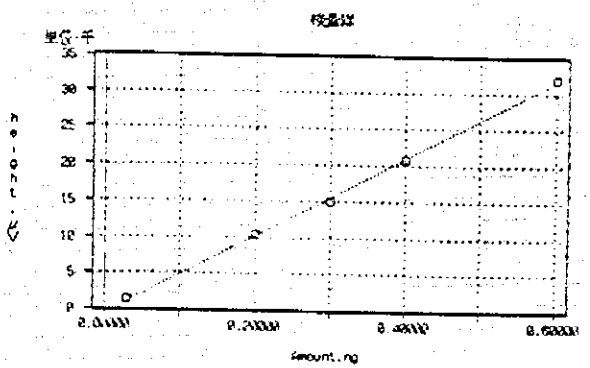
検量線 1997/06/17
ヘプタクロール heptachlor

Y=aX+b
a= 668500.99
b= 23.321913
r = 0.9999341



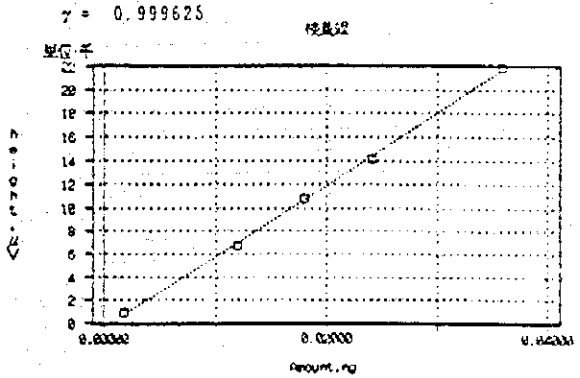
検量線 1997/06/10
カルボフラン carbofuran

Y=aX+b
a= 53700.427
b= -547.7306
r = 0.9994334



検量線 1997/06/17
ディルドリン dieldrin

Y=aX+b
a= 614673.27
b= -368.6012
r = 0.999625



検量線 1997/06/10
フェニトロチオン fenitrothion

Y=aX+b
a= 101716.76
b= -617.5279
r = 0.9997867

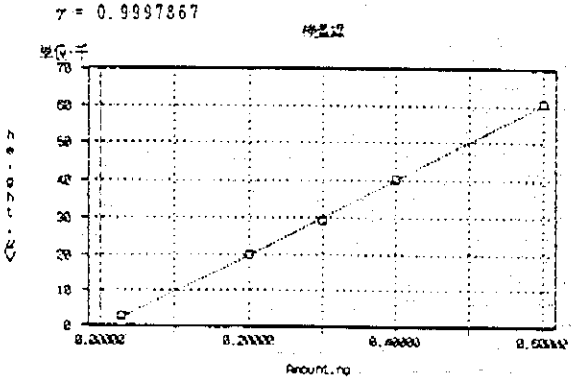
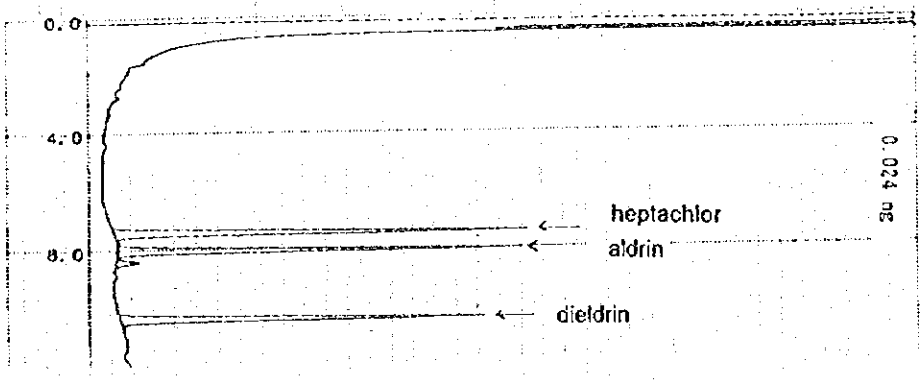


Fig.2 Chromatograms of standard pesticides (1)

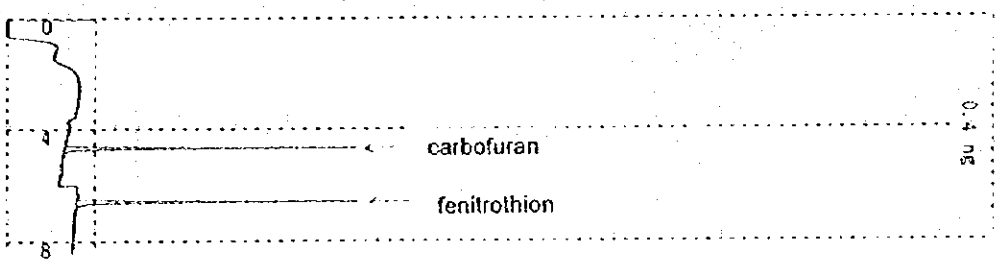
CHROMATOPAC C-R7A CH=1 REPORT No.=37 ﾌｧｲﾙ=2:970617.C02 97/06/17 09:26:34



** 定量計算結果 **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC		NAME
1	1	7.431	143800	16057		1	0.024	ﾍﾌﾟﾀｸﾛﾙ	heptachlor
	2	8.029	142507	15774		2	0.0237	ｱﾙﾄﾞﾘﾝ	aldrin
	3	8.417	8971	1012					
	5	10.365	127644	14149		3	0.0236	ﾃﾞｨﾙﾄﾞﾘﾝ	dieldrin

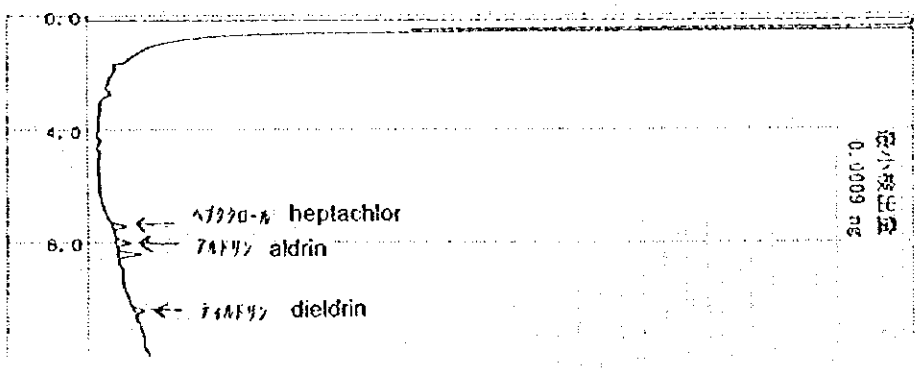
CHROMATOPAC C-R4A CH=1 REPORT No.=2 ﾌｧｲﾙ=2:970610.C04 97/06/10 16:20:08



** 定量計算結果 **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME	
1	1	4.697	85138	20821		1	20821	ｶﾙﾎﾞﾌﾗﾝ	carbofuran
	2	6.589	177880	40291		2	40291.25	ﾌｪﾆﾄﾛﾁｵﾝ	fenitrothion

CHROMATOPAC C-R7A CH=1 REPORT No.=41 ﾌｧｲﾙ=2:970617.C06 97/06/17 10:29:02

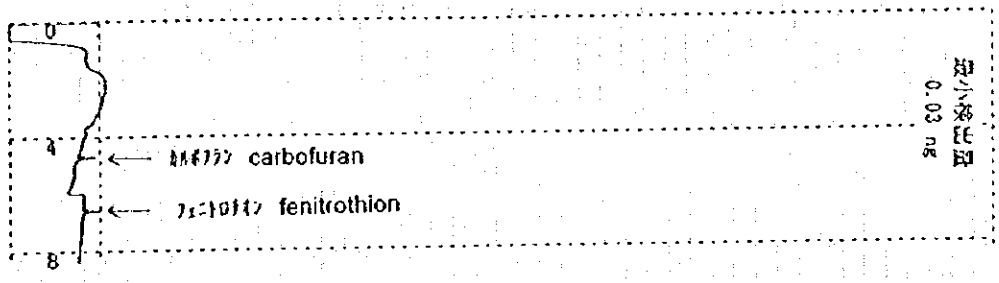


** 定量計算結果 **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC		NAME
1	2	7.424	5887	648		1	0.0009	ﾍﾌﾟﾀｸﾛﾙ	heptachlor
	3	8.021	7094	681		2	0.0012	ｱﾙﾄﾞﾘﾝ	aldrin
	4	8.416	9347	1043					
	5	10.369	4402	498		3	0.0012	ﾃﾞｨﾙﾄﾞﾘﾝ	dieldrin

Fig.2 Chromatograms of standard pesticides (2)

CHROMATOPAC C-R4A CH=1 REPORT No.=1 クロマト=2:970610.C01 97/06/10 15:47:47

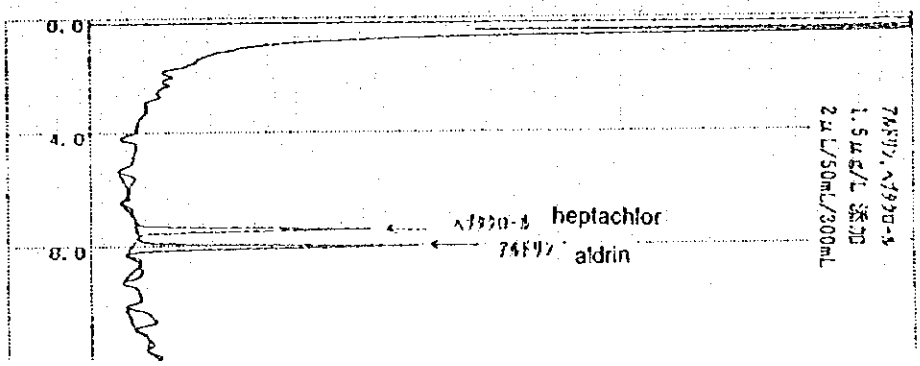


** 定量計算結果 **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	1	4.713	5251	1346		1	1346.375	carbofuran
	2	6.605	11207	2624		2	2624.3125	fenitrothion

Fig.3 Recovery Studies (1)

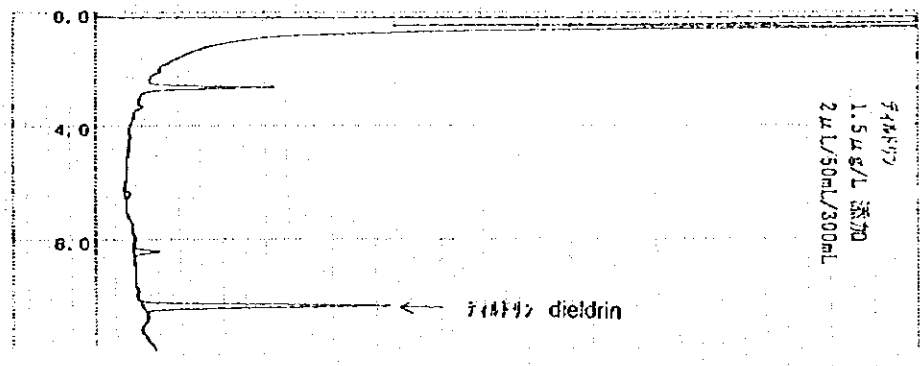
CHROMATOPAC C-R7A CH=1 REPORT No.=43 ｸﾛﾏﾄ=2:970617.C08 97/06/17 11:41:24



** 定量計算結果 **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	2	5.623	10941	586				
	3	6.32	1878	248				
	4	6.708	4034	263				
	6	7.445	81107	9109		1	0.0136	heptachlor
	7	8.043	106682	11175		2	0.0169	aldrin

CHROMATOPAC C-R7A CH=1 REPORT No.=44 ｸﾛﾏﾄ=2:970617.C09 97/06/17 11:57:58

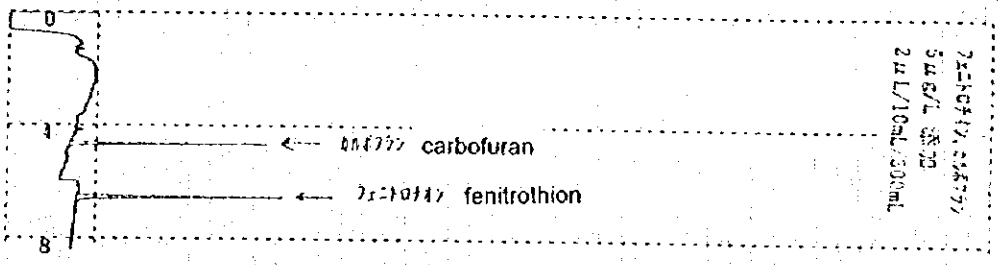


** 定量計算結果 **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	1	6.371	3651	292				
	4	8.428	9804	1112				
	6	10.373	85788	9632		3	0.0162	dieldrin

Fig.3 Recovery Studies (2)

CHROMATOPAC C-R4A CH=1 REPORT No.=3 ｸﾛﾏﾄ=2:970610.C06 97/06/10 16:41:01

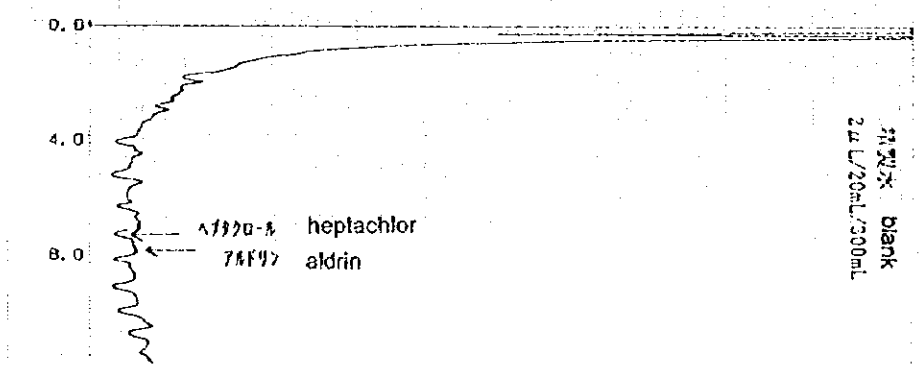


** 定量計算結果 **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	1	4.688	59321	14483		1	14483.3125	ｶﾙﾎﾞﾌﾗﾝ carbofuran
	2	6.581	130171	29912		2	29911.5	ﾌｪﾆﾄﾛﾁｵﾝ fenitrothion

Fig.4 Chromatograms of the samples (1)

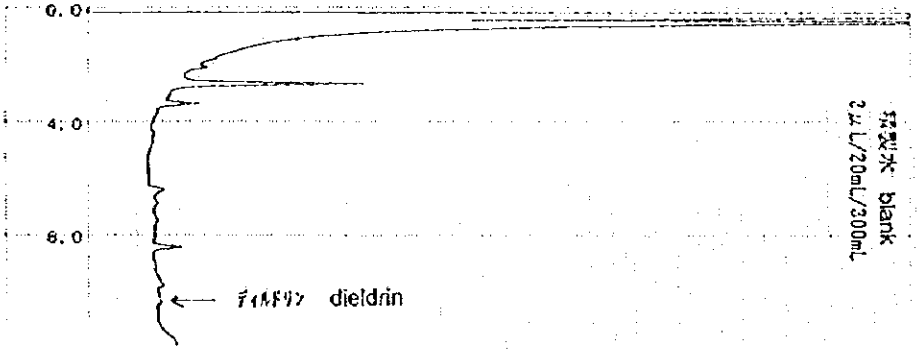
CHROMATOPAC C-R7A CH=1 REPORT No.=1 ﾌｧｲﾙ=2:970613.C08 97/06/13 15:47:08



** 定量計算結果 ** 注意 ｴﾗｰ有 CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
		TOTAL	0	0			0	

CHROMATOPAC C-R7A CH=1 REPORT No.=2 ﾌｧｲﾙ=2:970613.C09 97/06/13 16:22:02

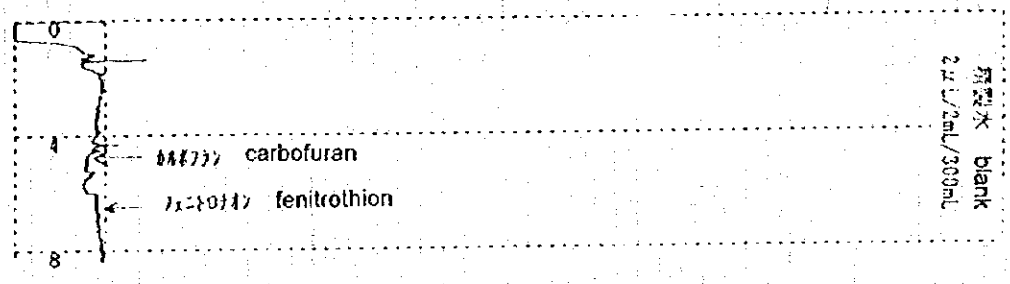


** 定量計算結果 ** 注意 ｴﾗｰ有 CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
		TOTAL	0	0			0	

Fig.4 Chromatograms of the samples (2)

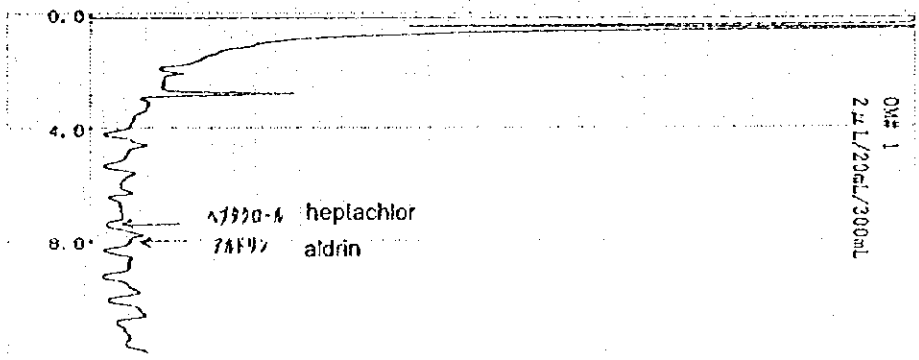
CHROMATOPAC C-R4A CH=1 REPORT No.=4 クロマト=2:970609.C01 97/06/09 12:30:45



** 定量計算結果 ** 注意 エラー有 CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
	TOTAL		0	0			0	

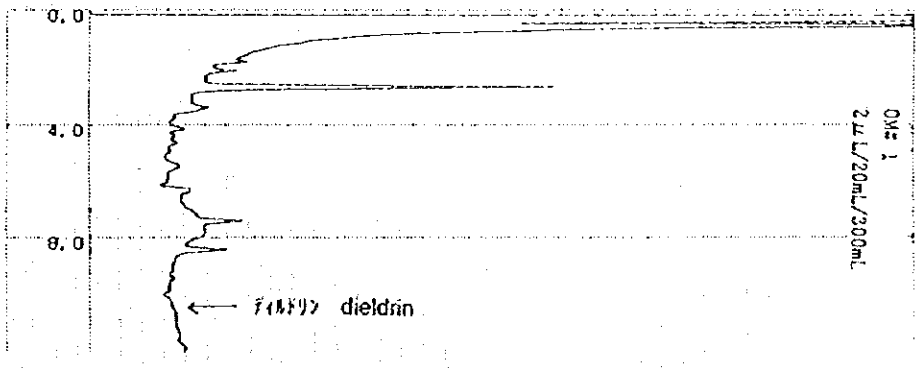
CHROMATOPAC C-R7A CH=1 REPORT No.=10 ﾌｧｲﾙ=2:970617.C18 97/06/17 14:32:50



** 定量計算結果 ** 注意 エラー有 CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
	TOTAL		0	0			0	

CHROMATOPAC C-R7A CH=1 REPORT No.=4 ﾌｧｲﾙ=2:970617.C12 97/06/17 13:00:28

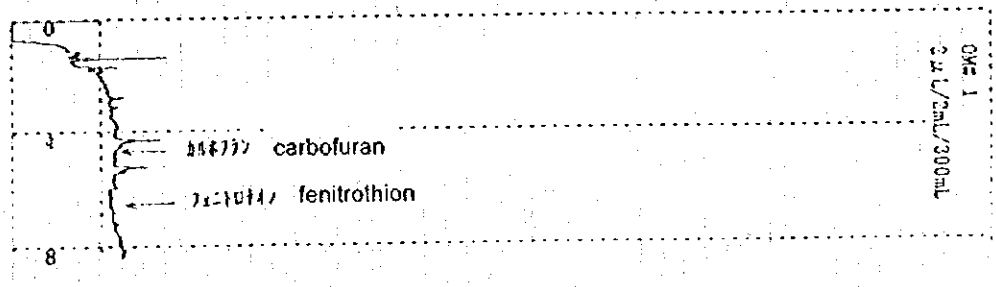


** 定量計算結果 ** 注意 エラー有 CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
	TOTAL		0	0			0	

Fig.4 Chromatograms of the samples (3)

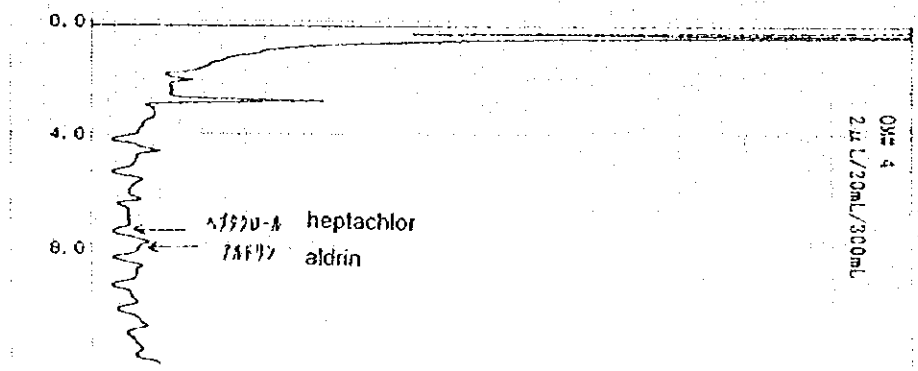
CHROMATOPAC C-R4A CH=1 REPORT No.=5 ﾌｧｲﾙ=2:970609.C10 97/06/09 18:37:18



** 定量計算結果 ** 注意 ｴﾗｰ有 CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
TOTAL			0	0			0	

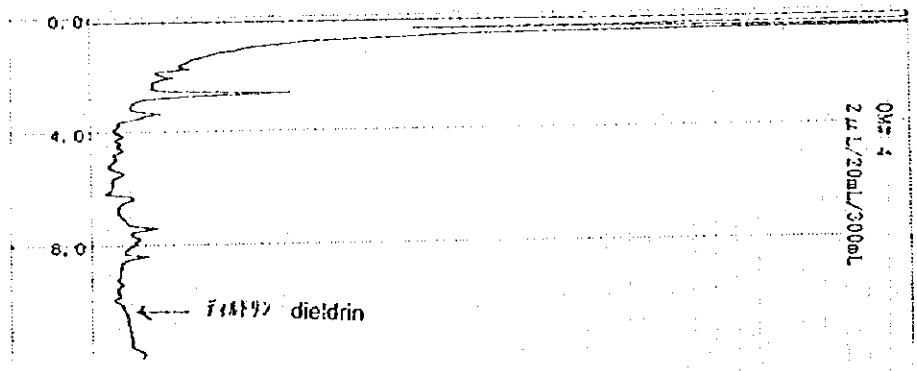
CHROMATOPAC C-R7A CH=1 REPORT No.=11 ﾌｧｲﾙ=2:970617.C19 97/06/17 14:49:24



** 定量計算結果 ** 注意 ｴﾗｰ有 CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
TOTAL			0	0			0	

CHROMATOPAC C-R7A CH=1 REPORT No.=6 ﾌｧｲﾙ=2:970617.C14 97/06/17 13:31:02

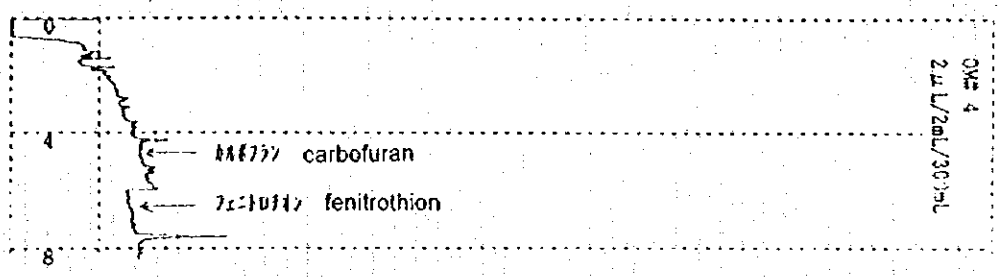


** 定量計算結果 ** 注意 ｴﾗｰ有 CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
TOTAL			0	0			0	

Fig.4 Chromatograms of the samples (4)

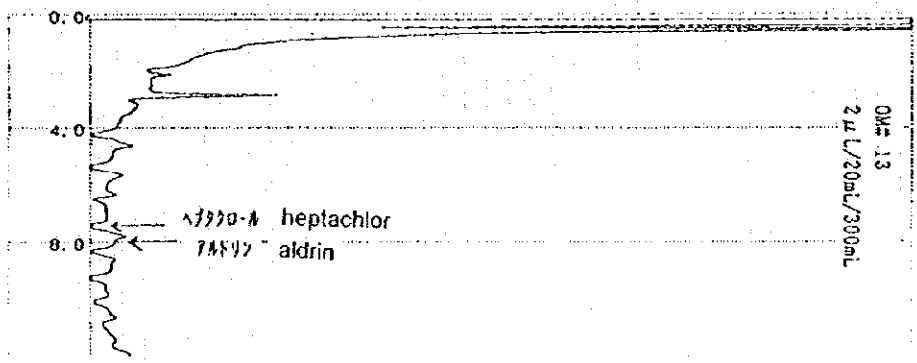
CHROMATOPAC C-R4A CH=1 REPORT No.=6 ｸﾛﾏﾄ=2:970609.C12 97/06/09 18:57:15



** 定量計算結果 ** 注意 ｲﾝﾃｸﾞ CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
TOTAL			0	0			0	

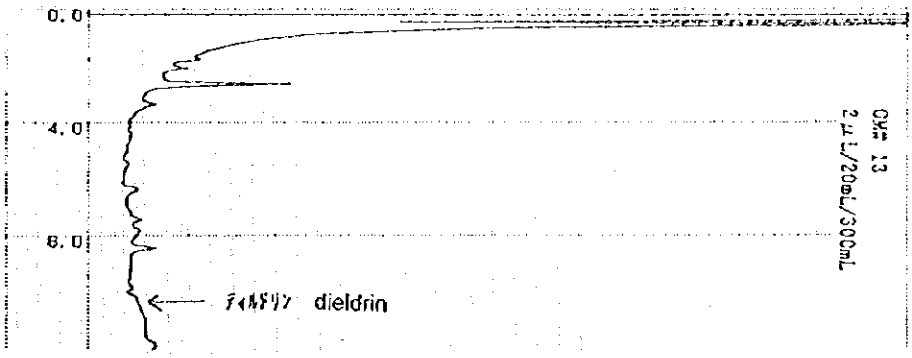
CHROMATOPAC C-R7A CH=1 REPORT No.=14 ﾌｧｲﾙ=2:970617.C22 97/06/17 15:36:32



** 定量計算結果 ** 注意 ｲﾝﾃｸﾞ CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
TOTAL			0	0			0	

CHROMATOPAC C-R7A CH=1 REPORT No.=8 ﾌｧｲﾙ=2:970617.C16 97/06/17 14:02:18

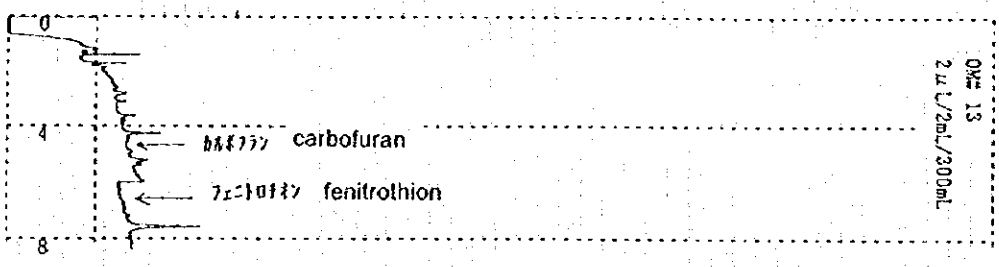


** 定量計算結果 ** 注意 ｲﾝﾃｸﾞ CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
TOTAL			0	0			0	

Fig.4 Chromatograms of the samples (5)

CHROMATOPAC C-R4A CH=1 REPORT No.=7 クロマト=2:970609.C14 97/06/09 19:20:01



** 定量計算結果 ** 注意 エラー有 CALERROR: 1

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
TOTAL			0	0			0	

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4-b

Report on the Analysis of Chlorinated Pesticides In Groundwater Samples

Marwan Dimashki, MSc.

August 18, 1997

1. Summary:

Three groundwater samples from Al-Oumawiyin wellfield were analysed for a group of chlorinated pesticides (namely; BHC, lindane, heptachlor, aldrin, endosulfan, DDE, dieldrin, endrin, TDE, and DDT). The results obtained during this analysis indicate that non of the above listed chlorinated pesticides were present in the three samples at levels above the method detection limit (MDL).

2. Sampling:

Location: Al-Oumawiyin wells # 1, 4, and 13

Date: May 27 - 28, 1997.

Sample volume: approximately 1.5 Litre.

Storage: samples were stored in glass containers at 4°C.

3. Analytical Laboratory:

The Higher Institute of Applied Sciences and Technology (HIAST)
Environmental Research Laboratory
Damascus, POBox 31983
SYRIA

4. Reagents, Chemicals, and Instrumentation:

Dichloromethane (DCM): 99.8% pure. Contains Amylene (≈ 25mg/L) used as a stabilising agent (Riedel-deHaën).

Hexane: 99.8% pure. Chromosolv, HPLC-grade (Riedel-deHaën).

Distilled Deionised Water (DDW): (Advantec Toyo Kaisha, ltd)

BHC : 60% pure and 40% other isomers(Chrompack).

Lindane : 99% pure (Chrompack).

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Heptachlor : 99% pure (Chrompack).

Aldrin : 99% pure (Chrompack).

Endosulfan : 96% pure (Chrompack).

DDE: 70% pure (Chrompack).

Dieldrin : 99% pure (Chrompack).

Endrin : 99% pure (Chrompack).

TDE : 70% pure (Chrompack).

DDT ; 99% pure (Chrompack).

Gas Chromatograph: VISTA 6000 GC with ECD detector (Varian Instruments).

Chart recorder : Model U-228 (Pantos, Japan).

5. GC Operational Conditions:

Column: SP2250 (equivalent to DB-17), 30 meter, 0.25mm i.d., 0.2µm film thickness (SUPPELCO).

Temperature programme: 160 °C (1 min) - 2 °C/min gradient - 240 °C (20min).

Gas flow rates : carrier (N_2) at 20 psi, make-up (N_2) = 40 ml/min (at 100°C).

Injector: splitless at 240 °C.

ECD temperature: 380 °C, ECD range : 10, baseline: 8.9 mV, Attenuation: 16

Recorder chart speed: 2.5 mm/min

Table(1): Compounds elution order and retention time.

Compound	Peak number *	Retention time (minutes)
BHC	1	09.2
Lindane	2	11.8
Heptachlor	3	13.0
Aldrin	4	15.0
Endosulfan	5	21.8
DDE	6	23.4
Dieldrin	7	23.5
Endrin	8	26.0
TDE	9	27.8
DDT	10	30.2

* : Peak elution order as indicated in Figure 1.

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6. Quantification:

A series of stock solutions (1 g/L) were prepared by dissolving accurate amounts of pure solids in hexane. Containers were placed in ultrasonic bath for ten minutes to ensure complete dissolution of compounds. A series of working standard solutions (0.05 to 0.12 mg/L), containing all chlorinated pesticides listed in Table 1, were prepared by dilution of the stock solutions. Stocks and working standard solutions were stored in a freezer at minus 18 °C. 1 µL of the working standard mixture solutions were injected into the GC and a standard calibration curve for each compound was established by plotting the peak area versus concentrations.

7. Sample Extraction and Analysis:

Transfer 1 litre of the water sample to a 2 litre separator funnel and add 5 g of NaCl and 25 ml of dichloromethane. Shake well for 5 minutes and separate out the dichloromethane phase. Repeat this step three times and combine the dichloromethane extracts. Concentrate the dichloromethane to about 2 ml in a rotary evaporator under vacuum at 40 °C. Transfer the concentrate to a graduated Kudema-Danish tube. Wash the flask with 2 mL of dichloromethane and add it to the graduated tube containing the sample. Remove solvent by blowing under a gentle stream of clean nitrogen gas. Dissolve the sample in 500 µL of hexane, and sonicate the sample in the ultrasonic bath for 5 minutes. Inject 1 µL into the GC system and calculate the concentrations from the standard calibration curves. Correct the concentration for sample volume and recovery efficiency.

8. Detection Limits:

The instrumental detection limit (IDL), defined as the minimum on-column injected mass (in ng) that can be detected by the instrument, was determined by injecting a set of diluted concentrations until the detector signal was no longer observable. Table 2 lists the instrumental limit of detection (IDL) for each

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individual chlorinated pesticide defined as signal-to-noise ratio of 3 (S/N ~ 3). The method detection limit (MDL) defined as, the minimum concentration of the compound in a water sample (in µg/L), that can be extracted, concentrated, and detected by the instrument. MDL values listed in Table 2 are calculated from the experimental IDL values, water sample volume, extract final volume, and GC injection volume.

TABLE (2): Instrumental detection limit (IDL) and calculated method detection limit (MDL).

Compound	IDL (ng)	Injection volume (µL)	Extract final volume (µL)	Sample volume (mL)	(MDL) Method detection limit (µg/L)
BHC	0.066	1	500	1000	0.033
Lindane	0.016	1	500	1000	0.008
Heptachlor	0.056	1	500	1000	0.028
Aldrin	0.018	1	500	1000	0.009
Endosulfan	0.028	1	500	1000	0.014
DDE	0.024	1	500	1000	0.012
Dieldrin	0.020	1	500	1000	0.010
Endrin	0.026	1	500	1000	0.013
TDE	0.046	1	500	1000	0.023
DDT	0.036	1	500	1000	0.018

9. Percentage Recovery:

Two recovery tests were performed in order to determine the average recovery efficiency of the method. 500 µL of the standard mixture was spiked to one litre of distilled deionised water, and the sample was treated in the same manner as described previously in section 7. Table 3 lists the results of percentage recovery efficiency for each analyte. It is evident from the results of the two recovery tests that the method employed gave good recovery efficiencies for all compounds except for heptachlor, which had the lowest recovery. However, the reason for the low recovery of heptachlor was not investigated, since it is beyond the scope

of this report. Determination of lindane recovery was hampered by the co-elution of the unknown peak with lindane in the recovery samples.

TABLE (3): Results of recovery efficiency tests (2 tests).

Compound	Amount Added (µg)	Recovery Test 1 (%)	Recovery Test 2 (%)	Average Recovery (%)
BHC	100	89	91	90
Lindane	50	-	-	-
Heptachlor	100	53	61	57
Aldrin	50	81	85	83
Endosulfan	50	95	97	96
DDE	50	98	100	99
Dieldrin	50	97	99	98
Endrin	50	100	100	100
TDE	100	100	100	100
DDT	50	89	93	91

10. Results:

Table 4 lists the results of analysis of chlorinated pesticides in three water samples collected from Al-Oumawiyin wells # 1, 4, and 13. The results indicate that non of the aforementioned chlorinated pesticides was present in the water samples in concentration greater than the method detection limit given in this study. The unknown peak that appears at the same retention time of lindane in the GC-ECD chromatograms of the three water samples and the DDW blank was tentatively identified as amylene which is originally present as a stabiliser in dichloromethane used for sample extraction. This was confirmed by rotary evaporation of 100 mL of the dichloromethane being used for the extraction of water samples and DDW blank and the chromatogram was compared with that obtained from similar treatment to an equal volume of dichloromethane of HPLC-grade which dose not contain amylene as a stabiliser.

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TABLE (4): Results of chlorinated pesticides analysis.

Compound	MDL (µg/L)	Well # 1 (µg/L)	Well # 4 (µg/L)	Well # 13 (µg/L)
BHC	0.033	N.D.	N.D.	N.D.
Lindane	0.008	N.D.	N.D.	N.D.
Heptachlor	0.028	N.D.	N.D.	N.D.
Aldrin	0.009	N.D.	N.D.	N.D.
Endosulfan	0.014	N.D.	N.D.	N.D.
DDE	0.012	N.D.	N.D.	N.D.
Dieldrin	0.010	N.D.	N.D.	N.D.
Endrin	0.013	N.D.	N.D.	N.D.
TDE	0.023	N.D.	N.D.	N.D.
DDT	0.018	N.D.	N.D.	N.D.

N.D. : below method detection limit (MDL).

Attachments:

Figure (1): GC-ECD chromatogram of chlorinated pesticides standard.

Figure (2): GC-ECD chromatogram of sample well # 1.

Figure (3): GC-ECD chromatogram of sample well # 4.

Figure (4): GC-ECD chromatogram of sample well # 13.

Figure (5): GC-ECD chromatogram of DDW blank.

Figure (6): GC-ECD chromatogram of syringe solvent blank (hexane).

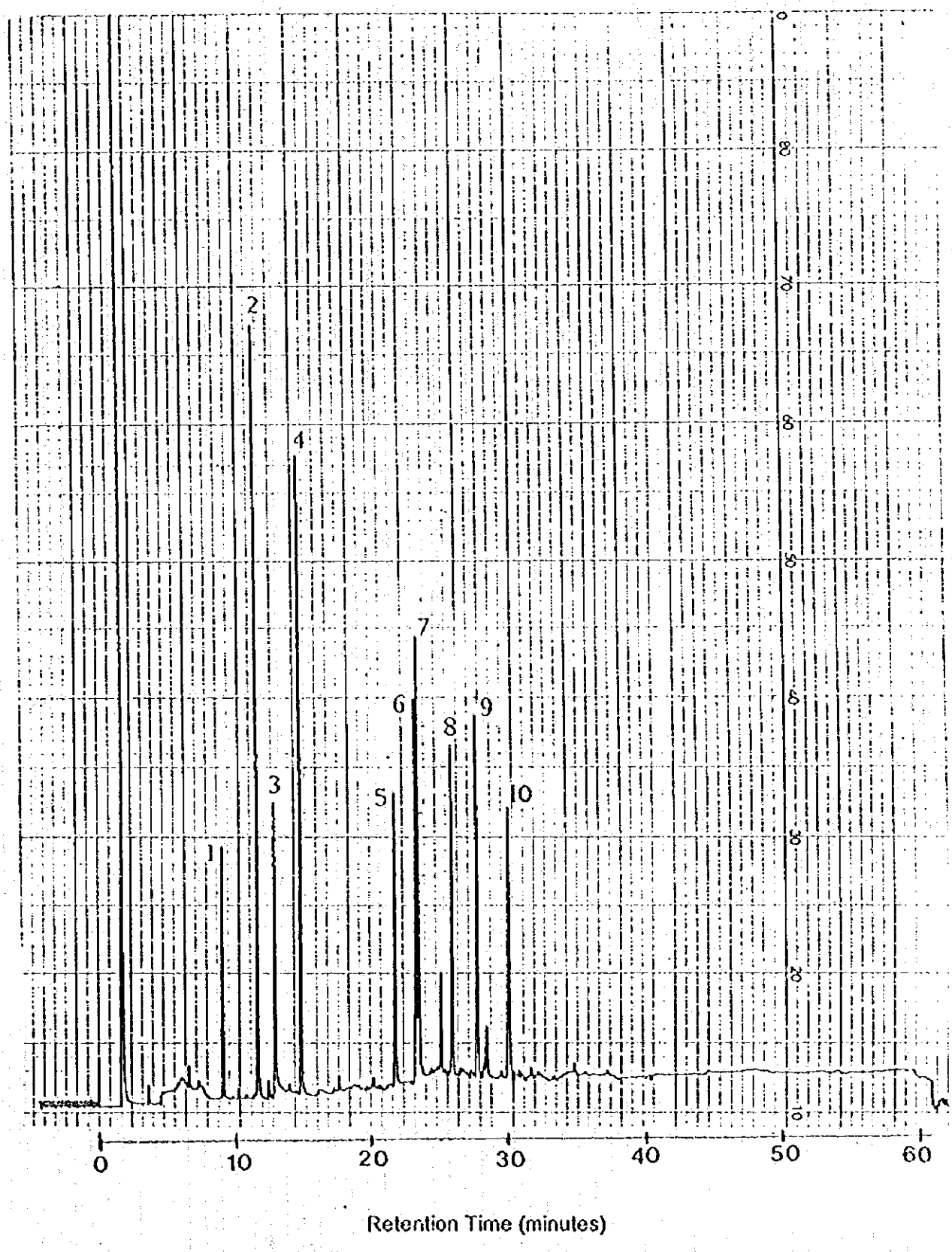

FIGURE (1): GC-ECD chromatogram of chlorinated pesticides standard mixture. Chromatographic conditions as indicated in the text. Peak identity: 1= BHC (1ng/µL); 2= Lindane (0.5 ng/µL); 3= Heptachlor (1 ng/µL); 4= Aldrin (0.5 ng/µL); 5= Endosulfan (0.5 ng/µL); 6= DDE (0.5 ng/µL); 7= Dieldrin (0.5 ng/µL); 8= Endrin (0.5 ng/µL); 9= TDE (1 ng/µL); and 10= DDT (0.5 ng/µL).

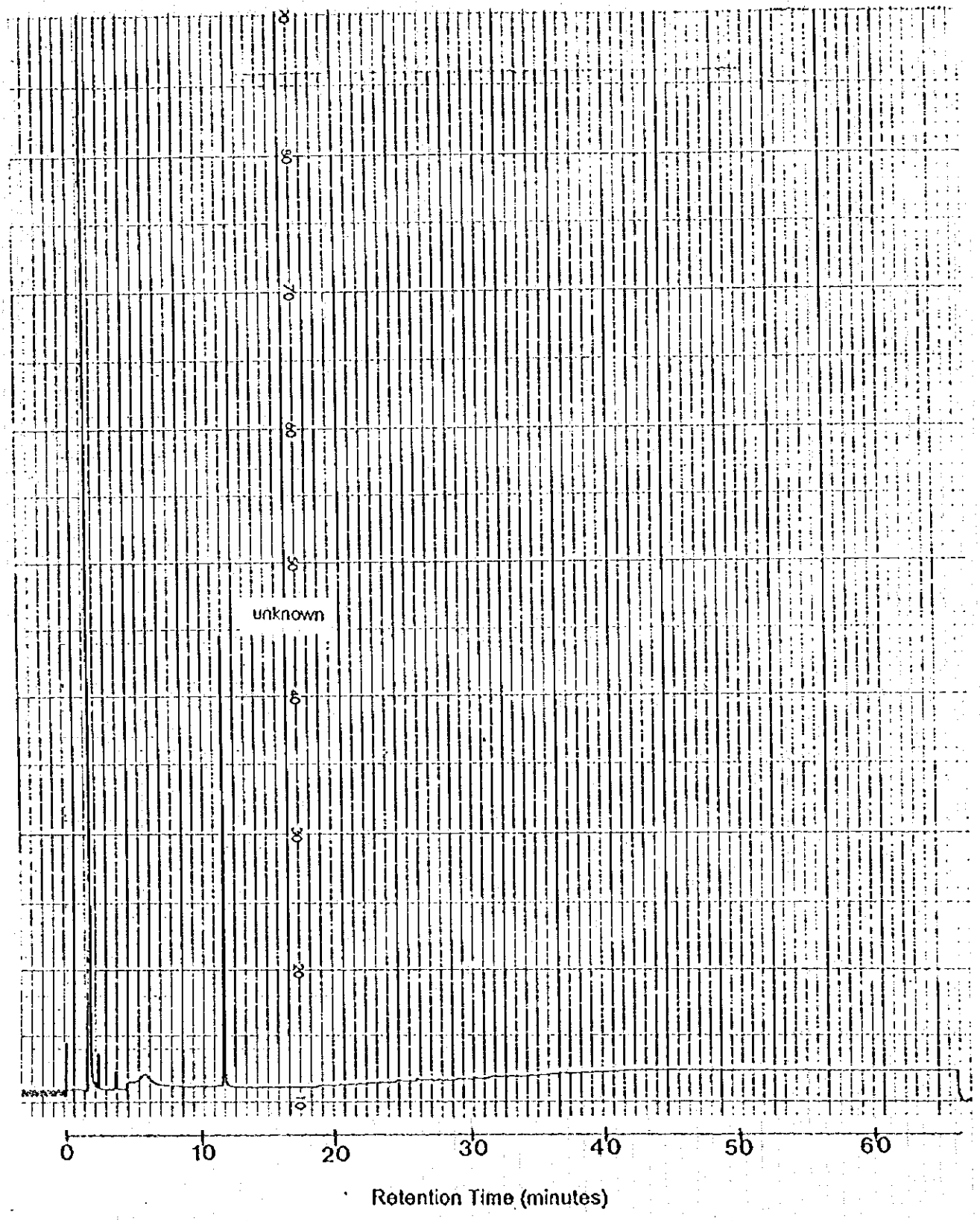

FIGURE (2): GC-ECD chromatogram of sample well # 1. Unknown peak was tentatively identified as amylene present as a stabiliser in dichloromethane used for sample extraction.

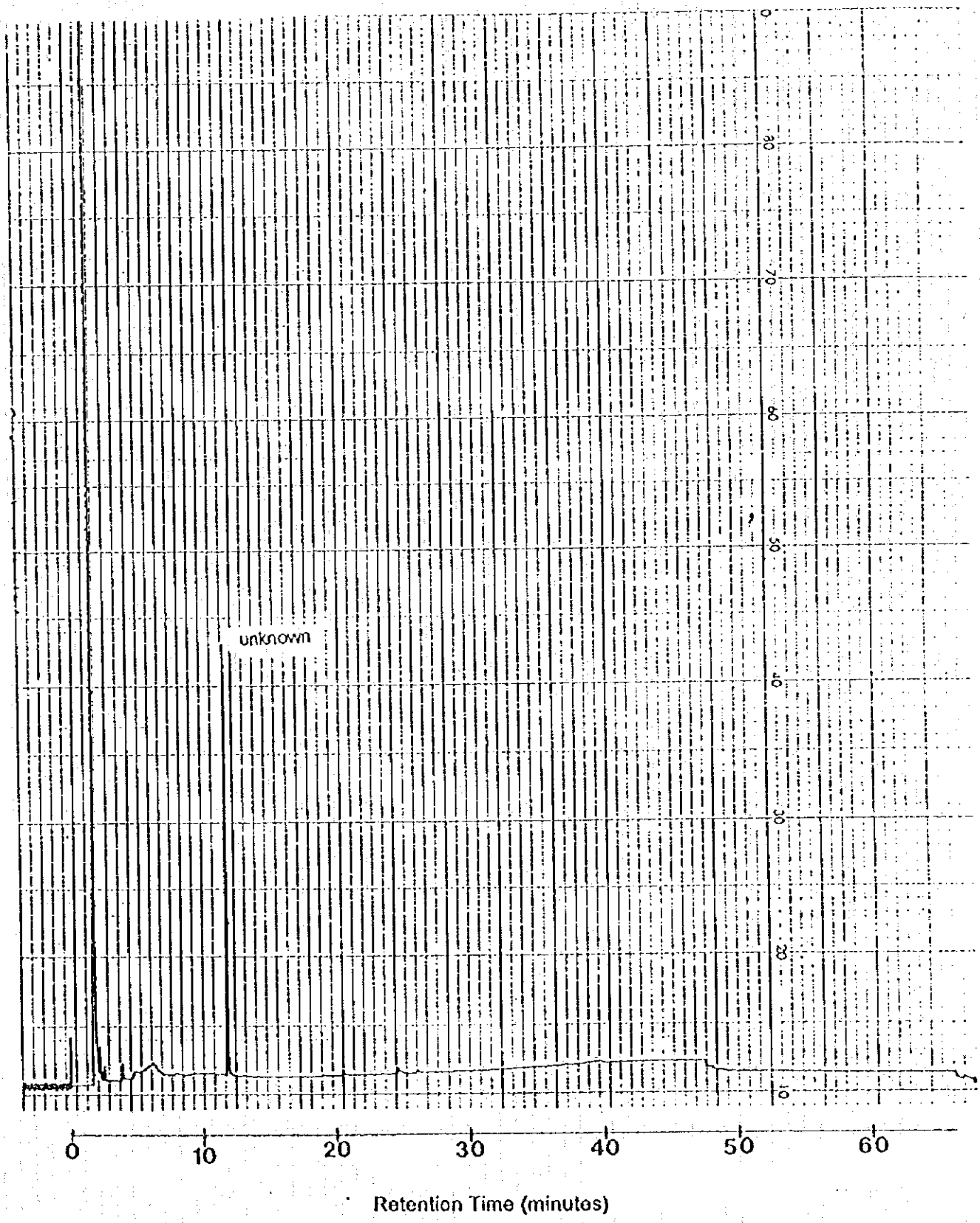

FIGURE (3): GC-ECD chromatogram of sample well # 4. Unknown peak was tentatively identified as amylene present as a stabiliser in dichloromethane used for sample extraction.

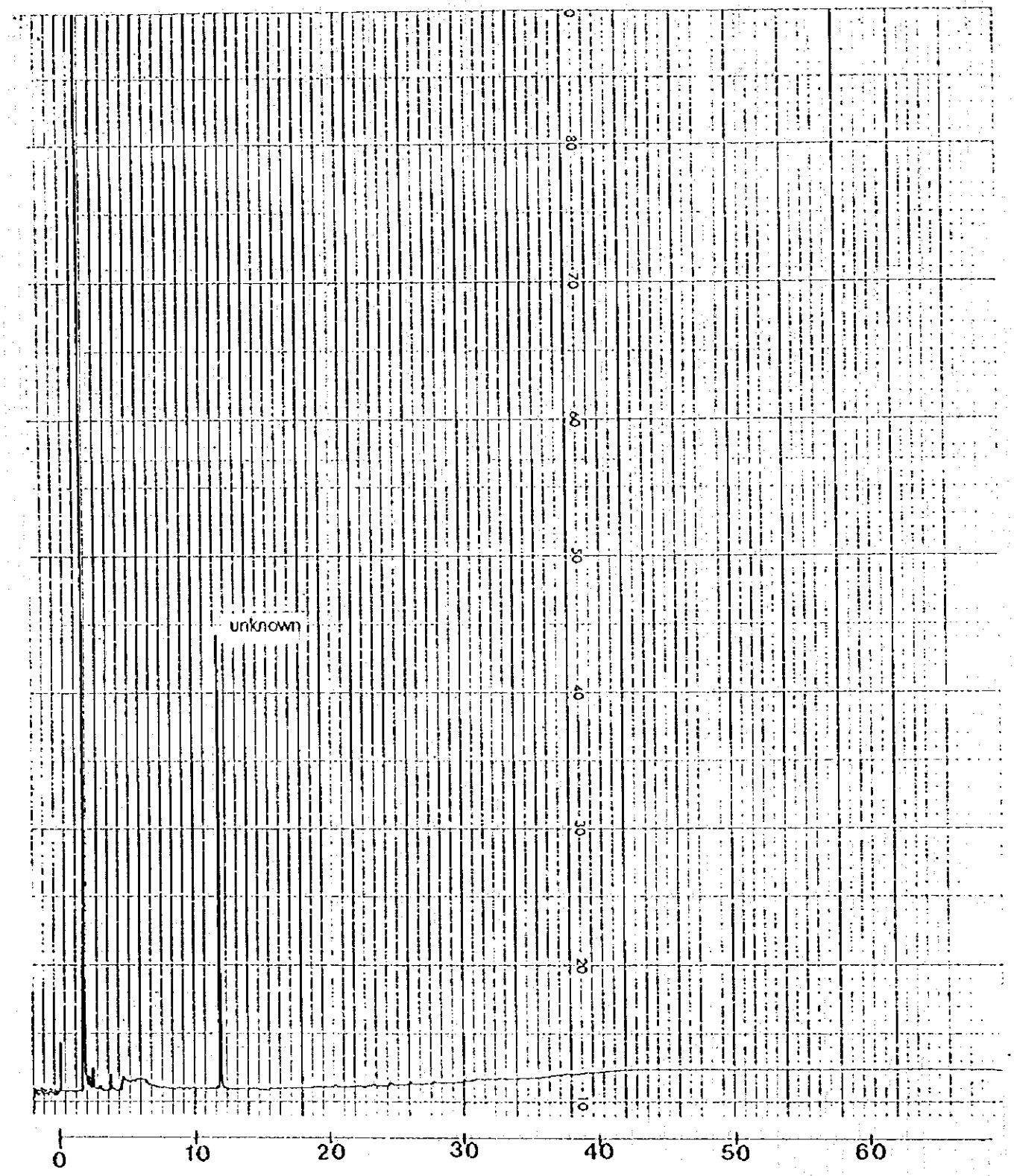

FIGURE (4): GC-ECD chromatogram of sample well # 13. Unknown peak was tentatively identified as amylene present as a stabiliser in dichloromethane used for sample extraction.

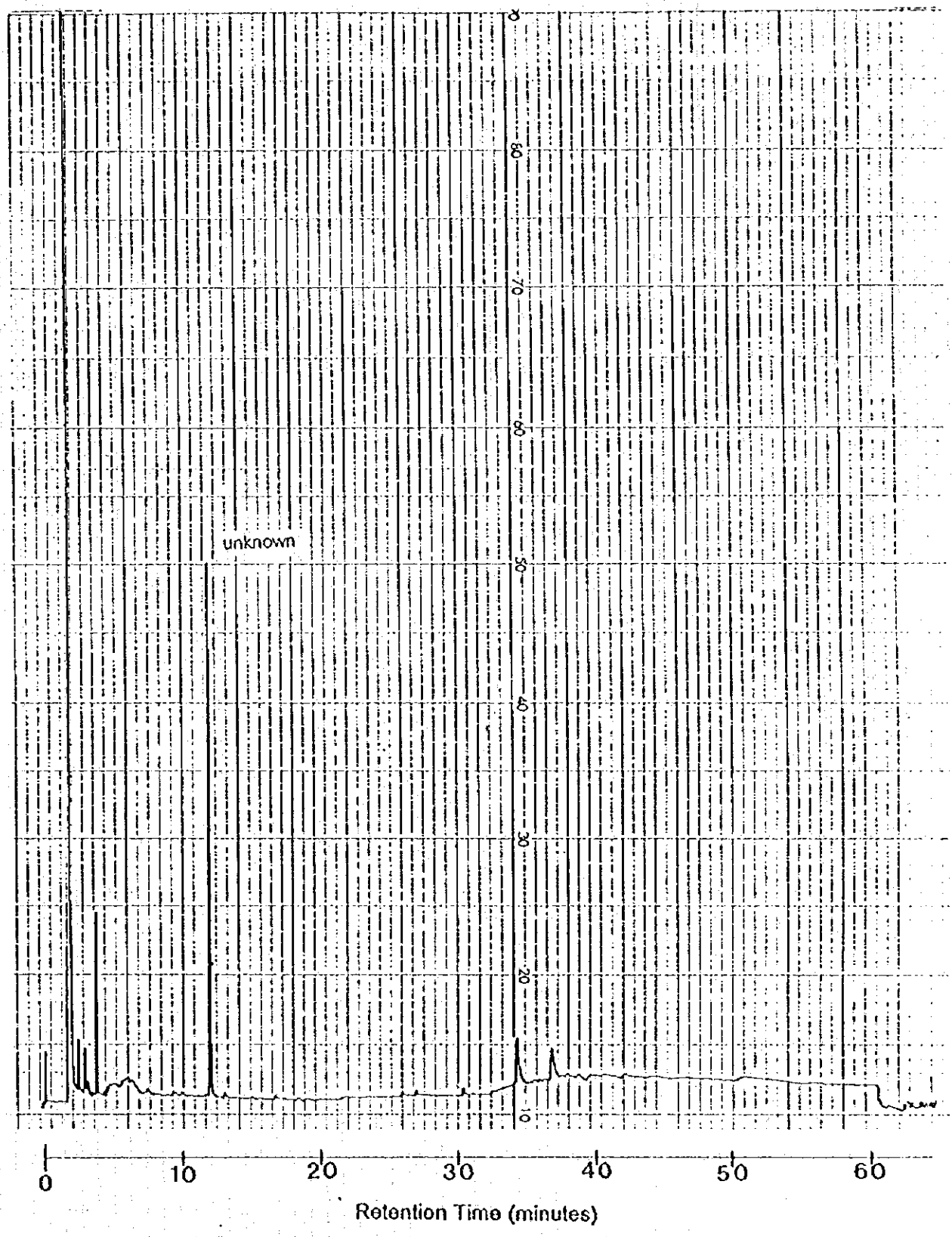

FIGURE (5): GC-ECD chromatogram of distilled deionised water blank (DDW). Unknown peak was tentatively identified as amylene present as a stabiliser in dichloromethane used for sample extraction.

FIGURE (6): GC-ECD chromatogram of syringe solvent blank (hexane, hplc-grade).

4-c

Table (1/5) Predicted Nitrate Concentration and Average Reach Time (Prsent)

Number of Node	901
Number of Pipe	917
Number of Source	50

Source No.	Source Name	NO3 (mg/l)
34	N34	25
51	N51	25
58	N58	4
71	N71	4
94	N94	25
130	N130	4
143	N143	4
149	N149	4
158	N158	4
207	N207	4
217	N217	4
432	N432	4
452	N452	4
477	N477	20
514	N514	4
519	N519	4
531	N531	4
536	N536	26
694	N694	4
722	N722	25
725	N725	23
728	N728	17
729	N729	17
733	N733	25
734	N734	25
736	N736	29
738	N738	30
748	N748	35
749	N749	30
753	N753	40
754	N754	35
757	N757	30
758	N758	30
759	N759	30
763	N763	35
764	N764	25
768	N768	25
775	N775	45
778	N778	35
780	N780	25
782	N782	25
784	N784	25
800	N800	25
838	N838	25
841	N841	10
842	N842	10
847	N847	25
850	N850	25
853	N853	25
897	N897	25

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N1	25.00	0.9	N57	25.00	0.7
N2	25.00	0.5	N58	4.00	0.0
N3	25.00	0.5	N59	4.00	0.0
N4	25.00	0.5	N60	4.00	0.1
N5	25.00	0.7	N61	4.00	0.6
N6	25.00	0.6	N62	4.00	0.7
N7	25.00	0.6	N63	4.00	0.9
N8	25.00	0.6	N64	4.00	1.0
N9	25.00	0.5	N65	4.00	1.0
N10	25.00	0.5	N66	4.00	1.0
N11	25.00	0.5	N67	4.00	1.2
N12	25.00	0.4	N68	4.00	1.1
N13	25.00	0.4	N69	25.00	0.2
N14	25.00	0.4	N70	25.00	0.4
N15	25.00	0.4	N71	4.00	0.0
N16	25.00	0.4	N72	4.00	0.0
N17	25.00	0.3	N73	4.00	0.0
N18	25.00	0.3	N74	4.00	0.0
N19	25.00	0.3	N75	4.00	0.0
N20	25.00	0.3	N76	4.00	0.0
N21	4.00	0.4	N77	4.00	0.0
N22	4.00	2.1	N78	4.00	0.1
N23	4.00	2.2	N79	4.00	0.1
N24	4.00	2.4	N80	4.00	0.1
N25	4.00	2.5	N81	4.00	0.1
N26	4.00	4.3	N82	4.00	0.2
N27	25.00	0.2	N83	4.00	0.2
N28	25.00	0.2	N84	4.00	0.2
N29	25.00	0.1	N85	4.00	0.3
N30	25.00	0.1	N86	4.00	0.3
N31	25.00	0.1	N87	4.00	0.3
N32	25.00	0.1	N88	25.00	6.1
N33	25.00	0.0	N89	25.00	2.4
N34	25.00	0.0	N90	25.00	0.1
N35	4.00	0.3	N91	4.00	0.3
N36	4.00	0.2	N92	4.00	0.3
N37	N/A	N/A	N93	4.00	0.3
N38	N/A	N/A	N94	25.00	0.0
N39	N/A	N/A	N95	25.00	0.7
N40	N/A	N/A	N96	25.00	0.8
N41	N/A	N/A	N97	25.00	0.9
N42	N/A	N/A	N98	25.00	1.4
N43	N/A	N/A	N99	25.00	2.1
N44	4.00	3.8	N100	25.00	2.2
N45	4.00	4.0	N101	25.00	18.4
N46	4.00	4.4	N102	25.00	2.6
N47	25.00	0.8	N103	25.00	2.9
N48	25.00	0.9	N104	25.00	4.4
N49	25.00	0.9	N105	25.00	1.5
N50	25.00	2.4	N106	25.00	1.6
N51	25.00	0.0	N107	25.00	1.6
N52	25.00	2.0	N108	25.00	1.7
N53	25.00	0.2	N109	10.00	0.0
N54	25.00	0.4	N110	10.00	0.4
N55	25.00	0.6	N111	10.00	1.1
N56	25.00	0.7	N112	10.00	1.3

note N/A : isolated node

Table (2/5) Predicted Nitrate Concentration and Average Reach Time (Prsent)

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N113	10.00	1.9	N170	4.00	0.9	N227	4.00	4.4	N284	4.00	2.2
N114	10.00	2.4	N171	4.00	1.8	N228	4.00	1.4	N285	4.00	1.7
N115	10.00	0.1	N172	4.00	0.7	N229	4.00	1.5	N286	4.00	1.7
N116	10.00	2.1	N173	4.00	1.6	N230	4.00	2.1	N287	4.00	1.9
N117	10.00	3.2	N174	4.00	0.8	N231	4.00	4.2	N288	4.00	7.5
N118	10.00	4.6	N175	4.00	0.8	N232	4.00	3.9	N289	4.00	3.6
N119	25.00	2.2	N176	4.00	0.7	N233	4.00	3.5	N290	4.00	2.9
N120	25.00	2.5	N177	4.00	0.8	N234	4.00	3.4	N291	4.00	2.5
N121	N/A	N/A	N178	4.00	1.0	N235	4.00	3.4	N292	4.00	2.3
N122	4.00	0.3	N179	4.00	1.1	N236	N/A	N/A	N293	4.00	1.6
N123	4.00	0.3	N180	4.00	0.7	N237	4.00	2.2	N294	4.00	1.2
N124	4.00	0.2	N181	4.00	0.9	N238	4.00	2.1	N295	4.00	1.2
N125	4.00	0.2	N182	4.00	0.8	N239	6.19	10.2	N296	4.00	1.1
N126	4.00	0.1	N183	4.00	0.8	N240	6.19	5.6	N297	4.00	0.8
N127	4.00	0.1	N184	4.00	0.8	N241	6.19	5.1	N298	4.00	0.8
N128	4.00	0.1	N185	4.00	0.8	N242	6.19	5.8	N299	4.00	1.0
N129	4.00	0.0	N186	4.00	0.3	N243	6.19	7.2	N300	4.00	1.0
N130	4.00	0.0	N187	4.00	0.3	N244	6.19	7.5	N301	4.00	1.0
N131	4.00	0.6	N188	4.00	0.4	N245	6.19	8.3	N302	4.00	1.2
N132	4.00	0.4	N189	4.00	0.5	N246	6.19	13.6	N303	4.00	1.2
N133	4.00	0.3	N190	4.00	0.7	N247	6.19	16.9	N304	4.00	1.2
N134	4.00	0.3	N191	4.00	0.2	N248	7.05	1.0	N305	4.00	1.3
N135	4.00	0.3	N192	4.00	1.9	N249	4.00	1.1	N306	4.00	1.3
N136	4.00	0.5	N193	4.00	0.6	N250	4.00	0.8	N307	4.00	1.3
N137	4.00	0.8	N194	4.00	1.2	N251	4.00	0.8	N308	4.00	1.4
N138	4.00	1.1	N195	4.00	1.6	N252	4.00	0.8	N309	4.00	2.9
N139	4.00	2.6	N196	4.00	1.9	N253	4.00	1.7	N310	4.00	2.5
N140	4.00	0.2	N197	4.00	2.1	N254	N/A	N/A	N311	4.00	2.2
N141	4.00	0.2	N198	4.00	2.3	N255	4.00	1.1	N312	4.00	2.2
N142	4.00	0.1	N199	4.00	2.7	N256	4.00	1.0	N313	4.00	2.1
N143	4.00	0.0	N200	4.00	2.8	N257	4.00	1.0	N314	4.00	2.0
N144	4.00	1.8	N201	4.00	4.5	N258	4.00	1.0	N315	4.00	2.0
N145	4.00	1.7	N202	4.00	8.7	N259	4.00	0.9	N316	4.00	2.0
N146	4.00	0.7	N203	4.00	7.0	N260	4.00	6.5	N317	4.00	1.9
N147	4.00	0.5	N204	4.00	0.7	N261	4.00	0.8	N318	4.00	1.9
N148	4.00	0.5	N205	4.00	0.1	N262	7.42	1.9	N319	4.00	1.8
N149	4.00	0.0	N206	4.00	0.0	N263	7.42	1.6	N320	4.00	1.8
N150	4.00	0.9	N207	4.00	0.0	N264	4.00	0.9	N321	4.00	1.9
N151	4.00	0.7	N208	4.00	2.6	N265	4.00	0.9	N322	25.00	7.0
N152	4.00	0.7	N209	4.00	1.5	N266	4.00	0.9	N323	4.00	2.4
N153	4.00	0.3	N210	4.00	0.3	N267	4.00	1.1	N324	4.00	2.2
N154	4.00	0.2	N211	4.00	0.2	N268	4.00	1.1	N325	4.00	2.0
N155	4.00	0.2	N212	4.00	0.2	N269	4.00	1.1	N326	4.00	2.0
N156	4.00	0.1	N213	4.00	0.2	N270	4.00	1.2	N327	4.00	1.6
N157	4.00	0.1	N214	4.00	0.1	N271	4.00	1.2	N328	4.00	1.6
N158	4.00	0.0	N215	4.00	0.1	N272	4.00	1.0	N329	4.00	1.5
N159	4.00	0.3	N216	4.00	0.1	N273	4.00	1.6	N330	4.00	1.5
N160	4.00	0.3	N217	4.00	0.0	N274	4.00	1.9	N331	4.00	1.5
N161	4.00	0.3	N218	25.00	1.8	N275	4.00	0.7	N332	4.00	1.5
N162	4.00	0.2	N219	25.00	1.9	N276	4.00	0.7	N333	4.00	1.4
N163	4.00	0.3	N220	25.00	2.0	N277	4.00	0.6	N334	4.00	1.6
N164	4.00	0.9	N221	25.00	1.5	N278	4.00	0.6	N335	4.00	1.6
N165	4.00	0.9	N222	25.00	1.4	N279	4.00	0.5	N336	4.00	2.3
N166	4.00	1.1	N223	25.00	1.3	N280	4.00	1.0	N337	4.00	2.4
N167	4.00	0.6	N224	25.00	1.2	N281	4.00	1.2	N338	4.00	2.4
N168	4.00	0.6	N225	25.00	1.2	N282	4.00	2.4	N339	4.00	2.5
N169	4.00	0.7	N226	25.00	1.1	N283	4.00	2.6	N340	4.00	2.8

note : N/A : isolated node

Table (3/5) Predicted Nitrate Concentration and Average Reach Time (Prsent)

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N341	4.00	2.4	N395	25.00	1.0	N455	25.00	0.2	N512	N/A	N/A
N342	4.00	2.0	N399	25.00	1.5	N456	25.00	0.3	N513	4.00	5.3
N343	4.00	2.0	N400	25.00	2.3	N457	25.00	3.1	N514	4.00	0.0
N344	4.00	1.9	N401	25.00	3.0	N458	25.00	0.3	N515	4.00	0.0
N345	4.00	1.9	N402	4.00	0.2	N459	25.00	1.2	N516	4.00	0.1
N346	4.00	1.9	N403	4.00	0.2	N460	25.00	0.5	N517	4.00	1.5
N347	4.00	4.7	N404	4.00	0.2	N461	4.00	2.8	N518	4.00	9.5
N348	4.00	3.3	N405	4.00	0.2	N462	25.00	7.1	N519	4.00	0.0
N349	4.00	3.1	N406	25.00	1.6	N463	N/A	N/A	N520	4.00	0.1
N350	4.00	0.8	N407	25.00	1.5	N464	4.00	0.5	N521	4.00	0.1
N351	4.00	0.7	N408	25.00	1.4	N465	4.00	0.6	N522	4.00	0.4
N352	4.00	0.6	N409	25.00	1.4	N466	4.00	0.5	N523	4.00	0.2
N353	4.00	0.5	N410	25.00	1.3	N467	4.00	1.9	N524	4.00	0.5
N354	4.00	0.4	N411	25.00	1.3	N468	N/A	N/A	N525	4.00	0.8
N355	4.00	0.4	N412	25.00	1.2	N469	4.00	0.8	N526	4.00	2.2
N356	25.00	1.6	N413	25.00	1.4	N470	4.00	3.9	N527	4.00	28.2
N357	25.00	1.8	N414	7.42	1.3	N471	N/A	N/A	N528	4.00	1.1
N358	25.00	2.3	N415	4.00	0.3	N472	4.00	0.9	N529	4.00	0.3
N359	4.00	17.6	N416	4.00	1.1	N473	N/A	N/A	N530	4.00	0.1
N360	4.00	1.0	N417	4.00	2.9	N474	7.08	1.1	N531	4.00	0.0
N361	4.00	1.0	N418	4.00	3.0	N475	7.42	1.1	N532	4.00	0.4
N362	4.00	1.0	N419	4.00	3.1	N476	7.08	0.9	N533	4.00	1.0
N363	4.00	1.0	N420	4.00	4.3	N477	20.00	0.0	N534	4.00	1.3
N364	4.00	1.4	N421	4.00	5.0	N478	20.00	0.0	N535	4.00	0.8
N365	30.00	0.2	N422	4.00	6.2	N479	20.00	0.0	N536	26.00	0.0
N366	4.00	3.5	N423	N/A	N/A	N480	20.00	0.1	N537	4.00	0.9
N367	4.00	3.4	N424	4.00	26.2	N481	20.00	0.1	N538	18.05	0.3
N368	4.00	3.0	N425	4.00	7.6	N482	20.00	0.2	N539	4.00	1.9
N369	4.00	2.8	N426	4.00	16.6	N483	20.00	0.3	N540	4.00	0.9
N370	4.00	2.2	N427	N/A	N/A	N484	6.19	4.3	N541	4.00	0.8
N371	4.00	2.0	N428	4.00	114.4	N485	6.19	4.9	N542	4.00	0.9
N372	4.00	1.6	N429	4.00	18.4	N486	6.19	7.3	N543	4.00	0.9
N373	4.00	1.3	N430	N/A	N/A	N487	6.19	3.8	N544	4.00	1.1
N374	4.00	1.4	N431	4.00	134.5	N488	6.19	4.2	N545	4.00	1.1
N375	4.00	2.0	N432	4.00	0.0	N489	6.19	4.1	N546	4.00	1.2
N376	4.00	2.9	N433	4.00	0.1	N490	6.19	4.0	N547	4.00	0.9
N377	4.00	1.5	N434	4.00	0.2	N491	25.00	1.6	N548	4.00	0.9
N378	4.00	2.3	N435	4.00	0.2	N492	25.00	1.4	N549	4.00	0.9
N379	4.00	1.6	N436	4.00	0.4	N493	25.00	1.2	N550	4.00	1.0
N380	4.00	1.5	N437	4.00	0.5	N494	25.00	1.1	N551	4.00	1.0
N381	4.00	1.5	N438	4.00	0.7	N495	25.00	1.3	N552	9.53	0.7
N382	4.00	3.7	N439	4.00	0.7	N496	25.00	1.6	N553	18.05	0.3
N383	4.00	1.3	N440	4.00	0.9	N497	6.19	3.5	N554	18.05	0.3
N384	4.00	1.1	N441	4.00	1.0	N498	25.00	1.4	N555	18.05	0.3
N385	4.00	1.5	N442	4.00	1.0	N499	25.00	1.3	N556	18.05	0.4
N386	4.00	1.3	N443	4.00	1.1	N500	25.00	1.1	N557	18.05	0.3
N387	4.00	1.3	N444	4.00	1.2	N501	25.00	1.1	N558	18.05	0.4
N388	4.00	1.5	N445	4.00	1.3	N502	4.00	8.5	N559	18.05	0.4
N389	4.00	1.4	N446	4.00	1.8	N503	N/A	N/A	N560	18.05	0.4
N390	4.00	2.9	N447	4.00	1.9	N504	4.00	0.6	N561	4.00	0.3
N391	4.00	2.3	N448	4.00	2.0	N505	4.00	0.6	N562	4.00	0.4
N392	4.00	2.5	N449	4.00	2.3	N506	4.00	0.7	N563	4.00	0.4
N393	4.00	2.1	N450	4.00	2.4	N507	4.00	0.5	N564	4.00	0.4
N394	4.00	2.1	N451	4.00	3.6	N508	4.00	31.1	N565	9.53	0.6
N395	4.00	2.7	N452	4.00	0.0	N509	4.00	0.5	N566	9.53	0.9
N396	25.00	0.5	N453	25.00	2.2	N510	4.00	0.6	N567	9.53	0.6
N397	25.00	0.6	N454	25.00	0.1	N511	4.00	5.1	N568	4.00	1.2

note N/A : isolated node

Table (4/5) Predicted Nitrate Concentration and Average Reach Time (Prsent)

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N569	4.00	1.1	N626	4.00	2.3	N683	25.00	0.4	N740	4.00	2.0
N570	4.00	1.1	N627	4.00	3.9	N684	25.00	0.4	N741	28.16	0.4
N571	4.00	1.2	N628	4.00	2.3	N685	25.00	1.7	N742	28.16	0.5
N572	4.00	1.3	N629	4.00	3.2	N686	25.00	1.6	N743	28.46	3.4
N573	4.00	1.6	N630	4.00	2.2	N687	25.00	0.9	N744	30.00	2.5
N574	4.00	1.6	N631	4.00	0.9	N688	25.00	0.6	N745	30.00	0.3
N575	4.00	1.7	N632	4.00	1.1	N689	25.00	0.6	N746	30.00	0.0
N576	4.00	1.7	N633	4.00	1.2	N690	25.00	0.7	N747	31.83	0.0
N577	4.00	1.1	N634	4.00	1.1	N691	25.00	0.7	N748	35.00	0.0
N578	4.00	1.6	N635	4.00	1.1	N692	25.00	0.4	N749	30.00	0.0
N579	4.00	1.3	N636	4.00	1.0	N693	25.00	0.4	N750	28.16	0.6
N580	4.00	1.3	N637	4.00	1.0	N694	4.00	0.0	N751	30.99	0.5
N581	4.00	1.6	N638	4.00	1.1	N695	4.00	0.3	N752	35.00	0.0
N582	4.00	1.7	N639	4.00	1.1	N696	4.00	0.4	N753	40.00	0.0
N583	4.00	1.6	N640	4.00	1.4	N697	4.00	0.4	N754	35.00	0.0
N584	4.00	2.1	N641	4.00	1.3	N698	4.00	1.5	N755	30.00	0.2
N585	4.00	2.5	N642	4.00	1.3	N699	4.00	0.8	N756	30.00	0.0
N586	4.00	3.1	N643	4.00	1.4	N700	4.00	1.3	N757	30.00	0.0
N587	4.00	3.6	N644	4.00	1.7	N701	4.00	2.3	N758	30.00	0.0
N588	6.30	4.0	N645	4.00	2.1	N702	4.00	2.9	N759	30.00	0.0
N589	4.00	3.5	N646	4.00	0.2	N703	4.00	0.2	N760	11.19	0.3
N590	4.00	0.3	N647	4.00	0.3	N704	4.00	0.4	N761	11.19	0.3
N591	4.00	1.4	N648	4.00	0.5	N705	4.00	0.8	N762	11.19	0.4
N592	4.00	1.1	N649	4.00	0.6	N706	4.00	2.2	N763	35.00	0.0
N593	4.00	1.2	N650	4.00	0.7	N707	4.00	3.6	N764	25.00	0.0
N594	4.00	1.5	N651	4.00	0.5	N708	4.00	0.5	N765	25.00	0.0
N595	4.00	1.7	N652	4.00	0.7	N709	4.00	0.5	N766	25.00	0.0
N596	4.00	1.8	N653	4.00	0.9	N710	4.00	0.1	N767	25.00	0.0
N597	4.00	2.1	N654	4.00	1.2	N711	4.00	0.4	N768	25.00	0.0
N598	4.00	2.3	N655	4.00	1.4	N712	4.00	0.4	N769	4.00	0.7
N599	4.00	4.1	N656	4.00	2.2	N713	4.00	0.5	N770	4.00	0.7
N600	N/A	N/A	N657	4.00	4.1	N714	4.00	1.0	N771	4.00	1.2
N601	4.00	1.3	N658	9.53	0.7	N715	4.00	0.5	N772	4.00	3.5
N602	4.00	1.5	N659	9.53	0.7	N716	4.00	0.7	N773	4.00	3.5
N603	4.00	1.3	N660	4.00	1.0	N717	4.00	0.7	N774	8.14	2.1
N604	4.00	1.5	N661	4.00	1.0	N718	4.00	1.1	N775	45.00	0.0
N605	4.00	1.6	N662	4.00	1.1	N719	7.42	1.1	N776	4.00	1.5
N606	4.00	2.4	N663	4.00	0.9	N720	7.05	1.7	N777	4.00	1.5
N607	4.00	2.9	N664	25.00	0.1	N721	25.00	0.1	N778	35.00	0.0
N608	7.05	1.0	N665	N/A	N/A	N722	25.00	0.0	N779	25.00	1.1
N609	11.36	1.1	N666	4.00	0.8	N723	7.05	2.1	N780	25.00	0.0
N610	25.00	0.0	N667	4.00	1.1	N724	11.36	0.9	N781	25.00	0.0
N611	4.00	3.6	N668	4.00	1.2	N725	23.00	0.0	N782	25.00	0.0
N612	4.00	3.7	N669	4.00	1.7	N726	12.27	1.3	N783	25.00	0.0
N613	4.00	1.6	N670	4.00	1.0	N727	12.27	1.3	N784	25.00	0.0
N614	4.00	1.3	N671	4.00	1.0	N728	17.00	0.0	N785	4.00	1.2
N615	4.00	1.3	N672	25.00	3.4	N729	17.00	0.0	N786	4.00	1.7
N616	4.00	0.8	N673	25.00	2.7	N730	7.05	3.3	N787	4.00	0.5
N617	4.00	3.9	N674	25.00	1.9	N731	25.00	0.0	N788	4.00	0.5
N618	4.00	6.0	N675	25.00	0.1	N732	25.00	0.0	N789	4.00	0.5
N619	N/A	N/A	N676	25.00	0.0	N733	25.00	0.0	N790	4.00	0.7
N620	4.00	2.2	N677	25.00	0.4	N734	25.00	0.0	N791	4.00	0.5
N621	N/A	N/A	N678	25.00	0.2	N735	29.13	0.3	N792	4.00	0.5
N622	N/A	N/A	N679	25.00	0.1	N736	29.00	0.0	N793	4.00	0.5
N623	N/A	N/A	N680	25.00	0.4	N737	30.00	0.0	N794	4.00	0.6
N624	4.00	2.2	N681	25.00	0.3	N738	30.00	0.0	N795	4.00	0.7
N625	4.00	2.2	N682	25.00	0.3	N739	4.00	1.7	N796	4.00	0.8

note N/A : isolated node

Table (5/5) Predicted Nitrate Concentration and Average Reach Time (Prsent)

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N797	4.00	0.8	N849	25.00	17.1	N901	25.00	0.0
N798	25.00	0.4	N850	25.00	0.0			
N799	25.00	0.4	N851	25.00	4.1			
N800	25.00	0.0	N852	25.00	11.1			
N801	25.00	0.0	N853	25.00	0.0			
N802	25.00	0.0	N854	25.00	0.4			
N803	25.00	0.0	N855	25.00	0.8			
N804	25.00	0.0	N856	25.00	1.5			
N805	25.00	0.2	N857	N/A	N/A			
N806	25.00	0.2	N858	N/A	N/A			
N807	23.00	0.0	N859	25.00	9.5			
N808	23.00	0.0	N860	25.00	0.1			
N809	25.00	0.0	N861	25.00	4.9			
N810	25.00	0.0	N862	25.00	0.9			
N811	25.00	0.0	N863	N/A	N/A			
N812	25.00	0.0	N864	N/A	N/A			
N813	30.00	0.0	N865	N/A	N/A			
N814	30.00	0.0	N866	N/A	N/A			
N815	35.00	0.0	N867	25.00	0.1			
N816	35.00	0.0	N868	25.00	2.0			
N817	35.00	0.0	N869	25.00	2.1			
N818	35.00	0.0	N870	25.00	1.7			
N819	4.00	1.5	N871	25.00	1.8			
N820	4.00	1.5	N872	25.00	1.9			
N821	37.95	0.0	N873	25.00	2.6			
N822	40.00	0.0	N874	25.00	4.3			
N823	23.84	1.3	N875	25.00	3.4			
N824	45.00	0.1	N876	25.00	2.5			
N825	30.00	0.0	N877	25.00	2.0			
N826	30.00	0.0	N878	25.00	2.4			
N827	30.00	0.0	N879	25.00	2.2			
N828	30.00	0.0	N880	25.00	1.3			
N829	30.00	0.0	N881	25.00	1.7			
N830	30.00	0.0	N882	25.00	1.7			
N831	30.00	0.0	N883	25.00	1.8			
N832	30.00	0.0	N884	25.00	1.9			
N833	29.00	0.0	N885	25.00	1.8			
N834	29.00	0.0	N886	25.00	2.1			
N835	25.00	0.1	N887	20.00	0.0			
N836	25.00	0.1	N888	20.00	0.0			
N837	4.00	0.4	N889	16.88	0.0			
N838	25.00	0.0	N890	17.00	0.0			
N839	25.00	0.2	N891	25.00	0.0			
N840	4.00	0.3	N892	25.00	0.0			
N841	10.00	0.0	N893	27.79	0.1			
N842	10.00	0.0	N894	35.00	0.0			
N843	4.00	0.3	N895	25.00	2.1			
N844	25.00	0.3	N896	4.00	0.1			
N845	25.00	21.9	N897	25.00	0.0			
N846	25.00	0.0	N898	4.00	0.1			
N847	25.00	0.0	N899	4.00	0.1			
N848	25.00	0.0	N900	25.00	0.0			

note N/A : isolated node

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Table (1/5) Predicted Nitrate Concentration and Average Reach Time (DMA)

Number of Node	901
Number of Pipe	917
Number of Source	50

Source No.	Source Name	NO3 (mg/l)
34	N34	25
51	N51	25
58	N58	4
71	N71	4
94	N94	25
130	N130	4
143	N143	4
149	N149	4
158	N158	4
207	N207	4
217	N217	4
432	N432	4
452	N452	4
477	N477	20
514	N514	4
519	N519	4
531	N531	4
536	N536	26
694	N694	4
722	N722	25
725	N725	23
728	N728	17
729	N729	17
733	N733	25
734	N734	25
736	N736	29
738	N738	30
748	N748	35
749	N749	30
753	N753	40
754	N754	35
757	N757	30
758	N758	30
759	N759	30
763	N763	35
764	N764	25
768	N768	25
775	N775	45
778	N778	35
780	N780	25
782	N782	25
784	N784	25
800	N800	25
838	N838	25
841	N841	10
842	N842	10
847	N847	25
850	N850	25
853	N853	25
897	N897	25

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N1	25.00	0.8	N57	25.00	0.7
N2	25.00	0.8	N58	4.00	0.0
N3	25.00	0.7	N59	4.00	0.0
N4	25.00	0.7	N60	4.00	0.1
N5	25.00	0.7	N61	4.00	0.4
N6	25.00	0.6	N62	4.00	0.5
N7	25.00	0.5	N63	4.00	0.6
N8	25.00	0.5	N64	4.00	0.6
N9	25.00	0.5	N65	4.00	0.7
N10	25.00	0.4	N66	4.00	0.7
N11	25.00	0.4	N67	4.00	0.7
N12	25.00	0.4	N68	4.00	0.7
N13	25.00	0.4	N69	25.00	0.2
N14	25.00	0.4	N70	25.00	0.3
N15	25.00	0.3	N71	4.00	0.0
N16	25.00	0.3	N72	4.00	0.0
N17	25.00	0.3	N73	4.00	0.0
N18	25.00	0.3	N74	4.00	0.0
N19	25.00	0.3	N75	4.00	0.0
N20	25.00	0.2	N76	4.00	0.0
N21	4.00	0.4	N77	4.00	0.0
N22	4.00	2.0	N78	4.00	0.1
N23	4.00	2.0	N79	4.00	0.1
N24	4.00	2.2	N80	4.00	0.1
N25	4.00	2.3	N81	4.00	0.1
N26	4.00	4.0	N82	4.00	0.2
N27	25.00	0.2	N83	4.00	0.2
N28	25.00	0.1	N84	4.00	0.2
N29	25.00	0.1	N85	4.00	0.3
N30	25.00	0.1	N86	4.00	0.3
N31	25.00	0.1	N87	4.00	0.3
N32	25.00	0.1	N88	25.00	5.6
N33	25.00	0.0	N89	25.00	2.2
N34	25.00	0.0	N90	25.00	0.1
N35	4.00	0.3	N91	4.00	0.3
N36	4.00	0.2	N92	4.00	0.3
N37	N/A	N/A	N93	4.00	0.3
N38	N/A	N/A	N94	25.00	0.0
N39	N/A	N/A	N95	25.00	0.7
N40	N/A	N/A	N96	25.00	0.7
N41	N/A	N/A	N97	25.00	0.8
N42	N/A	N/A	N98	25.00	1.3
N43	N/A	N/A	N99	25.00	1.9
N44	4.00	3.5	N100	25.00	2.1
N45	4.00	3.7	N101	25.00	17.0
N46	4.00	4.1	N102	25.00	2.4
N47	25.00	0.7	N103	25.00	2.7
N48	25.00	0.8	N104	25.00	4.1
N49	25.00	0.9	N105	25.00	1.5
N50	25.00	2.2	N106	25.00	1.6
N51	25.00	0.0	N107	25.00	1.6
N52	25.00	2.8	N108	25.00	1.6
N53	25.00	0.2	N109	10.00	0.0
N54	25.00	0.4	N110	10.00	0.3
N55	25.00	0.5	N111	10.00	1.0
N56	25.00	0.7	N112	10.00	1.2

note N/A : Isolated node

Table (2/5) Predicted Nitrate Concentration and Average Reach Time (DMA)

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N113	10.00	1.8	N170	4.00	1.3	N227	4.00	1.6	N284	4.00	1.3
N114	10.00	2.2	N171	4.00	2.1	N228	4.00	0.5	N285	4.00	2.5
N115	10.00	0.1	N172	4.00	1.0	N229	4.00	0.5	N286	4.00	2.6
N116	10.00	1.9	N173	4.00	1.8	N230	4.00	0.8	N287	4.00	2.9
N117	10.00	3.0	N174	4.00	1.0	N231	4.00	1.5	N288	4.00	7.0
N118	10.00	4.2	N175	4.00	1.0	N232	4.00	1.3	N289	4.00	3.4
N119	25.00	2.1	N176	4.00	1.0	N233	4.00	1.2	N290	4.00	2.9
N120	25.00	2.3	N177	4.00	1.0	N234	4.00	1.1	N291	4.00	2.7
N121	N/A	N/A	N178	4.00	0.9	N235	4.00	1.1	N292	4.00	2.6
N122	4.00	0.3	N179	4.00	0.8	N236	N/A	N/A	N293	4.00	2.1
N123	4.00	0.3	N150	4.00	0.8	N237	4.00	0.8	N294	4.00	1.5
N124	4.00	0.2	N181	4.00	1.1	N238	4.00	0.8	N295	4.00	1.4
N125	4.00	0.2	N182	4.00	1.0	N239	6.84	4.3	N296	4.00	1.3
N126	4.00	0.1	N183	4.00	1.0	N240	6.84	2.2	N297	4.00	0.8
N127	4.00	0.1	N184	4.00	1.0	N241	6.84	2.0	N298	4.00	0.8
N128	4.00	0.1	N185	4.00	0.8	N242	6.84	2.3	N299	4.00	1.1
N129	4.00	0.0	N186	4.00	0.3	N243	6.84	2.9	N300	4.00	1.1
N130	4.00	0.0	N187	4.00	0.3	N244	6.84	3.1	N301	4.00	1.1
N131	4.00	0.6	N188	4.00	0.4	N245	6.84	3.4	N302	4.00	1.5
N132	4.00	0.3	N189	4.00	0.5	N246	6.84	5.9	N303	4.00	1.5
N133	4.00	0.3	N190	4.00	0.7	N247	6.84	7.4	N304	4.00	1.5
N134	4.00	0.3	N191	4.00	0.2	N248	6.91	0.5	N305	4.00	1.7
N135	4.00	0.3	N192	4.00	1.8	N249	4.00	0.6	N306	4.00	1.8
N136	4.00	0.5	N193	4.00	0.5	N250	4.00	0.4	N307	4.00	1.8
N137	4.00	0.7	N194	4.00	1.1	N251	4.00	0.4	N308	4.00	1.8
N138	4.00	1.0	N195	4.00	1.4	N252	4.00	0.4	N309	4.00	1.7
N139	4.00	2.4	N196	4.00	1.7	N253	4.00	0.9	N310	4.00	1.4
N140	4.00	0.2	N197	4.00	1.9	N254	N/A	N/A	N311	4.00	2.7
N141	4.00	0.1	N198	4.00	2.1	N255	4.00	0.7	N312	4.00	2.8
N142	4.00	0.1	N199	4.00	2.5	N256	4.00	0.7	N313	4.00	3.8
N143	4.00	0.0	N200	4.00	2.6	N257	4.00	0.7	N314	4.00	3.3
N144	4.00	1.6	N201	4.00	4.4	N258	4.00	0.7	N315	4.00	3.1
N145	4.00	1.5	N202	4.00	8.0	N259	4.00	0.6	N316	4.00	3.0
N146	4.00	0.6	N203	4.00	6.5	N260	4.00	3.1	N317	4.00	2.7
N147	4.00	0.5	N204	4.00	0.7	N261	4.00	0.6	N318	4.00	2.6
N148	4.00	0.4	N205	4.00	0.1	N262	7.00	0.9	N319	4.00	2.5
N149	4.00	0.0	N206	4.00	0.0	N263	7.00	0.8	N320	4.00	2.4
N150	4.00	0.9	N207	4.00	0.0	N264	4.00	0.5	N321	4.00	1.0
N151	4.00	0.7	N208	4.00	2.4	N265	4.00	0.5	N322	25.00	6.5
N152	4.00	0.7	N209	4.00	1.4	N266	4.00	0.5	N323	4.00	2.2
N153	4.00	0.3	N210	4.00	0.3	N267	4.00	0.5	N324	4.00	2.0
N154	4.00	0.2	N211	4.00	0.2	N268	4.00	0.5	N325	4.00	1.9
N155	4.00	0.2	N212	4.00	0.2	N269	4.00	0.6	N326	4.00	1.8
N156	4.00	0.2	N213	4.00	0.1	N270	4.00	0.6	N327	4.00	1.5
N157	4.00	0.1	N214	4.00	0.1	N271	4.00	0.6	N328	4.00	1.4
N158	4.00	0.0	N215	4.00	0.1	N272	4.00	0.5	N329	4.00	1.4
N159	4.00	0.3	N216	4.00	0.1	N273	4.00	0.5	N330	4.00	1.4
N160	4.00	0.3	N217	4.00	0.0	N274	4.00	0.9	N331	4.00	1.4
N161	4.00	0.3	N218	25.00	1.7	N275	4.00	0.4	N332	4.00	1.3
N162	4.00	0.2	N219	25.00	1.8	N276	4.00	0.3	N333	4.00	1.3
N163	4.00	0.3	N220	25.00	1.9	N277	4.00	0.3	N334	4.00	1.4
N164	4.00	1.5	N221	25.00	1.4	N278	4.00	0.3	N335	4.00	1.5
N165	4.00	1.5	N222	25.00	1.4	N279	4.00	0.3	N336	4.00	2.1
N166	4.00	1.7	N223	25.00	1.2	N280	4.00	0.7	N337	4.00	2.2
N167	4.00	1.3	N224	25.00	1.1	N281	4.00	0.5	N338	4.00	2.2
N168	4.00	1.1	N225	25.00	1.1	N282	4.00	1.9	N339	4.00	2.3
N169	4.00	1.1	N226	25.00	1.1	N283	4.00	0.6	N340	4.00	2.5

note N/A : isolated node

Table (3/5) Predicted Nitrate Concentration and Average Reach Time (DMA)

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N341	4.00	2.1	N395	25.00	0.9	N155	25.00	0.2	N512	N/A	N/A
N342	4.00	1.8	N399	25.00	1.4	N456	25.00	0.2	N513	4.00	4.9
N343	4.00	1.8	N100	25.00	2.1	N457	25.00	2.9	N514	4.00	0.0
N344	4.00	1.8	N101	25.00	2.7	N458	25.00	0.3	N515	4.00	0.0
N345	4.00	1.7	N102	4.00	0.2	N459	25.00	1.1	N516	4.00	0.1
N346	4.00	1.7	N103	4.00	0.2	N460	25.00	0.5	N517	4.00	1.4
N347	4.00	4.4	N104	4.00	0.2	N461	4.00	1.1	N518	4.00	8.8
N348	4.00	3.0	N105	4.00	0.1	N462	25.00	6.5	N519	4.00	0.0
N349	4.00	2.8	N106	25.00	1.3	N463	N/A	N/A	N520	4.00	0.1
N350	4.00	0.7	N107	25.00	1.3	N464	4.00	0.4	N521	4.00	0.1
N351	4.00	0.6	N108	25.00	1.2	N465	4.00	0.6	N522	4.00	0.4
N352	4.00	0.5	N109	25.00	1.1	N466	4.00	0.4	N523	4.00	0.2
N353	4.00	0.4	N110	25.00	1.1	N467	4.00	1.8	N524	4.00	0.4
N354	4.00	0.4	N111	25.00	1.0	N468	N/A	N/A	N525	4.00	0.7
N355	4.00	0.3	N112	25.00	1.0	N469	4.00	1.0	N526	4.00	2.0
N356	25.00	1.5	N113	25.00	1.3	N470	4.00	3.9	N527	4.00	26.0
N357	25.00	1.7	N114	7.00	1.3	N471	N/A	N/A	N528	4.00	1.0
N358	25.00	2.1	N115	4.00	0.2	N472	4.00	1.0	N529	4.00	0.2
N359	4.00	16.2	N116	4.00	1.0	N473	N/A	N/A	N530	4.00	0.1
N360	4.00	1.1	N117	4.00	2.6	N474	6.91	1.1	N531	4.00	0.0
N361	4.00	1.1	N118	4.00	2.7	N475	7.00	1.2	N532	4.00	0.4
N362	4.00	1.1	N119	4.00	2.8	N476	6.91	0.9	N533	4.00	1.0
N363	4.00	1.1	N120	4.00	3.9	N477	20.00	0.0	N534	4.00	1.2
N364	4.00	1.4	N121	4.00	4.6	N478	20.00	0.0	N535	4.00	0.8
N365	30.00	0.3	N122	4.00	5.7	N479	20.00	0.0	N536	26.00	0.0
N366	4.00	3.3	N123	N/A	N/A	N480	20.00	0.1	N537	4.00	0.9
N367	4.00	3.3	N124	4.00	24.0	N481	20.00	0.1	N538	4.00	1.0
N368	4.00	3.0	N125	4.00	7.0	N482	20.00	0.2	N539	4.00	1.8
N369	4.00	2.7	N126	4.00	15.3	N483	20.00	0.3	N540	4.00	0.9
N370	4.00	2.2	N127	N/A	N/A	N484	6.84	3.1	N541	4.00	0.8
N371	4.00	2.0	N128	4.00	105.2	N485	6.84	3.7	N542	4.00	1.1
N372	4.00	1.7	N129	4.00	17.0	N486	6.84	5.9	N543	4.00	1.1
N373	4.00	1.3	N130	N/A	N/A	N487	6.84	2.7	N544	4.00	0.8
N374	4.00	1.3	N131	4.00	123.7	N488	6.84	3.0	N545	4.00	1.0
N375	4.00	1.8	N132	4.00	0.0	N489	6.84	2.9	N546	4.00	1.1
N376	4.00	2.8	N133	4.00	0.0	N490	6.84	2.9	N547	4.00	0.9
N377	4.00	1.6	N134	4.00	0.2	N491	25.00	1.6	N548	4.00	0.9
N378	4.00	2.0	N135	4.00	0.2	N492	25.00	1.3	N549	4.00	0.9
N379	4.00	1.5	N136	4.00	0.4	N493	25.00	1.2	N550	4.00	1.0
N380	4.00	1.5	N137	4.00	0.5	N494	25.00	1.1	N551	4.00	1.0
N381	4.00	1.4	N138	4.00	0.6	N495	25.00	1.2	N552	N/A	N/A
N382	4.00	3.5	N139	4.00	0.7	N496	25.00	1.5	N553	4.00	1.0
N383	4.00	1.3	N140	4.00	0.9	N497	6.84	2.4	N554	4.00	1.0
N384	4.00	1.2	N141	4.00	0.9	N498	25.00	1.3	N555	4.00	1.0
N385	4.00	1.5	N142	4.00	0.9	N499	25.00	1.2	N556	4.00	1.0
N386	4.00	1.3	N143	4.00	1.0	N500	25.00	1.0	N557	4.00	1.0
N387	4.00	1.3	N144	4.00	1.1	N501	25.00	1.1	N558	4.00	1.0
N388	4.00	1.4	N145	4.00	1.2	N502	4.00	7.0	N559	4.00	1.1
N389	4.00	1.3	N146	4.00	1.7	N503	N/A	N/A	N560	4.00	1.1
N390	4.00	2.6	N147	4.00	1.8	N504	4.00	0.9	N561	4.00	0.3
N391	4.00	2.1	N148	4.00	1.9	N505	4.00	1.0	N562	4.00	0.5
N392	4.00	2.2	N149	4.00	2.2	N506	4.00	1.1	N563	4.00	0.6
N393	4.00	1.8	N150	4.00	2.2	N507	4.00	0.6	N564	4.00	0.6
N394	4.00	1.8	N151	4.00	3.3	N508	4.00	0.7	N565	9.71	0.9
N395	4.00	2.7	N152	4.00	0.0	N509	4.00	0.6	N566	N/A	N/A
N396	25.00	0.5	N153	25.00	3.1	N510	4.00	0.7	N567	9.71	0.9
N397	25.00	0.6	N154	25.00	0.1	N511	4.00	5.1	N568	4.00	1.7

note N/A : Isolated node

Table (4/5) Predicted Nitrate Concentration and Average Reach Time (DMA)

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N569	4.00	1.5	N626	4.00	1.9	N683	25.00	0.4	N740	4.00	2.0
N570	4.00	1.5	N627	4.00	3.3	N684	25.00	0.4	N741	16.38	1.2
N571	4.00	1.6	N628	4.00	1.8	N685	25.00	1.6	N742	16.38	1.2
N572	4.00	1.7	N629	4.00	2.7	N686	25.00	1.4	N743	16.38	1.5
N573	4.00	2.2	N630	4.00	2.1	N687	25.00	0.8	N744	18.34	4.2
N574	4.00	2.2	N631	4.00	0.9	N688	25.00	0.6	N745	30.00	0.4
N575	4.00	1.8	N632	4.00	1.0	N689	25.00	0.5	N746	30.00	0.0
N576	4.00	1.8	N633	4.00	1.1	N690	25.00	0.7	N747	31.19	0.0
N577	4.00	4.1	N634	4.00	1.0	N691	25.00	0.7	N748	35.00	0.0
N578	4.00	2.2	N635	4.00	1.0	N692	25.00	0.4	N749	30.00	0.0
N579	4.00	1.3	N636	4.00	0.9	N693	25.00	0.4	N750	16.38	1.3
N550	4.00	1.3	N637	4.00	0.9	N694	4.00	0.0	N751	22.50	1.0
N581	4.00	1.6	N638	4.00	1.0	N695	4.00	0.2	N752	35.00	0.0
N582	4.00	1.6	N639	4.00	1.0	N696	4.00	0.3	N753	40.00	0.0
N583	4.00	1.5	N640	4.00	1.3	N697	4.00	0.4	N754	35.00	0.0
N584	4.00	2.1	N641	4.00	1.2	N698	4.00	1.4	N755	30.00	0.2
N585	4.00	2.4	N642	4.00	1.2	N699	4.00	0.8	N756	30.00	0.0
N586	4.00	3.0	N643	4.00	1.3	N700	4.00	1.2	N757	30.00	0.0
N587	4.00	3.5	N644	4.00	1.5	N701	4.00	2.1	N758	30.00	0.0
N588	5.38	3.9	N645	4.00	1.9	N702	4.00	2.6	N759	30.00	0.0
N589	4.00	3.3	N646	4.00	0.3	N703	4.00	0.2	N760	11.01	0.5
N590	4.00	0.3	N647	4.00	0.3	N704	4.00	0.3	N761	11.01	0.5
N591	4.00	1.3	N648	4.00	0.5	N705	4.00	0.7	N762	11.01	0.5
N592	4.00	1.0	N649	4.00	0.6	N706	4.00	2.1	N763	35.00	0.0
N593	4.00	1.1	N650	4.00	0.7	N707	4.00	3.3	N764	25.00	0.0
N594	4.00	1.4	N651	4.00	0.5	N708	4.00	0.5	N765	4.00	1.1
N595	4.00	1.5	N652	4.00	0.7	N709	4.00	0.5	N766	4.00	1.1
N596	4.00	1.7	N653	4.00	0.9	N710	4.00	0.1	N767	4.00	1.2
N597	4.00	1.9	N654	4.00	1.1	N711	4.00	0.3	N768	25.00	0.0
N598	4.00	2.1	N655	4.00	1.3	N712	4.00	0.3	N769	4.00	0.8
N599	4.00	1.2	N656	4.00	2.1	N713	4.00	0.4	N770	4.00	0.8
N600	4.0	1.2	N657	4.00	3.8	N714	4.00	0.9	N771	4.00	1.2
N601	4.00	0.8	N658	N/A	N/A	N715	4.00	0.5	N772	4.00	3.3
N602	4.00	1.0	N659	N/A	N/A	N716	4.00	0.6	N773	4.00	3.3
N603	4.00	0.8	N660	4.00	1.2	N717	4.00	0.7	N774	5.14	1.9
N604	4.00	1.0	N661	4.00	1.1	N718	4.00	1.0	N775	45.00	0.0
N605	4.00	1.1	N662	4.00	1.2	N719	7.00	1.2	N776	4.00	1.5
N606	4.00	1.8	N663	4.00	0.9	N720	6.91	1.6	N777	4.00	1.5
N607	4.00	2.3	N664	4.00	1.5	N721	25.00	0.1	N778	35.00	0.0
N608	6.91	1.0	N665	N/A	N/A	N722	25.00	0.0	N779	25.00	0.9
N609	11.15	1.0	N666	4.00	0.8	N723	6.91	2.1	N780	25.00	0.0
N610	25.00	0.0	N667	4.00	1.8	N724	11.15	0.9	N781	25.00	0.0
N611	4.00	3.4	N668	4.00	1.5	N725	23.00	0.0	N782	25.00	0.0
N612	4.00	3.9	N669	4.00	2.3	N726	11.45	1.4	N783	25.00	0.0
N613	4.00	1.4	N670	4.00	1.0	N727	11.45	1.5	N784	25.00	0.0
N614	4.00	1.2	N671	4.00	1.0	N728	17.00	0.0	N785	4.00	1.9
N615	4.00	1.2	N672	25.00	3.1	N729	17.00	0.0	N786	4.00	2.3
N616	4.00	0.8	N673	25.00	2.5	N730	5.92	3.3	N787	4.00	0.5
N617	4.00	3.6	N674	25.00	1.7	N731	25.00	0.0	N788	4.00	0.5
N618	4.00	5.6	N675	25.00	0.0	N732	25.00	0.0	N789	4.00	0.5
N619	N/A	N/A	N676	25.00	0.0	N733	25.00	0.0	N790	4.00	0.6
N620	4.00	3.2	N677	25.00	0.2	N734	25.00	0.0	N791	4.00	0.5
N621	N/A	N/A	N678	25.00	0.3	N735	29.20	0.3	N792	4.00	0.5
N622	N/A	N/A	N679	25.00	0.1	N736	29.00	0.0	N793	4.00	0.5
N623	N/A	N/A	N680	25.00	0.5	N737	30.00	0.0	N794	4.00	0.5
N624	4.00	1.7	N681	25.00	0.3	N738	30.00	0.0	N795	4.00	0.6
N625	4.00	1.7	N682	25.00	0.3	N739	4.00	1.9	N796	4.00	0.7

note N/A : isolated node

Table (5/5) Predicted Nitrate Concentration and Average Reach Time (DMA)

Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)	Node	NO3 (mg/l)	Reach Time (hour)
N797	4.00	0.1	N849	25.00	15.8	N901	4.00	1.2
N798	25.00	0.0	N850	25.00	0.0	N902	N/A	N/A
N799	25.00	0.0	N851	25.00	3.8	N903	N/A	N/A
N800	25.00	0.0	N852	25.00	10.2	N904	N/A	N/A
N801	25.00	0.0	N853	25.00	0.0	N905	N/A	N/A
N802	25.00	0.0	N854	25.00	0.4	N906	N/A	N/A
N803	25.00	0.0	N855	25.00	0.7	N907	N/A	N/A
N804	25.00	0.0	N856	25.00	1.4	NV100_1	N/A	N/A
N805	25.00	0.0	N857	N/A	N/A	NV100_2	N/A	N/A
N806	25.00	0.0	N858	N/A	N/A	NV101_1	N/A	N/A
N807	23.00	0.0	N859	25.00	8.7	NV101_2	N/A	N/A
N808	23.00	0.0	N860	25.00	0.1	NV103_1	N/A	N/A
N809	25.00	0.0	N861	25.00	4.5	NV103_2	N/A	N/A
N810	25.00	0.0	N862	25.00	0.8	N920	N/A	N/A
N811	25.00	0.0	N863	N/A	N/A			
N812	25.00	0.0	N864	N/A	N/A			
N813	30.00	0.0	N865	N/A	N/A			
N814	30.00	0.0	N866	N/A	N/A			
N815	35.00	0.0	N867	25.00	0.1			
N816	35.00	0.0	N868	25.00	1.9			
N817	35.00	0.0	N869	25.00	1.9			
N818	35.00	0.0	N870	25.00	1.5			
N819	4.00	0.1	N871	25.00	1.6			
N820	4.00	0.1	N872	25.00	1.7			
N821	37.93	0.0	N873	25.00	2.3			
N822	40.00	0.0	N874	25.00	3.9			
N823	5.14	0.2	N875	25.00	3.1			
N824	5.14	0.2	N876	25.00	2.2			
N825	30.00	0.0	N877	25.00	1.7			
N826	30.00	0.0	N878	25.00	2.1			
N827	30.00	0.0	N879	25.00	2.0			
N828	30.00	0.0	N880	25.00	1.1			
N829	30.00	0.0	N881	25.00	1.5			
N830	30.00	0.0	N882	25.00	1.5			
N831	30.00	0.0	N883	25.00	1.6			
N832	30.00	0.0	N884	25.00	1.7			
N833	29.00	0.0	N885	25.00	1.6			
N834	29.00	0.0	N886	25.00	1.8			
N835	25.00	0.0	N887	20.00	0.0			
N836	25.00	0.0	N888	20.00	0.0			
N837	4.00	0.0	N889	16.75	0.1			
N838	25.00	0.0	N890	17.00	0.0			
N839	25.00	0.0	N891	25.00	0.0			
N840	4.00	0.0	N892	25.00	0.0			
N841	10.00	0.0	N893	27.65	0.2			
N842	10.00	0.0	N894	35.00	0.0			
N843	4.00	0.0	N895	25.00	1.9			
N844	25.00	0.0	N896	4.00	0.1			
N845	25.00	1.7	N897	25.00	0.0			
N846	25.00	0.0	N898	4.00	0.2			
N847	25.00	0.0	N899	4.00	0.2			
N848	25.00	0.0	N900	4.00	1.2			

note N/A : isolated node