

## **Lampiran 1**

### **Perbandingan Formulasi Numerik menggunakan Beban Konstan pada QUAL2K dan Model Matematis**



Ruas Sungai	dx (km)	A (km <sup>2</sup> )	V (km <sup>3</sup> )	W (kg/h)	W/V (kgkm <sup>3</sup> /h)	u (km/h)	D (km <sup>2</sup> /h)	Δt (h)
Ruas 1	10	10	100	10	0.1	8	7	1
Ruas 2 - Ruas 5	10	10	100	0	0	8	7	1

Lampiran 1

Model Teoritis

$$\frac{dc}{dt} = \frac{W(t)}{V} - u \frac{\partial c}{\partial x} + D \frac{\partial^2 c}{\partial x^2}$$

Initial

$c_0^{r0}$	4	Boundary	$c_0^{r1}$	4	$c_0^{r8}$	4
$c_1^{r0}$	4		$c_0^{r2}$	4	$c_0^{r9}$	4
$c_2^{r0}$	4		$c_0^{r3}$	4	$c_0^{r10}$	4
$c_3^{r0}$	4		$c_0^{r4}$	4	$c_0^{r11}$	4
$c_4^{r0}$	4		$c_0^{r5}$	4	$c_0^{r12}$	4
$c_5^{r0}$	4		$c_0^{r6}$	4		
$c_6^{r0}$	4		$c_0^{r7}$	4		

Boundary

$c_6^{r1}$	4	$c_6^{r4}$	4	$c_6^{r7}$	4	$c_6^{r10}$	4
$c_6^{r2}$	4	$c_6^{r5}$	4	$c_6^{r8}$	4	$c_6^{r11}$	4
$c_6^{r3}$	4	$c_6^{r6}$	4	$c_6^{r9}$	4	$c_6^{r12}$	4

	t1	$c_0^{r0}$	k1	k2	k3	k4	k mean	$c_0^{r1}$
Ruas 1	0	4						
	1		0.1	0.1	0.1	0.1	0.1	4.1
Ruas 2	0	4						
	1		0	0	0	0	0	4
Ruas 3	0	4						
	1		0	0	0	0	0	4
Ruas 4	0	4						
	1		0	0	0	0	0	4
Ruas 5	0	4						
	1		0	0	0	0	0	4

	t2	$c_0^{r1}$	k1	k2	k3	k4	k mean	$c_0^{r2}$
Ruas 1	1	4.1						
	2		0.166	0.166	0.166	0.166	0.166	4.266
Ruas 2	1	4						
	2		-0.073	-0.073	-0.073	-0.073	-0.073	3.927
Ruas 3	1	4						
	2		0	0	0	0	0	4
Ruas 4	1	4						
	2		0	0	0	0	0	4
Ruas 5	1	4						
	2		0	0	0	0	0	4

	t3	$c_0^{r2}$	k1	k2	k3	k4	k mean	$c_0^{r3}$
Ruas 1	2	4.266						
	3		0.27045	0.27045	0.27045	0.27045	0.27045	4.53645
Ruas 2	2	3.927						
	3		-0.24236	-0.24236	-0.24236	-0.24236	-0.24236	3.68464
Ruas 3	2	4						
	3		0.05329	0.05329	0.05329	0.05329	0.05329	4.05329
Ruas 4	2	4						
	3		0	0	0	0	0	4
Ruas 5	2	4						
	3		0	0	0	0	0	4

	t4	$c_0^{r3}$	k1	k2	k3	k4	k mean	$c_0^{r4}$
Ruas 1	3	4.53645						
	4		0.4319818	0.4319818	0.4319818	0.4319818	0.4319818	4.9684318
Ruas 2	3	3.68464						
	4		-0.5960158	-0.5960158	-0.5960158	-0.5960158	-0.5960158	3.0886242
Ruas 3	3	4.05329						
	4		0.2653842	0.2653842	0.2653842	0.2653842	0.2653842	4.3186742
Ruas 4	3	4						
	4		-0.0389017	-0.0389017	-0.0389017	-0.0389017	-0.0389017	3.9610983
Ruas 5	3	4						
	4		0	0	0	0	0	4

	t5	$c_0^{r4}$	k1	k2	k3	k4	k mean	$c_0^{r5}$
Ruas 1	4	4.968432						
	5		0.675368682	0.675368682	0.675368682	0.675368682	0.675368682	5.6438005
Ruas 2	4	3.088624						
	5		-1.286156048	-1.286156048	-1.286156048	-1.28615605	-1.28615605	1.8024682
Ruas 3	4	4.318674						
	5		0.872906187	0.872906187	0.872906187	0.872906187	0.87290619	5.1915804
Ruas 4	4	3.961098						
	5		-0.258307288	-0.258307288	-0.258307288	-0.25830729	-0.25830729	3.702791
Ruas 5	4	4						
	5		0.028398241	0.028398241	0.028398241	0.028398241	0.02839824	4.0283982

	t6	$c_0^{r5}$	k1	k2	k3	k4	k mean	$c_0^{r6}$
Ruas 1	5	5.6438						
	6		1.031081089	1.031081089	1.031081089	1.031081089	1.03108109	6.6748816
Ruas 2	5	1.802468						
	6		-2.566934744	-2.566934744	-2.566934744	-2.56693474	-2.56693474	-0.764467
Ruas 3	5	5.19158						
	6		2.369836675	2.369836675	2.369836675	2.369836675	2.36983668	7.5614171
Ruas 4	5	3.702791						
	6		-1.064023738	-1.064023738	-1.064023738	-1.06402374	-1.06402374	2.6387673
Ruas 5	5	4.028398						
	6		0.2357054	0.2357054	0.2357054	0.2357054	0.2357054	4.2641036

	t7	$c^{t6}$	k1	k2	k3	k4	k mean	$c^{t7}$
Ruas 1	6	6.674882						
	7		1.531909175	1.531909175	1.531909175	1.531909175	1.53190918	8.2067907
Ruas 2	6	-0.76447						
	7		-4.847912303	-4.847912303	-4.847912303	-4.8479123	-4.8479123	-5.612379
Ruas 3	6	7.561417						
	7		5.733309583	5.733309583	5.733309583	5.733309583	5.73330958	13.294727
Ruas 4	6	2.638767						
	7		-3.4797608	-3.4797608	-3.4797608	-3.4797608	-3.4797608	-0.840994
Ruas 5	6	4.264104						
	7		1.168008293	1.168008293	1.168008293	1.168008293	1.16800829	5.4321119

Initial Condition

x	c (t0)
0	4
1	4
2	4
3	4
4	4
5	4

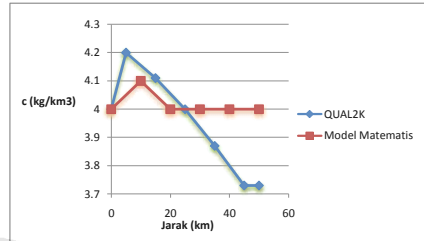
x	c (t1)
0	4
1	4.1
2	4
3	4
4	4
5	4

x	c (t2)
0	4
1	4.266
2	3.927
3	4
4	4
5	4

x	c (t3)
0	4
1	4.53645
2	3.68464
3	4.05329
4	4
5	4

x	c (t4)
0	4
1	4.9684318
2	3.0886242
3	4.3186742
4	3.9610983
5	4

x	c (t5)
0	4
1	5.6438005
2	1.8024682
3	5.1915804
4	3.702791
5	4.0283982

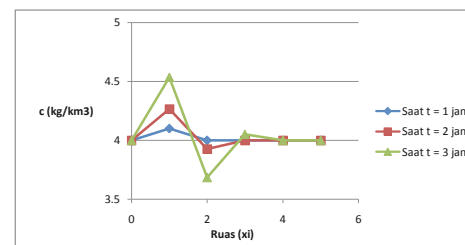
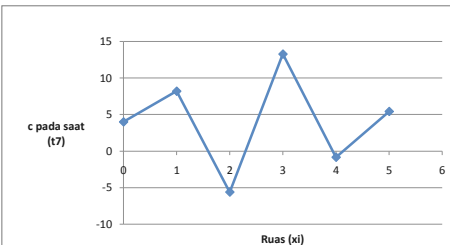
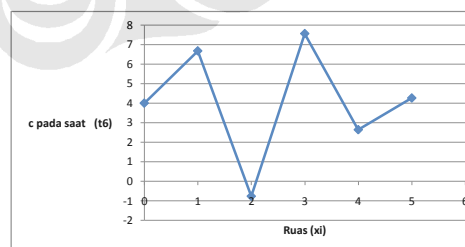
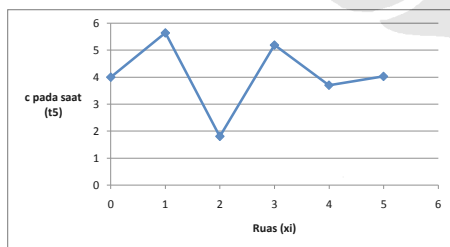
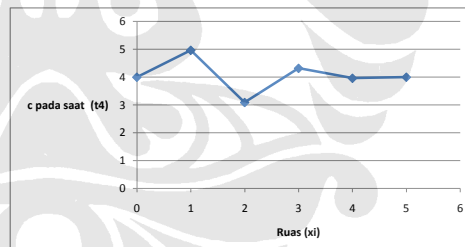
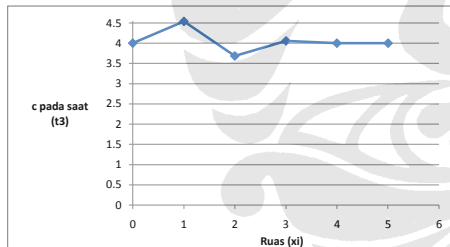
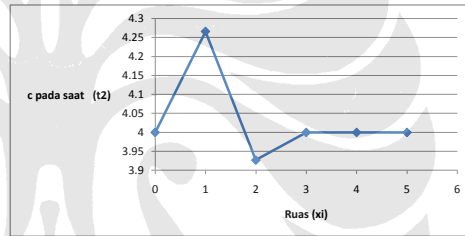
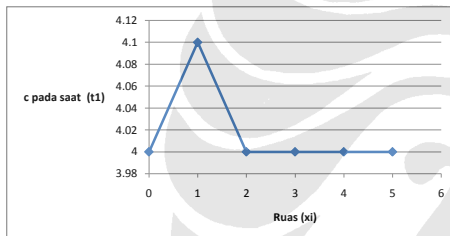


x	c (t6)
0	4
1	6.674882
2	-0.76447
3	7.561417
4	2.638767
5	4.264104

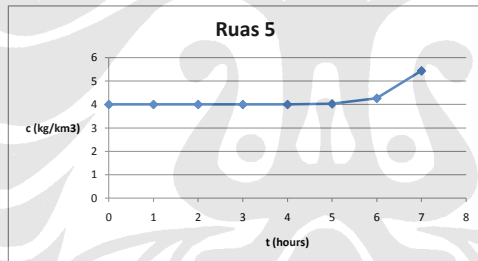
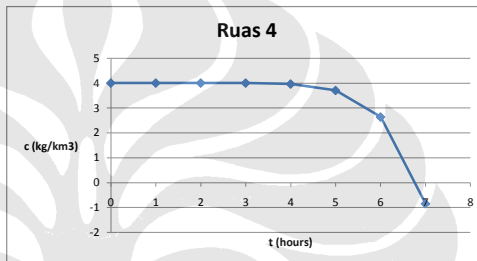
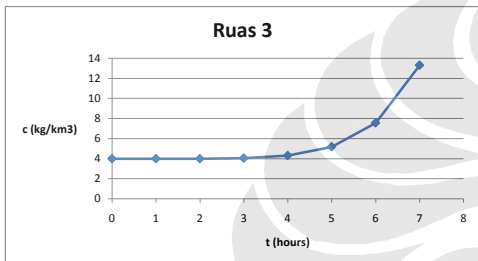
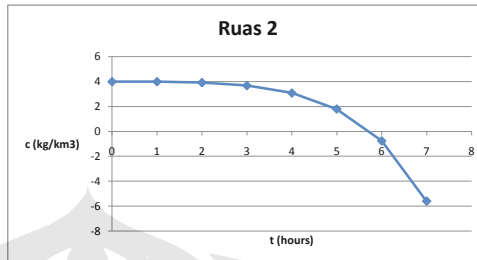
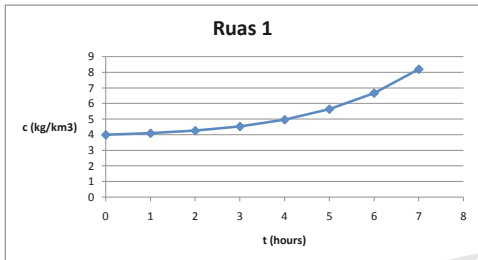
x	c (t7)
0	4
1	8.206790746
2	-5.612378896
3	13.29472665
4	-0.840993525
5	5.432111934

QUAL2K	x	c
	0	4
	5	4.2
	15	4.11
	25	4
	35	3.87
	45	3.73
	50	3.73

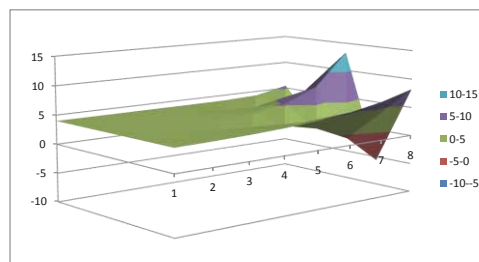
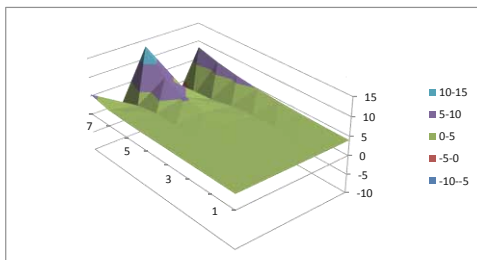
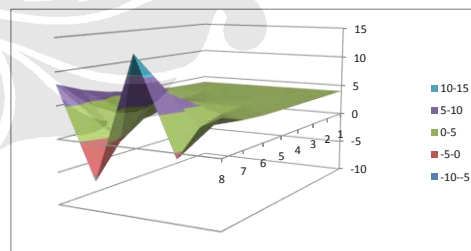
dx (Jarak)	c (t1)
0	4
10	4.1
20	4
30	4
40	4
50	4



Ruas 1		Ruas 2		Ruas 3		Ruas 4		Ruas 5	
t	c	t	c	t	c	t	c	t	c
0	4	0	4	0	4	0	4	0	4
1	4.1	1	4	1	4	1	4	1	4
2	4.266	2	3.927	2	4	2	4	2	4
3	4.53645	3	3.68464	3	4.05329	3	4	3	4
4	4.968432	4	3.0886242	4	4.3186742	4	3.9610983	4	4
5	5.6438	5	1.802468152	5	5.1915804	5	3.702791	5	4.028398
6	6.674882	6	-0.764466592	6	7.5614171	6	2.6387673	6	4.264104
7	8.206791	7	-5.612378896	7	13.294727	7	-0.840994	7	5.432112



	x=1	x=2	x=3	x=4	x=5
t=0	4	4	4	4	4
t=1	4.1	4	4	4	4
t=2	4.266	3.927	4	4	4
t=3	4.53645	3.68464	4.05329	4	4
t=4	4.9684318	3.0886242	4.3186742	3.9610983	4
t=5	5.643800482	1.802468152	5.191580387	3.702791012	4.02839824
t=6	6.674881571	-0.764466592	7.561417062	2.638767274	4.26410364
t=7	8.206790746	-5.612378896	13.29472665	-0.84099353	5.43211193



## **Lampiran 2**

### **Hasil Running Simulasi pada QUAL2K menggunakan Idealisasi Beban Konstan**



<b>QUAL2K FORTRAN</b>	
Stream Water Quality Model	
Steve Chapra, Hua Tao and Greg Pelletier	
Version 2.07	
	

Lampiran 2

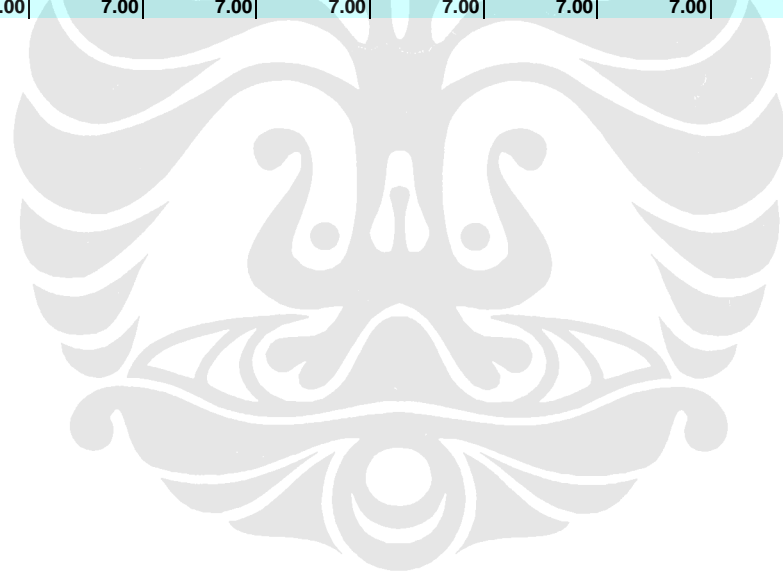
<b>System ID:</b>	
River name	Hipotetic River, beban konstan
Saved file name	SR08I704v2_7dummy
Directory where file saved	C:\Documents and Settings\elsa.BPR-PONDASI\My Documents\Qual2k
Month	7
Day	8
Year	2008
Time zone	Eastern
Daylight savings time	Yes
<b>Calculation:</b>	
Calculation step	0.0625 hours
Final time	3 day
Solution method (integration)	Euler
Solution method (pH)	Bisection
Program determined calc step	0.046875 hours
Time of last calculation	0.10 minutes
Time of sunrise	5:19 AM
Time of solar noon	12:53 PM
Time of sunset	8:26 PM
Photoperiod	15.13 hours

**QUAL2K****Stream Water Quality Model****Hipotetic River, beban konstan (7/8/2008)****Headwater Data:**

Note: \* required field

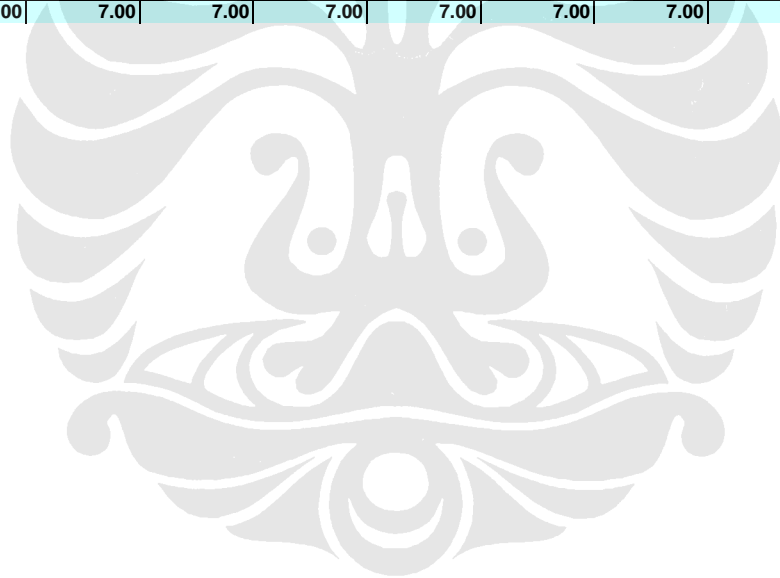
ID	Number of Headwaters*	1					
No. 1	Reach No.*	Headwater Name	Flow*	Elevation	Weir		
			Rate		Height	Width	adam
			(m <sup>3</sup> /s)	(m)	(m)	(m)	
	1	Mainstem headwater	0.022	293.983	0.0000	0.0000	1.2500
<b>Headwater Water Quality</b>		<b>Units</b>	<b>12:00 AM</b>	<b>1:00 AM</b>	<b>2:00 AM</b>	<b>3:00 AM</b>	<b>4:00 AM</b>
	Temperature	C	21.28	20.96	20.66	20.41	20.21
	Conductivity	umhos	0.00	0.00	0.00	0.00	0.00
	Inorganic Solids	mgD/L	0.00	0.00	0.00	0.00	0.00
	Dissolved Oxygen	mg/L	8.47	8.49	8.51	8.53	8.54
	CBODslow	mgO2/L	0.00	0.00	0.00	0.00	0.00
	CBODfast	mgO2/L	4.00	4.00	4.00	4.00	4.00
	Organic Nitrogen	ugN/L	280.00	280.00	280.00	280.00	280.00
	NH4-Nitrogen	ugN/L	40.00	40.00	40.00	40.00	40.00
	NO3-Nitrogen	ugN/L	23.00	23.00	23.00	23.00	23.00
	Organic Phosphorus	ugP/L	16.00	16.00	16.00	16.00	16.00
	Inorganic Phosphorus (SRP)	ugP/L	6.30	6.30	6.30	6.30	6.30
	Phytoplankton	ugA/L	10.00	10.00	10.00	10.00	10.00
	Detritus (POM)	mgD/L	0.00	0.00	0.00	0.00	0.00
	Pathogen	cfu/100 mL	0.00	0.00	0.00	0.00	0.00
	Alkalinity	mgCaCO3/L	200.00	200.00	200.00	200.00	200.00
	pH	s.u.	7.00	7.00	7.00	7.00	7.00

bdam	Rating Curves				Manning Formula					
	Velocity		Depth		Channel	Manning	Bot Width	Side	Side	
	Coefficient	Exponent	Coefficient	Exponent	Slope	n	m	Slope	Slope	
0.9000	0.0000	0.000	0.0000	0.000	0.035	0.0250	5.00	0.00	0.00	
5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	
20.09	20.05	20.09	20.21	20.41	20.66	20.96	21.28	21.59	21.89	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
8.55	8.55	8.55	8.54	8.53	8.51	8.49	8.47	8.44	8.42	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	
40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	
23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	
16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	
6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	
7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	





<b>Prescribed Dispersion</b>										
<b>m2/s</b>										
<b>7.00</b>										
<b>3:00 PM</b>	<b>4:00 PM</b>	<b>5:00 PM</b>	<b>6:00 PM</b>	<b>7:00 PM</b>	<b>8:00 PM</b>	<b>9:00 PM</b>	<b>10:00 PM</b>	<b>11:00 PM</b>		
22.14	22.34	22.46	22.50	22.46	22.34	22.14	21.89	21.59		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
8.40	8.39	8.38	8.38	8.38	8.39	8.40	8.42	8.44		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00		
280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00		
40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00		
23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00		
16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00		
6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30		
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00		
7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00		

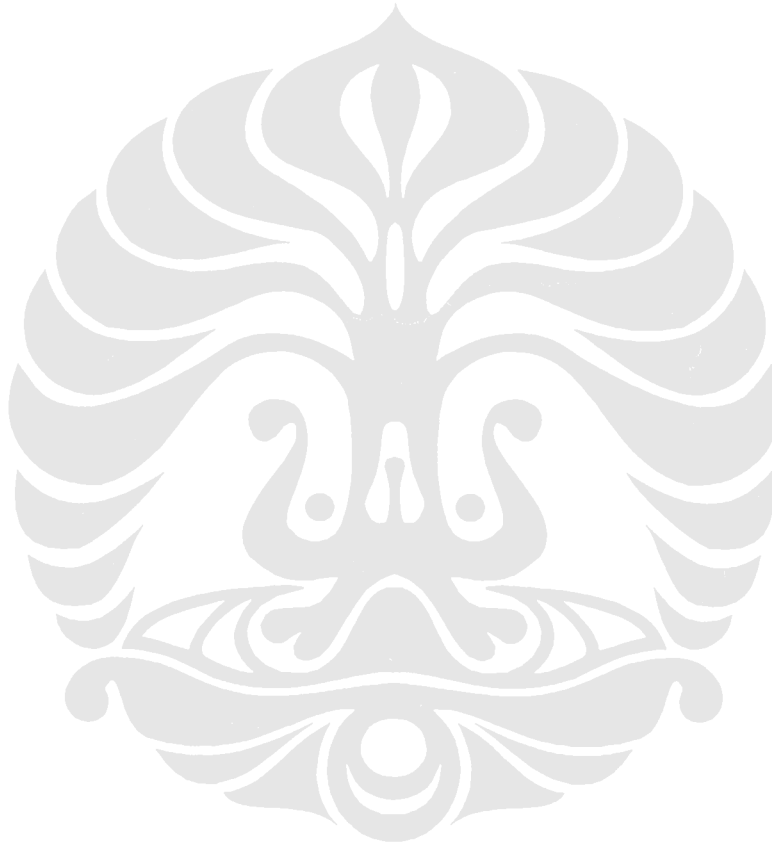


**QUAL2K****Stream Water Quality Model****Hipotetic River, beban konstan (7/8/2008)****Reach Data:**

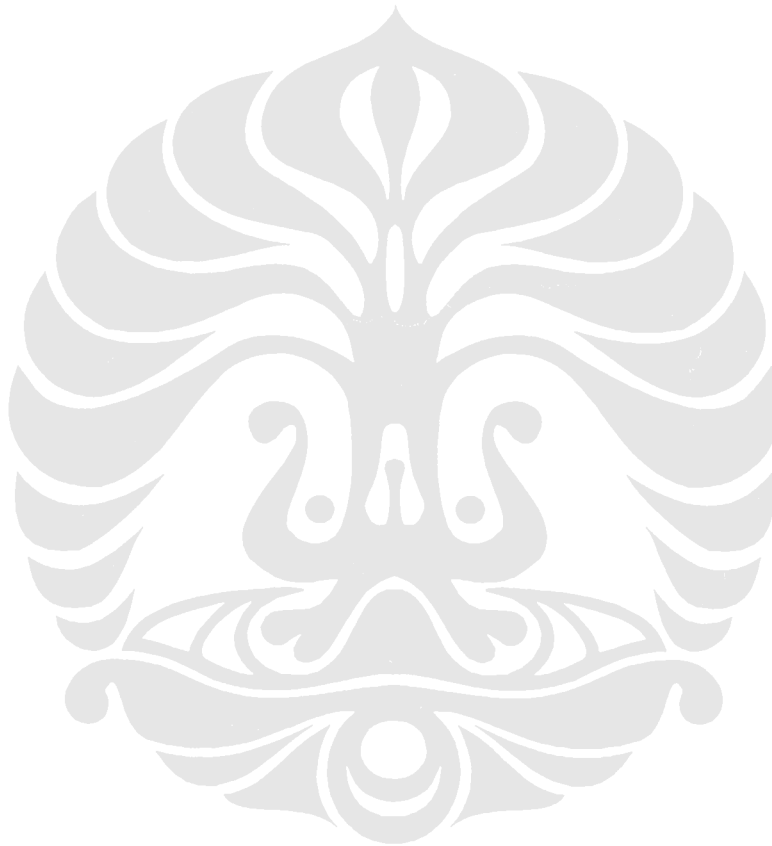
Reach for diel plot	5					
Element for diel plot	1	Reach	Headwater	Reach		
Reach	Downstream	Number	Reach	length	Downstream	
Label	end of reach label			(km)	Latitude	Longitude
		1	Yes	10.00	42.50	72.00
		2		10.00	42.50	72.00
		3		10.00	42.50	72.00
		4		10.00	42.50	72.00
		5		10.00	42.50	72.00



Location		Element	Elevation		Downstream				
Upstream (km)	Downstream (km)	Number >=1	Upstream (m)	Downstream (m)	Latitude			Longitude	
					Degrees	Minutes	Seconds	Degrees	Minutes
50.000	40.000	1	293.983	292.721	42.00	30	0	72.00	0
40.000	30.000	1	292.721	290.310	42.00	30	0	72.00	0
30.000	20.000	1	290.310	281.987	42.00	30	0	72.00	0
20.000	10.000	1	281.987	275.983	42.00	30	0	72.00	0
10.000	0.000	1	275.983	269.979	42.00	30	0	72.00	0



Hydraulic Model (Weir Overrides Manning Formula; Manning Formula Override Rating Curves)										
Seconds	Weir				Rating Curves				Channel Slope	Manning n
	Height (m)	Width (m)	adam	bdam	Velocity		Depth			
					Coefficient	Exponent	Coefficient	Exponent		
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250



Manning Formula			Prescribed	Bottom	Bottom	Prescribed	Prescribed	Prescribed	Prescribed
Bot Width	Side	Side	Dispersion	Algae	SOD	SOD	CH4 flux	NH4 flux	Inorg P flux
m	Slope	Slope	m2/s	Coverage	Coverage	gO2/m2/d	gO2/m2/d	mgN/m2/d	mgP/m2/d
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000

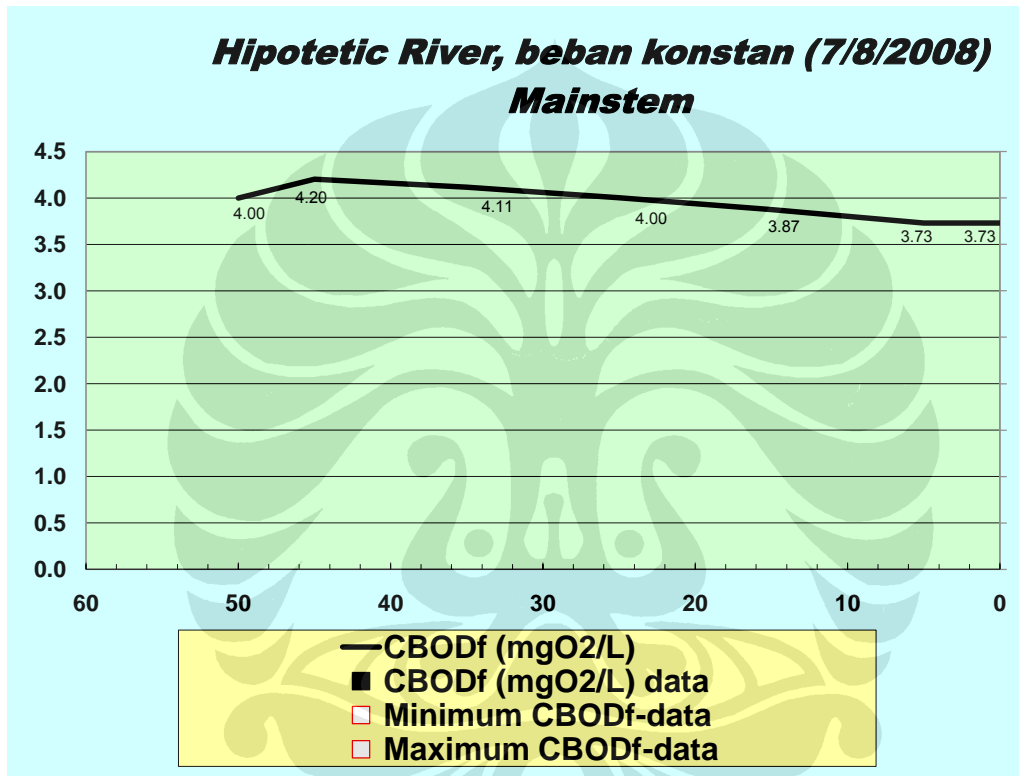


**QUAL2K**  
**Stream Water Quality Model**  
**Hipotetic River, beban konstan (7/8/2008)**  
**Point Source Data:**

\* The headwater of the mainstem (or tributary) where the point source enters.

Name	Headwater ID*	Headwater Name	Location km	Point	
				Abstraction m3/s	Inflow m3/s
Idealisasi beban konstan	1	Mainstem headwater	40.00	0.0000	0.0028

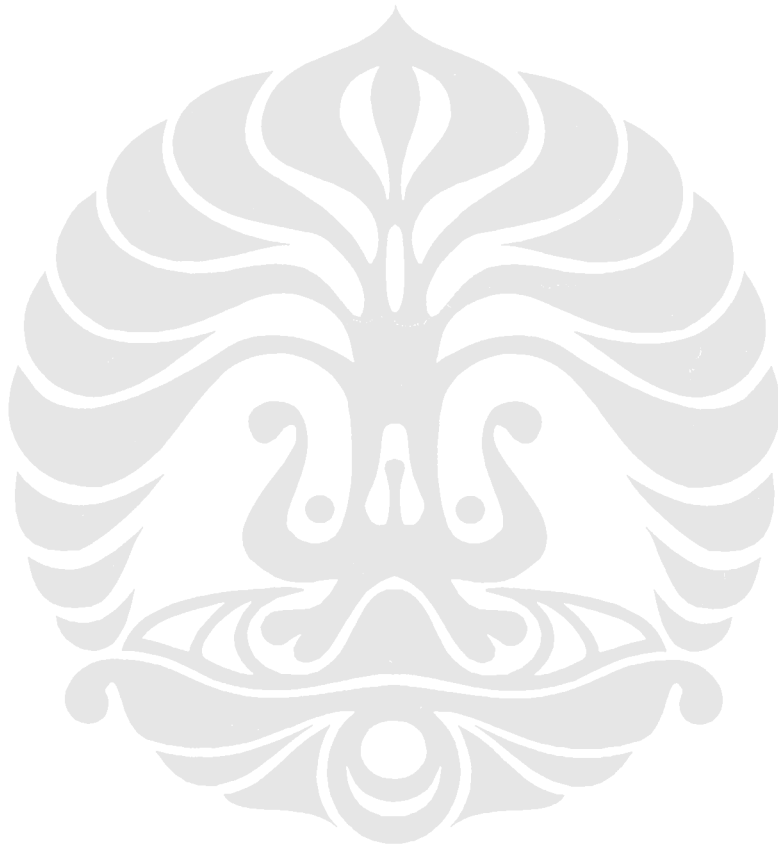
Hasil Running CBOD fast



Temperature			Specific Conductance		
mean	range/2	time of	mean	range/2	time of
°C	°C	max	umhos	umhos	max
25.00	0.00	12:00 AM	0.00	0.00	12:00 AM

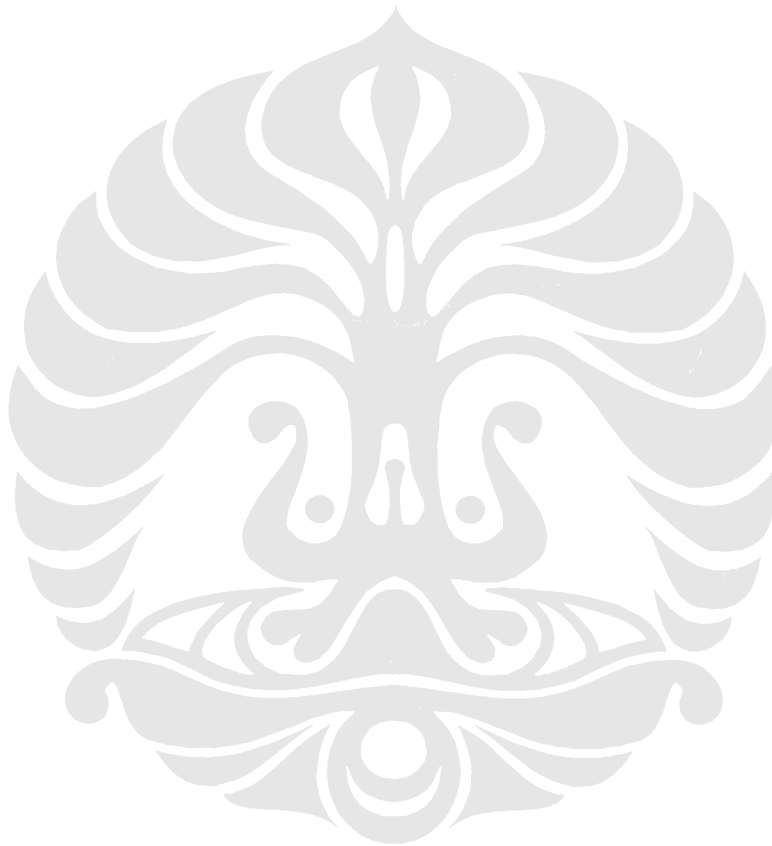


<i>Inorganic Suspended Solids</i>			<i>Dissolved Oxygen</i>		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>mg/L</i>	<i>mg/L</i>	<i>max</i>	<i>mg/L</i>	<i>mg/L</i>	<i>max</i>
48.50	0.00	12:00 AM	0.00	0.00	12:00 AM





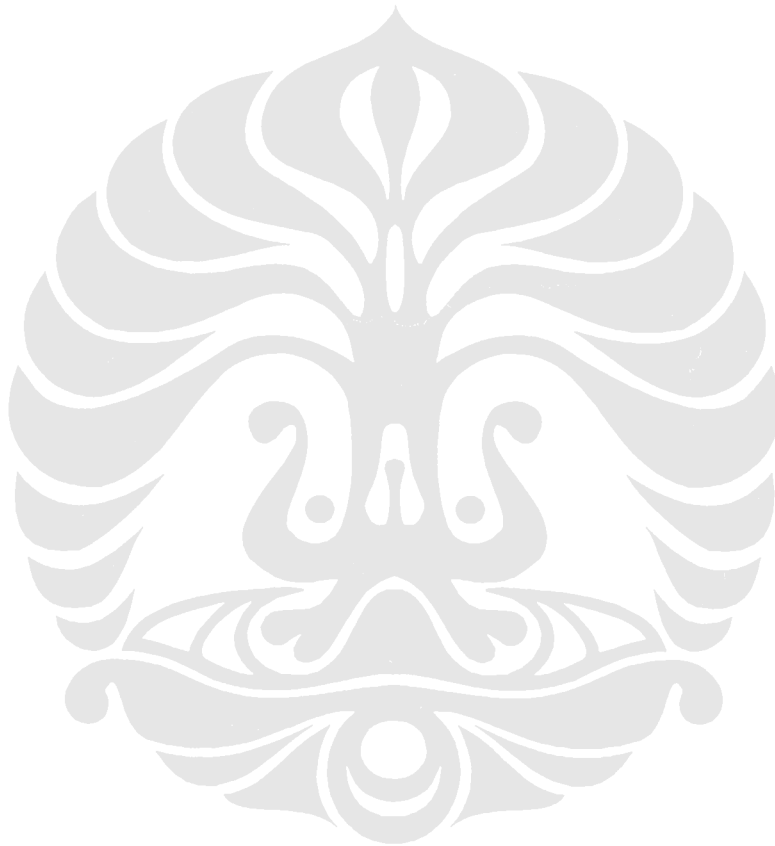
Slow CBOD			Fast CBOD		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>mgO2/L</i>	<i>mgO2/L</i>	<i>max</i>	<i>mgO2/L</i>	<i>mgO2/L</i>	<i>max</i>
0.00	0.00	12:00 AM	3.50	0.00	12:00 AM



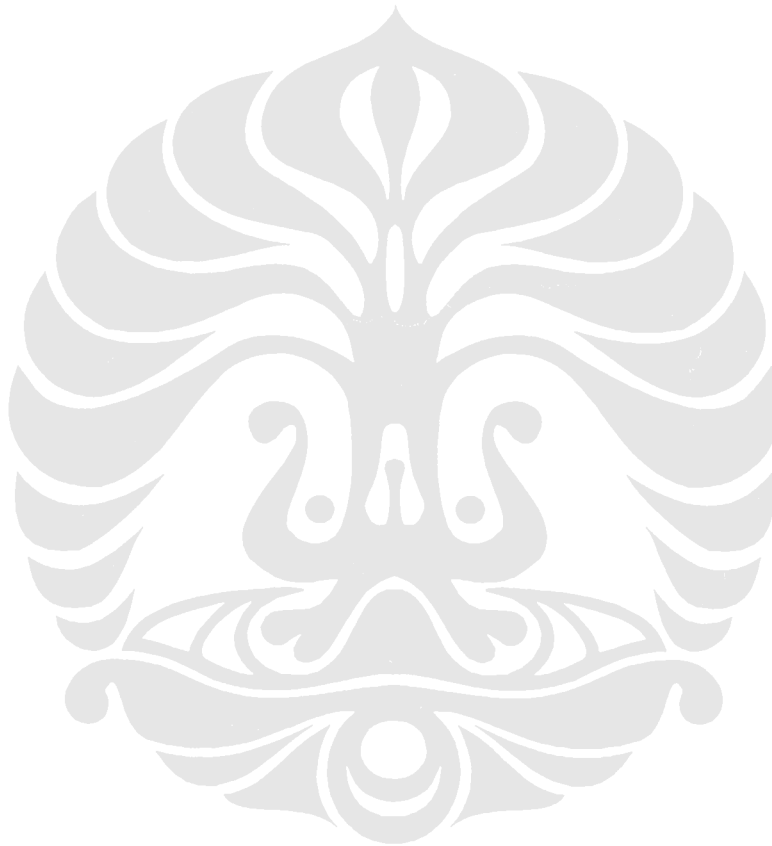
Organic N			Ammonia N		
mean	range/2	time of	mean	range/2	time of
ugN/L	ugN/L	max	ugN/L	ugN/L	max
716.50	0.00	12:00 AM	203.50	0.00	12:00 AM



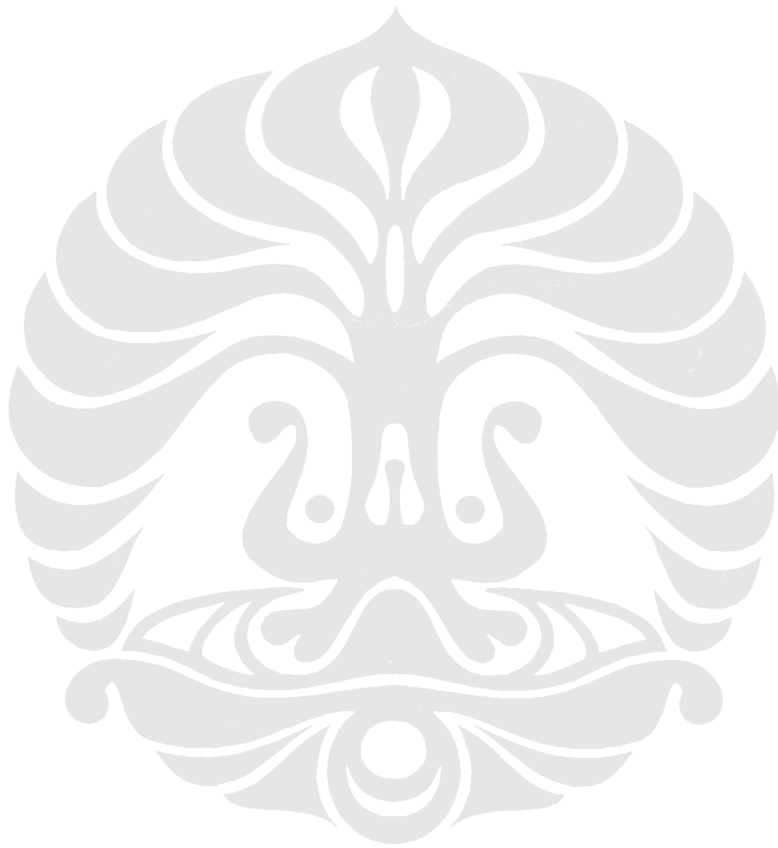
Nitrate + Nitrite N			Organic P		
mean	range/2	time of	mean	range/2	time of
ugN/L	ugN/L	max	ugP/L	ugP/L	max
11400.00	0.00	12:00 AM	0.00	0.00	12:00 AM



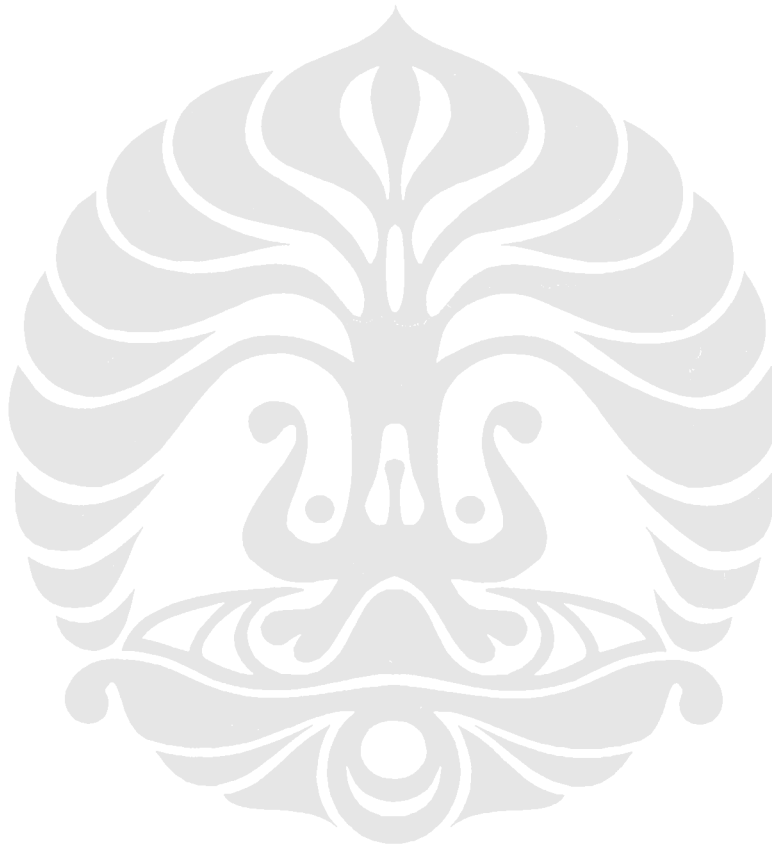
<i>Inorganic P</i>			<i>Phytoplankton</i>		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>ugP/L</i>	<i>ugP/L</i>	<i>max</i>	<i>ugA/L</i>	<i>ugA/L</i>	<i>max</i>
4150.00	0.00	12:00 AM	0.00	0.00	12:00 AM



<i>Detritus</i>			<i>Pathogen Indicator Bacteria</i>		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>mgD/L</i>	<i>mgD/L</i>	<i>max</i>	<i>cfu/100ml</i>	<i>cfu/100ml</i>	<i>max</i>
0.00	0.00	12:00 AM	0.00	0.00	12:00 AM



Alkalinity			pH		
mean	range/2	time of	mean	range/2	time of
mgCaCO3/L	mgCaCO3/L	max	s.u.	s.u.	max
200.00	0.00	12:00 AM	7.00	0.00	12:00 AM



### **Lampiran 3**

**Formulasi Numerik dengan  $t = 0.5$  jam menggunakan  
Beban Konstan pada Model Matematis**



Ruas Sungai	dx (km)	A (km <sup>2</sup> )	V (km <sup>3</sup> )	W (kg/h)	W/V (kg/km <sup>3</sup> h)	u (km/h)	D (km <sup>2</sup> /h)	Δt (h)
Ruas 1	10	10	100	10	0.1	8	7	0.5
Ruas 2 - Ruas 5	10	10	100	0	0	8	7	0.5

Lampiran 3

Model Teoritis

$$\frac{dc}{dt} = \frac{W(t)}{V} - u \frac{\partial c}{\partial x} + D \frac{\partial^2 c}{\partial x^2}$$

Initial

$c_0^{r0}$	0	Boundary	$c_0^{r1}$	0	$c_0^{r8}$	0
$c_1^{r0}$	0		$c_0^{r2}$	0	$c_0^{r9}$	0
$c_2^{r0}$	0		$c_0^{r3}$	0	$c_0^{r10}$	0
$c_3^{r0}$	0		$c_0^{r4}$	0	$c_0^{r11}$	0
$c_4^{r0}$	0		$c_0^{r5}$	0	$c_0^{r12}$	0
$c_5^{r0}$	0		$c_0^{r6}$	0		
$c_6^{r0}$	0		$c_0^{r7}$	0		

Boundary

$c_6^{r1}$	0	$c_6^{r4}$	0	$c_6^{r7}$	0	$c_6^{r10}$	0
$c_6^{r2}$	0	$c_6^{r5}$	0	$c_6^{r8}$	0	$c_6^{r11}$	0
$c_6^{r3}$	0	$c_6^{r6}$	0	$c_6^{r9}$	0	$c_6^{r12}$	0

	t1	$c^{r0}$	k1	k2	k3	k4	k mean	$c^{r1}$
Ruas 1	0	0						
	0.5		0.05	0.05	0.05	0.05	0.05	0.05
Ruas 2	0	0						
	0.5		0	0	0	0	0	0
Ruas 3	0	0						
	0.5		0	0	0	0	0	0
Ruas 4	0	0						
	0.5		0	0	0	0	0	0
Ruas 5	0	0						
	0.5		0	0	0	0	0	0

	t2	$c^{r1}$	k1	k2	k3	k4	k mean	$c^{r2}$
Ruas 1	0.5	0.05						
	1		0.0665	0.0665	0.0665	0.0665	0.0665	0.1165
Ruas 2	0.5	0						
	1		-0.01825	-0.01825	-0.01825	-0.01825	-0.01825	-0.01825
Ruas 3	0.5	0						
	1		0	0	0	0	0	0
Ruas 4	0.5	0						
	1		0	0	0	0	0	0
Ruas 5	0.5	0						
	1		0	0	0	0	0	0

	t3	$c^{r2}$	k1	k2	k3	k4	k mean	$c^{r3}$
Ruas 1	1	0.1165						
	1.5		0.08780625	0.08780625	0.08780625	0.08780625	0.08780625	0.2043063
Ruas 2	1	-0.01825						
	1.5		-0.048545	-0.048545	-0.048545	-0.048545	-0.048545	-0.066795
Ruas 3	1	0						
	1.5		0.00666125	0.00666125	0.00666125	0.00666125	0.00666125	0.0066613
Ruas 4	1	0						
	1.5		0	0	0	0	0	0
Ruas 5	1	0						
	1.5		0	0	0	0	0	0

	t4	$c^{r3}$	k1	k2	k3	k4	k mean	$c^{r4}$
Ruas 1	1.5	0.204306						
	2		0.115083238	0.115083238	0.115083238	0.115083238	0.11508324	0.3193895
Ruas 2	1.5	-0.0668						
	2		-0.096380988	-0.096380988	-0.096380988	-0.09638099	-0.09638099	-0.163176
Ruas 3	1.5	0.006661						
	2		0.026578388	0.026578388	0.026578388	0.026578388	0.02657839	0.0332396
Ruas 4	1.5	0						
	2		-0.002431356	-0.002431356	-0.002431356	-0.00243136	-0.00243136	-0.002431
Ruas 5	1.5	0						
	2		0	0	0	0	0	0

	t5	$c^{r4}$	k1	k2	k3	k4	k mean	$c^{r5}$
Ruas 1	2	0.319389						
	2.5		0.149687371	0.149687371	0.149687371	0.149687371	0.14968737	0.4690769
Ruas 2	2	-0.16318						
	2.5		-0.169261852	-0.169261852	-0.169261852	-0.16926185	-0.16926185	-0.332438
Ruas 3	2	0.03324						
	2.5		0.070443218	0.070443218	0.070443218	0.070443218	0.07044322	0.1036829
Ruas 4	2	-0.00243						
	2.5		-0.012934815	-0.012934815	-0.012934815	-0.01293482	-0.01293482	-0.015366
Ruas 5	2	0						
	2.5		0.000887445	0.000887445	0.000887445	0.000887445	0.00088745	0.0008874

	t6	$c^{r5}$	k1	k2	k3	k4	k mean	$c^{r6}$
Ruas 1	2.5	0.469077						
	3		0.193160039	0.193160039	0.193160039	0.193160039	0.19316004	0.6622369
Ruas 2	2.5	-0.33244						
	3		-0.27728864	-0.27728864	-0.27728864	-0.27728864	-0.27728864	-0.609726
Ruas 3	2.5	0.103683						
	3		0.155017338	0.155017338	0.155017338	0.155017338	0.15501734	0.2587002
Ruas 4	2.5	-0.01537						
	3		-0.042884018	-0.042884018	-0.042884018	-0.04288402	-0.04288402	-0.05825
Ruas 5	2.5	0.000887						
	3		0.005901509	0.005901509	0.005901509	0.005901509	0.00590151	0.006789



	t7	c <sup>t=6</sup>	k1	k2	k3	k4	k mean	c <sup>t=7</sup>
Ruas 1	3	0.662237						
	3.5		0.24719775	0.24719775	0.24719775	0.24719775	0.24719775	0.9094346
Ruas 2	3	-0.60973						
	3.5		-0.433871699	-0.433871699	-0.433871699	-0.4338717	-0.4338717	-1.043598
Ruas 3	3	0.2587						
	3.5		0.305882472	0.305882472	0.305882472	0.305882472	0.30588247	0.5645827
Ruas 4	3	-0.05825						
	3.5		-0.11341052	-0.11341052	-0.11341052	-0.11341052	-0.11341052	-0.171661
Ruas 5	3	0.006789						
	3.5		0.023501674	0.023501674	0.023501674	0.02350167	0.02350167	0.0302906

Initial Condition

x	c (t0)
0	0
1	0
2	0
3	0
4	0
5	0

x	c (t1)
0	0
1	0.05
2	0
3	0
4	0
5	0

x	c (t2)
0	0
1	0.1165
2	-0.01825
3	0
4	0
5	0

Kondisi pertama

x	c (t1)
0	0
1	0.1
2	0
3	0
4	0
5	0

x	c (t3)
0	0
1	0.204306
2	-0.0668
3	0.006661
4	0
5	0

x	c (t4)
0	0
1	0.319389488
2	-0.163175988
3	0.033239638
4	-0.002431356
5	0

x	c (t5)
0	0
1	0.4690769
2	-0.332438
3	0.1036829
4	-0.015366
5	0.0008874

Kondisi pertama

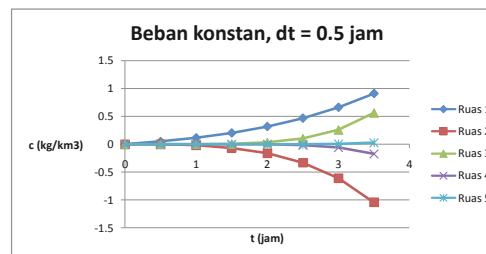
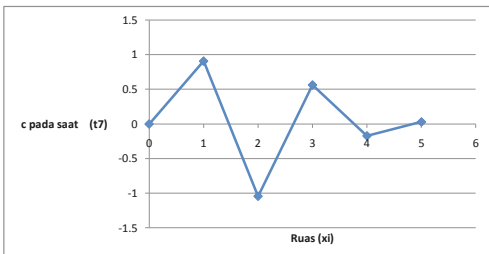
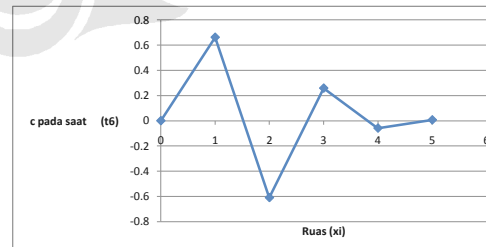
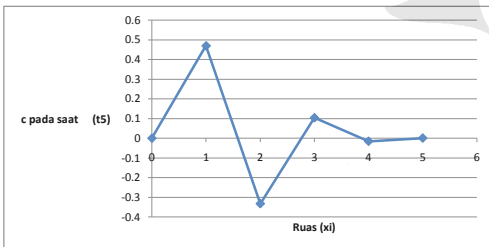
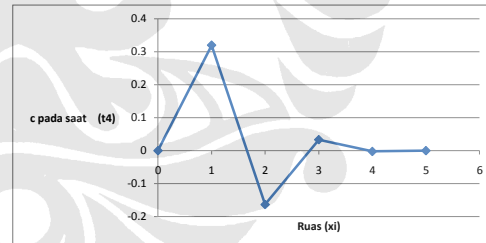
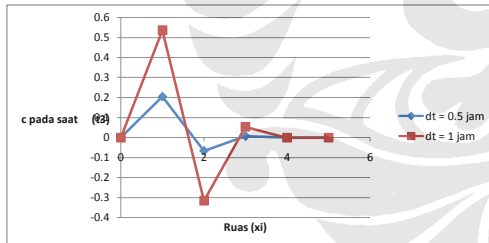
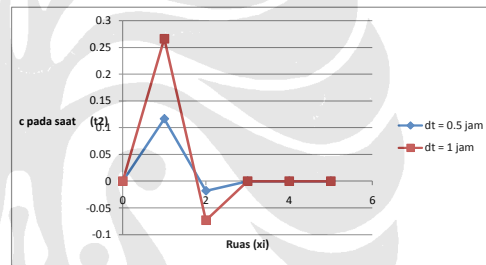
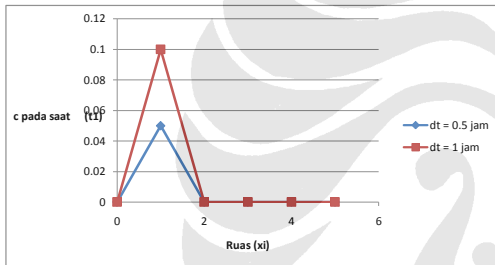
x	c (t2)
0	0
1	0.266
2	-0.073
3	0
4	0
5	0

x	c (t6)
0	0
1	0.662237
2	-0.60973
3	0.2587
4	-0.05825
5	0.006789

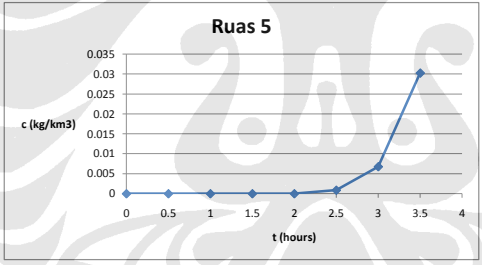
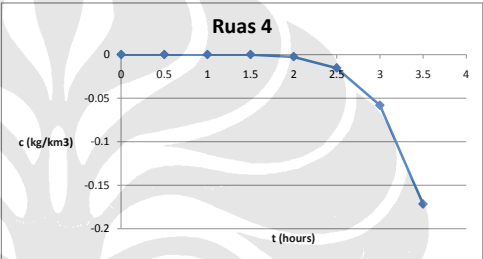
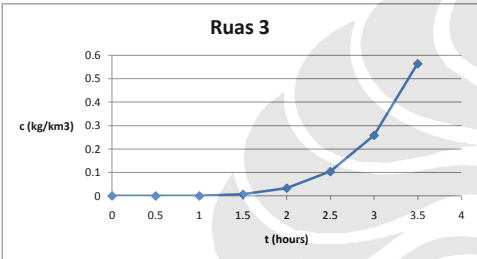
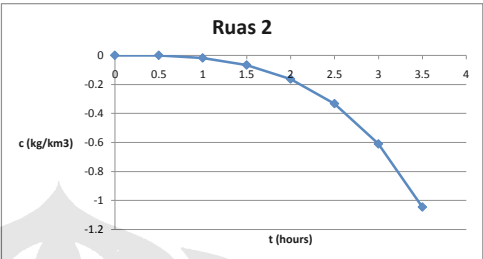
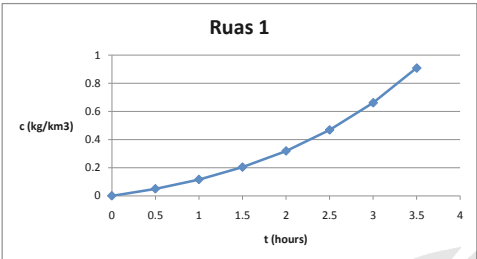
x	c (t7)
0	0
1	0.909434647
2	-1.043598179
3	0.564582666
4	-0.17166071
5	0.030290629

Kondisi pertama

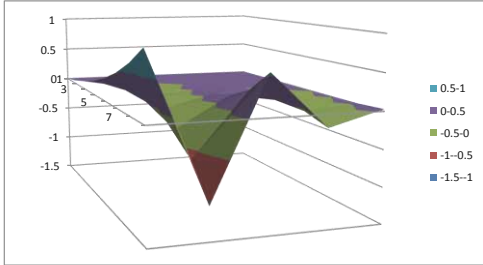
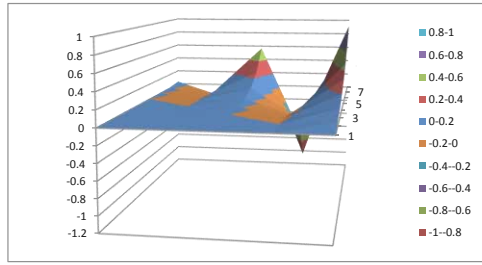
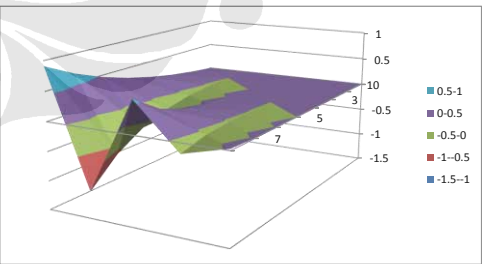
x	c (t3)
0	0
1	0.53645
2	-0.31536
3	0.053259
4	0
5	0



Ruas 1		Ruas 2		Ruas 3		Ruas 4		Ruas 5	
t	c	t	c	t	c	t	c	t	c
0	0	0	0	0	0	0	0	0	0
0.5	0.05	0.5	0	0.5	0	0.5	0	0.5	0
1	0.1165	1	-0.01825	1	0	1	0	1	0
1.5	0.204306	1.5	-0.066795	1.5	0.0066613	1.5	0	1.5	0
2	0.319389	2	-0.163175988	2	0.0332396	2	-0.002431	2	0
2.5	0.469077	2.5	-0.332437839	2.5	0.1036829	2.5	-0.015366	2.5	0.000887
3	0.662237	3	-0.609726479	3	0.2587002	3	-0.05825	3	0.006789
3.5	0.909435	3.5	-1.043598179	3.5	0.5645827	3.5	-0.171661	3.5	0.030291



	x=1	x=2	x=3	x=4	x=5
t=0	0	0	0	0	0
t=1	0.05	0	0	0	0
t=2	0.1165	-0.01825	0	0	0
t=3	0.20430625	-0.066795	0.00666125	0	0
t=4	0.319389488	-0.163175988	0.033239638	-0.00243136	0
t=5	0.469076859	-0.332437839	0.103682856	-0.01536617	0.00088745
t=6	0.662236898	-0.609726479	0.258700194	-0.05825019	0.00678895
t=7	0.909434647	-1.043598179	0.564582666	-0.17166071	0.03029063



## Lampiran 4

**Formulasi Numerik dengan  $x = 5$  km dan  $t = 0.5$  jam  
menggunakan Beban Konstan pada Model Matematis**



Ruas Sungai	dx (km)	A (km <sup>2</sup> )	V (km <sup>3</sup> )	W (kg/h)	W/V (kgkm <sup>3</sup> /h)	u (km/h)	D (km <sup>2</sup> /h)	Δt (h)
Ruas 1	5	10	100	10	0.1	8	7	0.5
Ruas 2 - Ruas 5	5	10	100	0	0	8	7	0.5

Lampiran 4

Model Teoritis

$$\frac{dc}{dt} = \frac{W(t)}{V} - u \frac{\partial c}{\partial x} + D \frac{\partial^2 c}{\partial x^2}$$

Initial	Boundary
$c_0^{t0}$	$c_0^{t1}$
$c_1^{t0}$	$c_0^{t2}$
$c_2^{t0}$	$c_0^{t3}$
$c_3^{t0}$	$c_0^{t4}$
$c_4^{t0}$	$c_0^{t5}$
$c_5^{t0}$	$c_0^{t6}$
$c_6^{t0}$	$c_0^{t7}$

Boundary
$c_6^{t1}$
$c_6^{t2}$
$c_6^{t3}$

	t1	$c^{t0}$	k1	k2	k3	k4	k mean	$c^{t1}$
Ruas 1	0	0						
	0.5		0.05	0.05	0.05	0.05	0.05	0.05
Ruas 2	0	0						
	0.5		0	0	0	0	0	0
Ruas 3	0	0						
	0.5		0	0	0	0	0	0
Ruas 4	0	0						
	0.5		0	0	0	0	0	0
Ruas 5	0	0						
	0.5		0	0	0	0	0	0

	t2	$c^{t1}$	k1	k2	k3	k4	k mean	$c^{t2}$
Ruas 1	0.5	0.05						
	1		0.076	0.076	0.076	0.076	0.076	0.126
Ruas 2	0.5	0						
	1		-0.033	-0.033	-0.033	-0.033	-0.033	-0.033
Ruas 3	0.5	0						
	1		0	0	0	0	0	0
Ruas 4	0.5	0						
	1		0	0	0	0	0	0
Ruas 5	0.5	0						
	1		0	0	0	0	0	0

	t3	$c^{t2}$	k1	k2	k3	k4	k mean	$c^{t3}$
Ruas 1	1	0.126						
	1.5		0.1109	0.1109	0.1109	0.1109	0.1109	0.2369
Ruas 2	1	-0.033						
	1.5		-0.10032	-0.10032	-0.10032	-0.10032	-0.10032	-0.13332
Ruas 3	1	0						
	1.5		0.02178	0.02178	0.02178	0.02178	0.02178	0.02178
Ruas 4	1	0						
	1.5		0	0	0	0	0	0
Ruas 5	1	0						
	1.5		0	0	0	0	0	0

	t4	$c^{t3}$	k1	k2	k3	k4	k mean	$c^{t4}$
Ruas 1	1.5	0.2369						
	2		0.1545232	0.1545232	0.1545232	0.1545232	0.1545232	0.3914232
Ruas 2	1.5	-0.13332						
	2		-0.2226312	-0.2226312	-0.2226312	-0.2226312	-0.2226312	-0.355951
Ruas 3	1.5	0.02178						
	2		0.0993168	0.0993168	0.0993168	0.0993168	0.0993168	0.1210968
Ruas 4	1.5	0						
	2		-0.0143748	-0.0143748	-0.0143748	-0.0143748	-0.0143748	-0.014375
Ruas 5	1.5	0						
	2		0	0	0	0	0	0

	t5	$c^{t4}$	k1	k2	k3	k4	k mean	$c^{t5}$
Ruas 1	2	0.391423						
	2.5		0.203706896	0.203706896	0.203706896	0.203706896	0.2037069	0.5951301
Ruas 2	2	-0.35595						
	2.5		-0.426480384	-0.426480384	-0.426480384	-0.42648038	-0.42648038	-0.782432
Ruas 3	2	0.121097						
	2.5		0.295885656	0.295885656	0.295885656	0.295885656	0.29588566	0.4169825
Ruas 4	2	-0.01437						
	2.5		-0.087398784	-0.087398784	-0.087398784	-0.08739878	-0.08739878	-0.101774
Ruas 5	2	0						
	2.5		0.009487368	0.009487368	0.009487368	0.009487368	0.00948737	0.0094874

	t6	$c^{t5}$	k1	k2	k3	k4	k mean	$c^{t6}$
Ruas 1	2.5	0.59513						
	3		0.249927228	0.249927228	0.249927228	0.249927228	0.24992723	0.8450573
Ruas 2	2.5	-0.78243						
	3		-0.741272743	-0.741272743	-0.741272743	-0.74127274	-0.74127274	-1.523704
Ruas 3	2.5	0.416982						
	3		0.718987421	0.718987421	0.718987421	0.718987421	0.71898742	1.1359699
Ruas 4	2.5	-0.10177						
	3		-0.326802453	-0.326802453	-0.326802453	-0.32680245	-0.32680245	-0.428576
Ruas 5	2.5	0.009487						
	3		0.072103997	0.072103997	0.072103997	0.072103997	0.072104	0.0815914

	t7	$c^{t=0}$	k1	k2	k3	k4	k mean	$c^{t=7}$
Ruas 1	3	0.845057						
	3.5		0.27611203	0.27611203	0.27611203	0.27611203	0.276112	1.1211685
Ruas 2	3	-1.5237						
	3.5		-1.191028301	-1.191028301	-1.191028301	-1.1910283	-1.1910283	-2.714733
Ruas 3	3	1.13597						
	3.5		1.536348547	1.536348547	1.536348547	1.536348547	1.53634855	2.6723184
Ruas 4	3	-0.42858						
	3.5		-0.961176867	-0.961176867	-0.961176867	-0.96117687	-0.96117687	-1.389753
Ruas 5	3	0.081591						
	3.5		0.325287694	0.325287694	0.325287694	0.325287694	0.32528769	0.4068791

Initial Condition

x	c (t0)
0	0
1	0
2	0
3	0
4	0
5	0

x	c (t1)
0	0
1	0.05
2	0
3	0
4	0
5	0

x	c (t2)
0	0
1	0.126
2	-0.033
3	0
4	0
5	0

Kondisi pertama

x	c (t1)
0	0
1	0.1
2	0
3	0
4	0
5	0

x	c (t3)
0	0
1	0.2369
2	-0.13332
3	0.02178
4	0
5	0

x	c (t4)
0	0
1	0.3914232
2	-0.359512
3	0.1210968
4	-0.0143748
5	0

x	c (t5)
0	0
1	0.5951301
2	-0.782432
3	0.4169825
4	-0.101774
5	0.0094874

Kondisi pertama

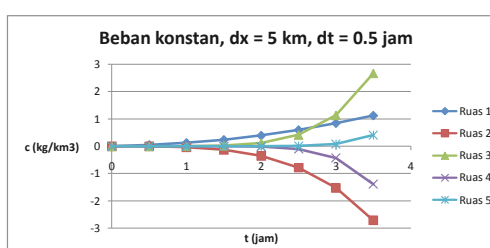
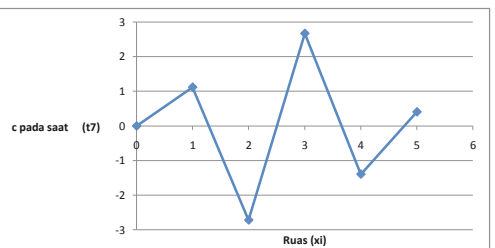
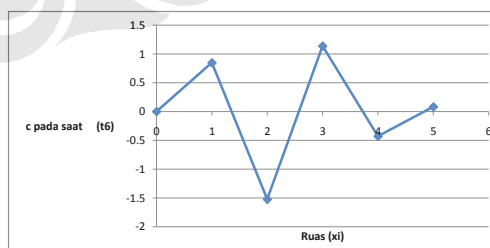
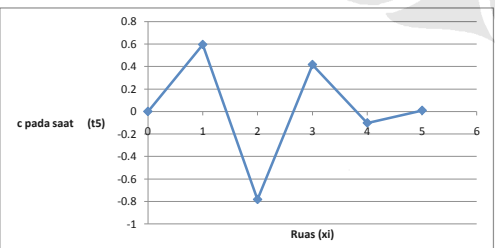
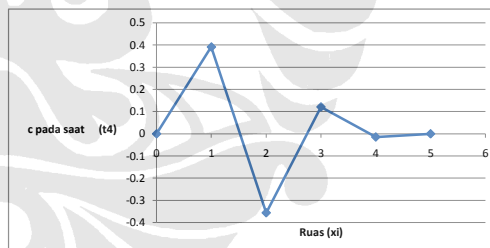
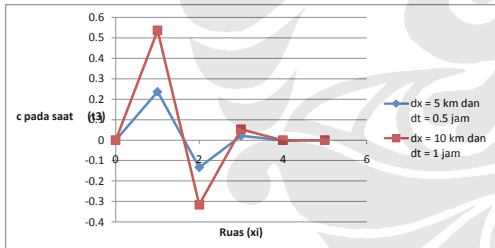
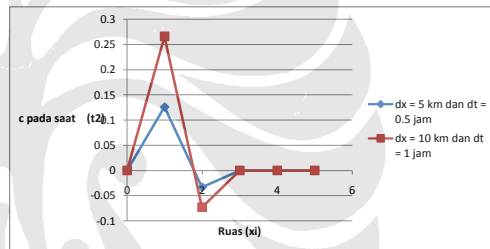
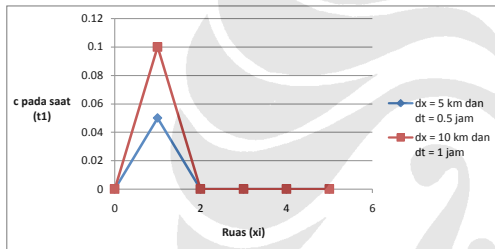
x	c (t2)
0	0
1	0.266
2	-0.073
3	0
4	0
5	0

x	c (t6)
0	0
1	0.845057
2	-1.5237
3	1.13597
4	-0.42858
5	0.081591

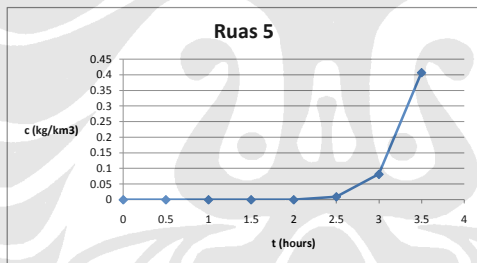
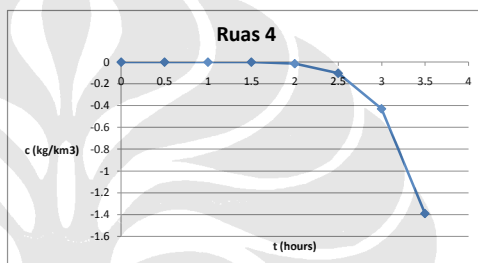
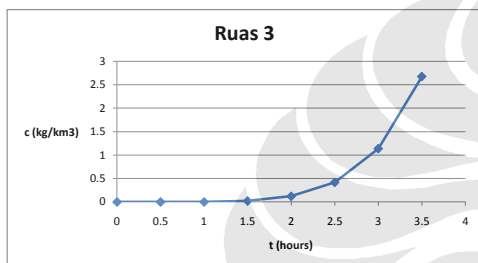
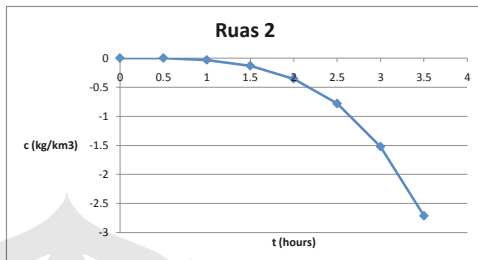
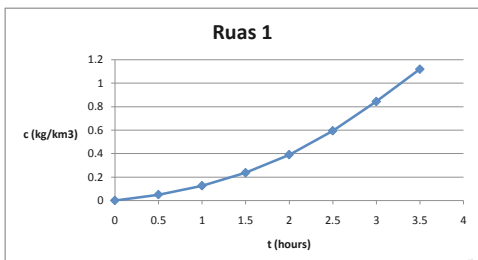
x	c (t7)
0	0
1	1.121168527
2	-2.714732629
3	2.672318423
4	-1.389752904
5	0.406879059

Kondisi pertama

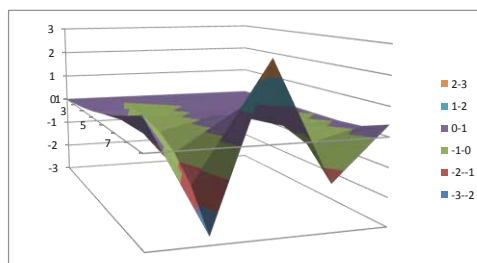
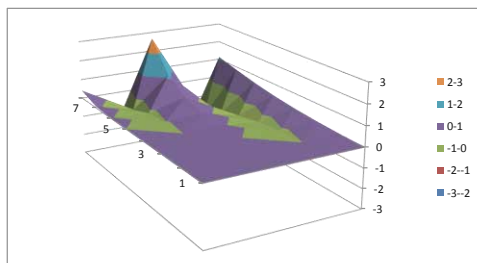
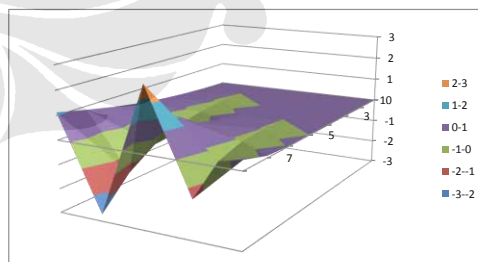
x	c (t3)
0	0
1	0.53645
2	-0.31536
3	0.053259
4	0
5	0



Ruas 1		Ruas 2		Ruas 3		Ruas 4		Ruas 5	
t	c	t	c	t	c	t	c	t	c
0	0	0	0	0	0	0	0	0	0
0.5	0.05	0.5	0	0.5	0	0.5	0	0.5	0
1	0.126	1	-0.033	1	0	1	0	1	0
1.5	0.2369	1.5	-0.13332	1.5	0.02178	1.5	0	1.5	0
2	0.391423	2	-0.359512	2	0.1210968	2	-0.014375	2	0
2.5	0.59513	2.5	-0.782431584	2.5	0.4169825	2.5	-0.101774	2.5	0.009487
3	0.845057	3	-1.523704327	3	1.1359699	3	-0.428576	3	0.081591
3.5	1.121169	3.5	-2.714732629	3.5	2.6723184	3.5	-1.389753	3.5	0.406879



	x=1	x=2	x=3	x=4	x=5
t=0	0	0	0	0	0
t=1	0.05	0	0	0	0
t=2	0.126	-0.033	0	0	0
t=3	0.2369	-0.13332	0.02178	0	0
t=4	0.3914232	-0.359512	0.1210968	-0.0143748	0
t=5	0.595130096	-0.782431584	0.416982456	-0.10177358	0.00948737
t=6	0.845057324	-1.523704327	1.135969877	-0.42857604	0.08159136
t=7	1.121168527	-2.714732629	2.672318423	-1.3897529	0.40687906



## **Lampiran 5**

### **Perbandingan Formulasi Numerik menggunakan Beban Non Konstan pada QUAL2K dan Model Matematis**



Lampiran 5

Ruas Sungai	dx (km)	A (m <sup>2</sup> )	V (km <sup>3</sup> )	W (kg/h)	W/V (kg/km <sup>3</sup> h)	u (km/h)	D (km <sup>2</sup> /h)	Δt (h)
Ruas 1	10	10	100	e <sup>Δt</sup>	0.01e <sup>Δt</sup>	8	7	1
Ruas 2 - Ruas 5	10	10	100	0	0	8	7	1

Model Teoritis

$$\frac{dc}{dt} = \frac{W(t)}{V} - u \frac{\partial c}{\partial x} + D \frac{\partial^2 c}{\partial x^2}$$

Initial

Initial	Boundary	Boundary	Boundary
c <sub>0</sub> <sup>t0</sup>	4	c <sub>0</sub> <sup>t1</sup>	4
c <sub>1</sub> <sup>t0</sup>	4	c <sub>0</sub> <sup>t2</sup>	4
c <sub>2</sub> <sup>t0</sup>	4	c <sub>0</sub> <sup>t3</sup>	4
c <sub>3</sub> <sup>t0</sup>	4	c <sub>0</sub> <sup>t4</sup>	4
c <sub>4</sub> <sup>t0</sup>	4	c <sub>0</sub> <sup>t5</sup>	4
c <sub>5</sub> <sup>t0</sup>	4	c <sub>0</sub> <sup>t6</sup>	4
c <sub>6</sub> <sup>t0</sup>	4	c <sub>0</sub> <sup>t7</sup>	4

Boundary

c <sub>6</sub> <sup>t1</sup>	4	c <sub>6</sub> <sup>t4</sup>	4	c <sub>6</sub> <sup>t7</sup>	4	c <sub>6</sub> <sup>t10</sup>	4
c <sub>6</sub> <sup>t2</sup>	4	c <sub>6</sub> <sup>t5</sup>	4	c <sub>6</sub> <sup>t8</sup>	4	c <sub>6</sub> <sup>t11</sup>	4
c <sub>6</sub> <sup>t3</sup>	4	c <sub>6</sub> <sup>t6</sup>	4	c <sub>6</sub> <sup>t9</sup>	4	c <sub>6</sub> <sup>t12</sup>	4

	t1	c <sup>t0</sup>	k1	k2	k3	k4	k mean	c <sup>t1</sup>
Ruas 1	0	4						
	1		0.01	0.016487213	0.016487213	0.02718282	0.01718861	4.0171886
Ruas 2	0	4						
	1		0	0	0	0	0	4
Ruas 3	0	4						
	1		0	0	0	0	0	4
Ruas 4	0	4						
	1		0	0	0	0	0	4
Ruas 5	0	4						
	1		0	0	0	0	0	4

	t2	c <sup>t1</sup>	k1	k2	k3	k4	k mean	c <sup>t2</sup>
Ruas 1	1	4.017189						
	2		0.038527304	0.056161379	0.056161379	0.085235054	0.05806798	4.0752566
Ruas 2	1	4						
	2		-0.012547687	-0.012547687	-0.012547687	-0.01254769	-0.01254769	3.9874523
Ruas 3	1	4						
	2		0	0	0	0	0	4
Ruas 4	1	4						
	2		0	0	0	0	0	4
Ruas 5	1	4						
	2		0	0	0	0	0	4

	t3	c <sup>t2</sup>	k1	k2	k3	k4	k mean	c <sup>t3</sup>
Ruas 1	2	4.075257						
	3		0.122681582	0.170615971	0.170615971	0.249646419	0.17579865	4.2510552
Ruas 2	2	3.987452						
	3		-0.063218785	-0.063218785	-0.063218785	-0.06321878	-0.06321878	3.9242335
Ruas 3	2	4						
	3		0.009159811	0.009159811	0.009159811	0.009159811	0.00915981	4.0091598
Ruas 4	2	4						
	3		0	0	0	0	0	4
Ruas 5	2	4						
	3		0	0	0	0	0	4

	t4	c <sup>t3</sup>	k1	k2	k3	k4	k mean	c <sup>t4</sup>
Ruas 1	3	4.251055						
	4		0.361248212	0.491547397	0.491547397	0.706374443	0.50563537	4.7566906
Ruas 2	3	3.924234						
	4		-0.232635009	-0.232635009	-0.232635009	-0.23263501	-0.23263501	3.6915985
Ruas 3	3	4.00916						
	4		0.061355	0.061355	0.061355	0.061355	0.061355	4.0705148
Ruas 4	3	4						
	4		-0.006686662	-0.006686662	-0.006686662	-0.00668666	-0.00668666	3.9933133
Ruas 5	3	4						
	4		0	0	0	0	0	4

	t5	c <sup>t4</sup>	k1	k2	k3	k4	k mean	c <sup>t5</sup>
Ruas 1	4	4.756691						
	5		1.023809339	1.377999269	1.377999269	1.96195976	1.41629436	6.172985
Ruas 2	4	3.691599						
	5		-0.750993088	-0.750993088	-0.750993088	-0.75099309	-0.75099309	2.9406054
Ruas 3	4	4.070515						
	5		0.27120479	0.27120479	0.27120479	0.27120479	0.27120479	4.3417196
Ruas 4	4	3.993313						
	5		-0.055889009	-0.055889009	-0.055889009	-0.05588901	-0.05588901	3.9374243
Ruas 5	4	4						
	5		0.004881264	0.004881264	0.004881264	0.004881264	0.00488126	4.0048813

	t6	c <sup>t5</sup>	k1	k2	k3	k4	k mean	c <sup>t6</sup>
Ruas 1	5	6.172985						
	6		2.844144523	3.806932636	3.806932636	5.394301926	3.9110295	10.084014
Ruas 2	5	2.940605						
	6		-2.261559075	-2.261559075	-2.261559075	-2.26155908	-2.26155908	0.6790464
Ruas 3	5	4.34172						
	6		0.994512675	0.994512675	0.994512675	0.994512675	0.99451267	5.3362323
Ruas 4	5	3.937424						
	6		-0.290413564	-0.290413564	-0.290413564	-0.29041356	-0.29041356	3.6470108
Ruas 5	5	4.004881						
	6		0.048901874	0.048901874	0.048901874	0.048901874	0.04890187	4.0537831



	t7	$c^{t6}$	k1	k2	k3	k4	k mean	$c^{t7}$
Ruas 1	6	10.08401						
	7		7.817272261	10.43440186	10.43440186	14.74931923	10.7173665	20.801381
Ruas 2	6	0.679046						
	7		-6.539623712	-6.539623712	-6.539623712	-6.53962371	-6.53962371	-5.860577
Ruas 3	6	5.336232						
	7		3.281500215	3.281500215	3.281500215	3.281500215	3.28150022	8.6177325
Ruas 4	6	3.647011						
	7		-1.204657637	-1.204657637	-1.204657637	-1.20465764	-1.20465764	2.4423531
Ruas 5	6	4.053783						
	7		0.293179013	0.293179013	0.293179013	0.293179013	0.29317901	4.3469622

Initial Condition

x	c (t0)
0	4
1	4
2	4
3	4
4	4
5	4

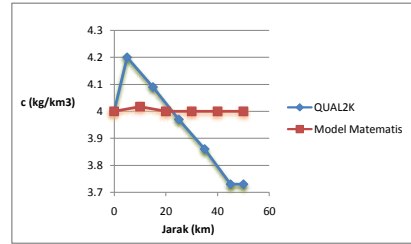
x	c (t1)
0	4
1	4.017188612
2	4
3	4
4	4
5	4

x	c (t2)
0	4
1	4.0752566
2	3.9874523
3	4
4	4
5	4

x	c (t3)
0	4
1	4.251055
2	3.924234
3	4.00916
4	4
5	4

x	c (t4)
0	4
1	4.756690613
2	3.691598519
3	4.070514811
4	3.993313338
5	4

x	c (t5)
0	4
1	6.172985
2	2.9406054
3	4.3417196
4	3.9374243
5	4.0048813

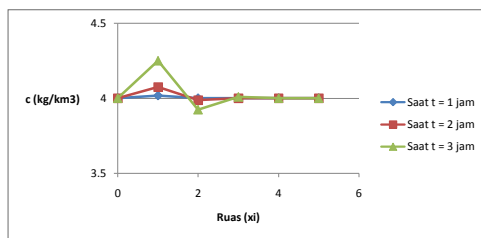
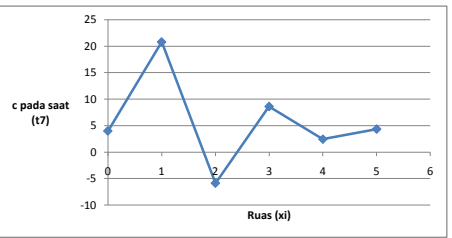
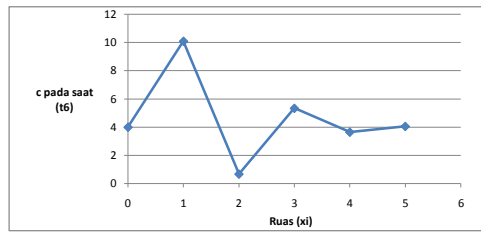
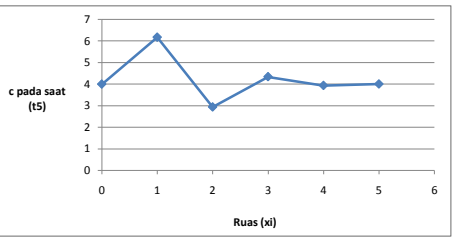
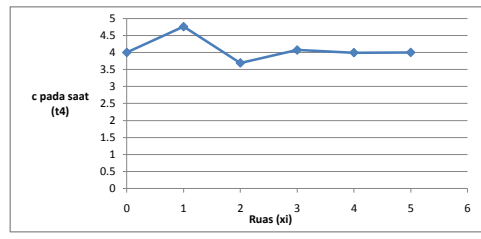
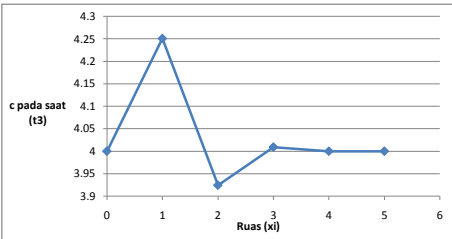
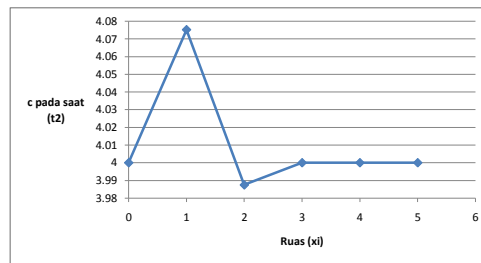
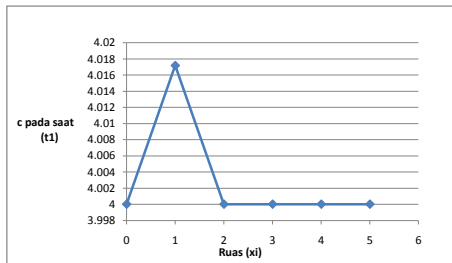


x	c (t6)
0	4
1	10.08401
2	0.679046
3	5.336232
4	3.647011
5	4.053783

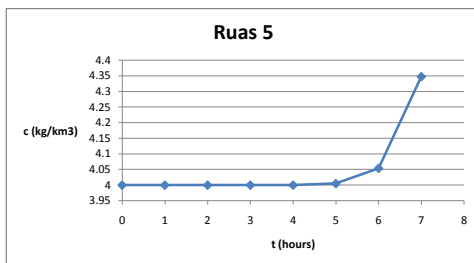
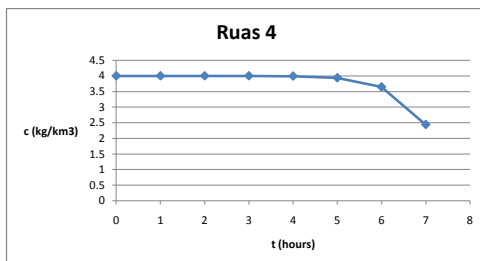
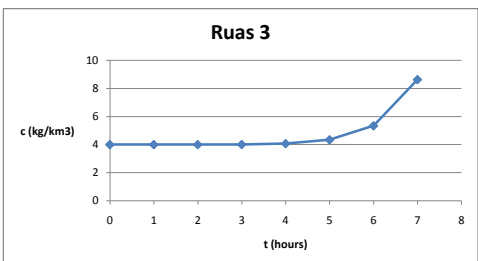
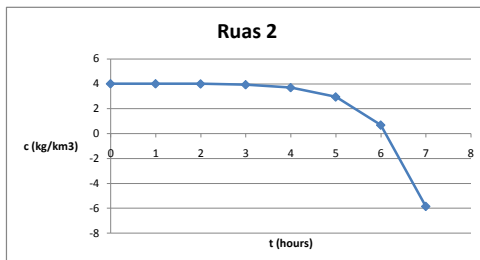
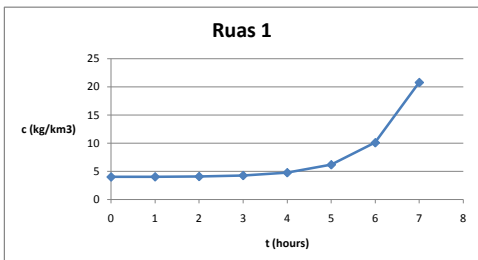
x	c (t7)
0	4
1	20.80138096
2	-5.860577355
3	8.617732492
4	2.442353127
5	4.346962151

QUAL2K	dx (Jarak)	c (t1)
	0	4
	5	4.2
	15	4.09
	25	3.97
	35	3.86
	45	3.73
	50	3.73

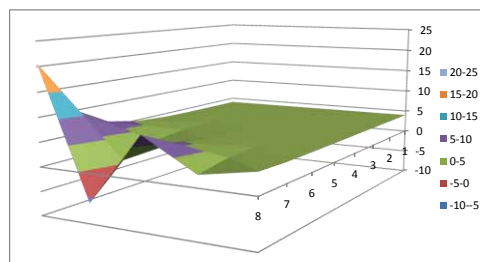
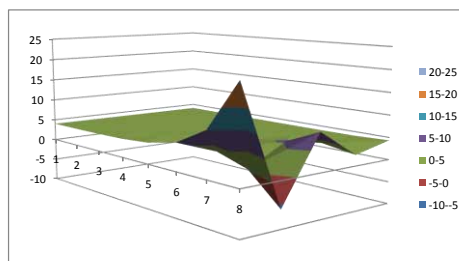
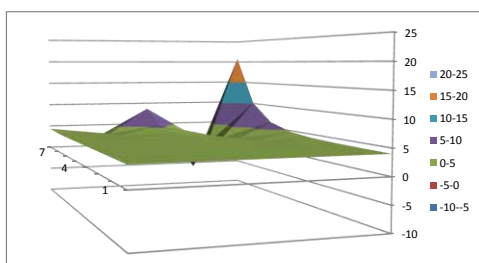
dx (Jarak)	c (t1)
0	4
10	4.0171886
20	4
30	4
40	4
50	4



Ruas 1		Ruas 2		Ruas 3		Ruas 4		Ruas 5	
t	c	t	c	t	c	t	c	t	c
0	4	0	4	0	4	0	4	0	4
1	4.017189	1	4	1	4	1	4	1	4
2	4.075257	2	3.987452313	2	4	2	4	2	4
3	4.251055	3	3.924233528	3	4.0091598	3	4	3	4
4	4.756691	4	3.691598519	4	4.0705148	4	3.99331334	4	4
5	6.172985	5	2.940605432	5	4.3417196	5	3.93742433	5	4.00488126
6	10.08401	6	0.679046357	6	5.3362323	6	3.64701076	6	4.05378314
7	20.80138	7	-5.860577355	7	8.6177325	7	2.44235313	7	4.34696215



	x=1	x=2	x=3	x=4	x=5
t=0	4	4	4	4	4
t=1	4.017188612	4	4	4	4
t=2	4.075256591	3.987452313	4	4	4
t=3	4.251055239	3.924233528	4.009159811	4	4
t=4	4.756690613	3.691598519	4.070514811	3.993313338	4
t=5	6.172984975	2.940605432	4.341719601	3.937424328	4.00488126
t=6	10.08401447	0.679046357	5.336232276	3.647010764	4.05378314
t=7	20.80138096	-5.860577355	8.617732492	2.442353127	4.34696215



## **Lampiran 6**

### **Hasil Running Simulasi pada QUAL2K menggunakan Idealisasi Beban Non Konstan**

**QUAL2K FORTRAN**  
**Stream Water Quality Model**  
**Steve Chapra, Hua Tao and Greg Pelletier**  
**Version 2.07**



Lampiran 6

<b>System ID:</b>	
River name	Hipotetic River, beban non konstan
Saved file name	SR081704v2_7dummy
Directory where file saved	C:\Documents and Settings\elsa.BPR-PONDASI\My Documents\Qual2k
Month	7
Day	8
Year	2008
Time zone	Eastern
Daylight savings time	Yes
<b>Calculation:</b>	
Calculation step	0.0625 hours
Final time	3 day
Solution method (integration)	Euler
Solution method (pH)	Bisection
Program determined calc step	0.046875 hours
Time of last calculation	0.09 minutes
Time of sunrise	5:19 AM
Time of solar noon	12:53 PM
Time of sunset	8:26 PM
Photoperiod	15.13 hours

**QUAL2K****Stream Water Quality Model****Hipotetic River, beban non konstan (7/8/2008)****Headwater Data:**

Note: \* required field

ID	Number of Headwaters*	1						
No. 1	Reach No.*	Headwater Name	Flow*	Elevation	Weir			
			Rate		Height	Width	adam	
			(m <sup>3</sup> /s)	(m)	(m)	(m)		
	1	Mainstem headwater	0.022	293.983	0.0000	0.0000	1.2500	
		Headwater Water Quality	Units	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM
		Temperature	C	21.28	20.96	20.66	20.41	20.21
		Conductivity	umhos	0.00	0.00	0.00	0.00	0.00
		Inorganic Solids	mgD/L	0.00	0.00	0.00	0.00	0.00
		Dissolved Oxygen	mg/L	8.47	8.49	8.51	8.53	8.54
		CBODslow	mgO2/L	0.00	0.00	0.00	0.00	0.00
		CBODfast	mgO2/L	4.00	4.00	4.00	4.00	4.00
		Organic Nitrogen	ugN/L	280.00	280.00	280.00	280.00	280.00
		NH4-Nitrogen	ugN/L	40.00	40.00	40.00	40.00	40.00
		NO3-Nitrogen	ugN/L	23.00	23.00	23.00	23.00	23.00
		Organic Phosphorus	ugP/L	16.00	16.00	16.00	16.00	16.00
		Inorganic Phosphorus (SRP)	ugP/L	6.30	6.30	6.30	6.30	6.30
		Phytoplankton	ugA/L	10.00	10.00	10.00	10.00	10.00
		Detritus (POM)	mgD/L	0.00	0.00	0.00	0.00	0.00
		Pathogen	cfu/100 mL	0.00	0.00	0.00	0.00	0.00
		Alkalinity	mgCaCO3/L	200.00	200.00	200.00	200.00	200.00
		pH	s.u.	7.00	7.00	7.00	7.00	7.00

bdam	Rating Curves				Manning Formula					
	Velocity		Depth		Channel	Manning	Bot Width	Side	Side	
	Coefficient	Exponent	Coefficient	Exponent	Slope	n	m	Slope	Slope	
0.9000	0.0000	0.000	0.0000	0.000	0.035	0.0250	5.00	0.00	0.00	
5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	
20.09	20.05	20.09	20.21	20.41	20.66	20.96	21.28	21.59	21.89	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
8.55	8.55	8.55	8.54	8.53	8.51	8.49	8.47	8.44	8.42	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	
40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	
23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	
16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	
6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	
7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	

<b>Prescribed Dispersion</b>									
<b>m2/s</b>									
7.00									
<b>3:00 PM</b>	<b>4:00 PM</b>	<b>5:00 PM</b>	<b>6:00 PM</b>	<b>7:00 PM</b>	<b>8:00 PM</b>	<b>9:00 PM</b>	<b>10:00 PM</b>	<b>11:00 PM</b>	
22.14	22.34	22.46	22.50	22.46	22.34	22.14	21.89	21.59	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
8.40	8.39	8.38	8.38	8.38	8.39	8.40	8.42	8.44	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	
40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	
23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	
16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	
6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	
7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	

**QUAL2K**  
**Stream Water Quality Model**  
**Hipotetic River, beban non konstan (7/8/2008)**  
**Reach Data:**

Reach for diel plot	5					
Element for diel plot	1	Reach	Headwater	Reach	Downstream	
Reach	Downstream	Number	Reach	length	Downstream	
Label	end of reach label			(km)	Latitude	Longitude
		1	Yes	10.00	42.50	72.00
		2		10.00	42.50	72.00
		3		10.00	42.50	72.00
		4		10.00	42.50	72.00
		5		10.00	42.50	72.00



Location		Element	Elevation		Downstream				
Upstream	Downstream	Number	Upstream	Downstream	Latitude			Longitude	
(km)	(km)	>=1	(m)	(m)	Degrees	Minutes	Seconds	Degrees	Minutes
50.000	40.000	1	293.983	292.721	42.00	30	0	72.00	0
40.000	30.000	1	292.721	290.310	42.00	30	0	72.00	0
30.000	20.000	1	290.310	281.987	42.00	30	0	72.00	0
20.000	10.000	1	281.987	275.983	42.00	30	0	72.00	0
10.000	0.000	1	275.983	269.979	42.00	30	0	72.00	0

Hydraulic Model (Weir Overrides Manning Formula; Manning Formula Override Rating Curves)										
	Weir				Rating Curves				Channel	Manning
Seconds	Height (m)	Width (m)	adam	bdam	Velocity		Depth		Slope	n
					Coefficient	Exponent	Coefficient	Exponent		
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250
0	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0350	0.0250

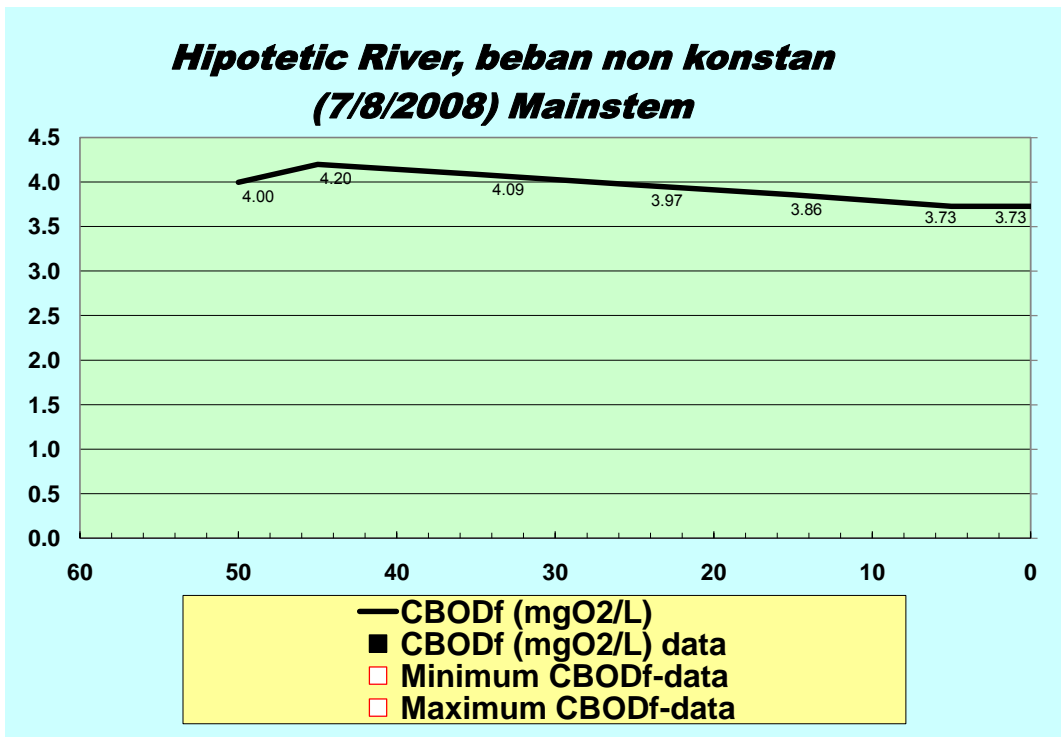
Manning Formula			Prescribed	Bottom	Bottom	Prescribed	Prescribed	Prescribed	Prescribed
Bot Width	Side	Side	Dispersion	Algae	SOD	SOD	CH4 flux	NH4 flux	Inorg P flux
m	Slope	Slope	m2/s	Coverage	Coverage	gO2/m2/d	gO2/m2/d	mgN/m2/d	mgP/m2/d
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000
5.00	0.0000	0.0000	7.00	50.00%	50.00%	0.00	0.0000	0.0000	0.0000

**QUAL2K**  
**Stream Water Quality Model**  
**Hipotetic River, beban non konstan (7/8/2008)**  
**Point Source Data:**

\* The headwater of the mainstem (or tributary) where the point source enters.

Name	Headwater ID*	Headwater Name	Location km	Point	
				Abstraction m3/s	Inflow m3/s
Idealisasi beban non konstan	1	Mainstem headwater	40.00	0.0000	0.0007

Hasil Running CBOD fast



<i>Temperature</i>			<i>Specific Conductance</i>		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>°C</i>	<i>°C</i>	<i>max</i>	<i>umhos</i>	<i>umhos</i>	<i>max</i>
25.00	0.00	12:00 AM	0.00	0.00	12:00 AM

<i>Inorganic Suspended Solids</i>			<i>Dissolved Oxygen</i>		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>mg/L</i>	<i>mg/L</i>	<i>max</i>	<i>mg/L</i>	<i>mg/L</i>	<i>max</i>
48.50	0.00	12:00 AM	0.00	0.00	12:00 AM

Slow CBOD			Fast CBOD		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>mgO2/L</i>	<i>mgO2/L</i>	<i>max</i>	<i>mgO2/L</i>	<i>mgO2/L</i>	<i>max</i>
0.00	0.00	12:00 AM	3.50	0.00	12:00 AM

Organic N			Ammonia N		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>ugN/L</i>	<i>ugN/L</i>	<i>max</i>	<i>ugN/L</i>	<i>ugN/L</i>	<i>max</i>
716.50	0.00	12:00 AM	203.50	0.00	12:00 AM



Nitrate + Nitrite N			Organic P		
mean	range/2	time of	mean	range/2	time of
ugN/L	ugN/L	max	ugP/L	ugP/L	max
11400.00	0.00	12:00 AM	0.00	0.00	12:00 AM

<i>Inorganic P</i>			<i>Phytoplankton</i>		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>ugP/L</i>	<i>ugP/L</i>	<i>max</i>	<i>ugA/L</i>	<i>ugA/L</i>	<i>max</i>
4150.00	0.00	12:00 AM	0.00	0.00	12:00 AM

<i>Detritus</i>			<i>Pathogen Indicator Bacteria</i>		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>mgD/L</i>	<i>mgD/L</i>	<i>max</i>	<i>cfu/100ml</i>	<i>cfu/100ml</i>	<i>max</i>
0.00	0.00	12:00 AM	0.00	0.00	12:00 AM

<i>Alkalinity</i>			<i>pH</i>		
<i>mean</i>	<i>range/2</i>	<i>time of</i>	<i>mean</i>	<i>range/2</i>	<i>time of</i>
<i>mgCaCO3/L</i>	<i>mgCaCO3/L</i>	<i>max</i>	<i>s.u.</i>	<i>s.u.</i>	<i>max</i>
200.00	0.00	12:00 AM	7.00	0.00	12:00 AM

## **Lampiran 7**

**Formulasi Numerik dengan  $t = 0.5$  jam menggunakan  
Beban Non Konstan pada Model Matematis**

Lampiran 7

Ruas Sungai	dx (km)	A (km <sup>2</sup> )	V (km <sup>3</sup> )	W (kg/h)	W/V (kg/km <sup>3</sup> h)	u (km/h)	D (km <sup>2</sup> /h)	Δt (h)
Ruas 1	10	10	100	e <sup>Δt</sup>	0.01e <sup>Δt</sup>	8	7	0.5
Ruas 2 - Ruas 5	10	10	100	0	0	8	7	0.5

Model Teoritis  $\frac{dc}{dt} = \frac{W(t)}{V} - u \frac{\partial c}{\partial x} + D \frac{\partial^2 c}{\partial x^2}$

Initial

$c_0^{r0}$	0	Boundary	$c_0^{r1}$	0	$c_0^{r8}$	0
$c_1^{r0}$	0		$c_0^{r2}$	0	$c_0^{r9}$	0
$c_2^{r0}$	0		$c_0^{r3}$	0	$c_0^{r10}$	0
$c_3^{r0}$	0		$c_0^{r4}$	0	$c_0^{r11}$	0
$c_4^{r0}$	0		$c_0^{r5}$	0	$c_0^{r12}$	0
$c_5^{r0}$	0		$c_0^{r6}$	0		
$c_6^{r0}$	0		$c_0^{r7}$	0		

Boundary

$c_6^{r1}$	0	$c_6^{r4}$	0	$c_6^{r7}$	0	$c_6^{r10}$	0
$c_6^{r2}$	0	$c_6^{r5}$	0	$c_6^{r8}$	0	$c_6^{r11}$	0
$c_6^{r3}$	0	$c_6^{r6}$	0	$c_6^{r9}$	0	$c_6^{r12}$	0

	t1	$c^{r0}$	k1	k2	k3	k4	k mean	$c^{r1}$
Ruas 1	0	0						
	0.5		0.005	0.006420127	0.006420127	0.008243607	0.00648735	0.0064874
Ruas 2	0	0						
	0.5		0	0	0	0	0	0
Ruas 3	0	0						
	0.5		0	0	0	0	0	0
Ruas 4	0	0						
	0.5		0	0	0	0	0	0
Ruas 5	0	0						
	0.5		0	0	0	0	0	0

	t2	$c^{r1}$	k1	k2	k3	k4	k mean	$c^{r2}$
Ruas 1	0.5	0.006487						
	1		0.010384433	0.012725827	0.012725827	0.015732236	0.01283666	0.019324
Ruas 2	0.5	0						
	1		-0.002367884	-0.002367884	-0.002367884	-0.00236788	-0.00236788	-0.002368
Ruas 3	0.5	0						
	1		0	0	0	0	0	0
Ruas 4	0.5	0						
	1		0	0	0	0	0	0
Ruas 5	0.5	0						
	1		0	0	0	0	0	0

	t3	$c^{r2}$	k1	k2	k3	k4	k mean	$c^{r3}$
Ruas 1	1	0.019324						
	1.5		0.019885459	0.023745765	0.023745765	0.028702497	0.0239285	0.0432525
Ruas 2	1	-0.00237						
	1.5		-0.007834667	-0.007834667	-0.007834667	-0.00783467	-0.00783467	-0.010203
Ruas 3	1	0						
	1.5		0.000864278	0.000864278	0.000864278	0.000864278	0.00086428	0.0008643
Ruas 4	1	0						
	1.5		0	0	0	0	0	0
Ruas 5	1	0						
	1.5		0	0	0	0	0	0

	t4	$c^{r3}$	k1	k2	k3	k4	k mean	$c^{r4}$
Ruas 1	1.5	0.043253						
	2		0.036324689	0.042689258	0.042689258	0.050861527	0.04299054	0.0862431
Ruas 2	1.5	-0.0102						
	2		-0.019123761	-0.019123761	-0.019123761	-0.01912376	-0.01912376	-0.029326
Ruas 3	1.5	0.000864						
	2		0.004009143	0.004009143	0.004009143	0.004009143	0.00400914	0.0048734
Ruas 4	1.5	0						
	2		-0.000315461	-0.000315461	-0.000315461	-0.00031546	-0.00031546	-0.000315
Ruas 5	1.5	0						
	2		0	0	0	0	0	0

	t5	$c^{r4}$	k1	k2	k3	k4	k mean	$c^{r5}$
Ruas 1	2	0.086243						
	2.5		0.064379074	0.074872475	0.074872475	0.088346268	0.07536921	0.1616123
Ruas 2	2	-0.02933						
	2.5		-0.04098583	-0.04098583	-0.04098583	-0.04098583	-0.04098583	-0.070312
Ruas 3	2	0.004873						
	2.5		0.012301291	0.012301291	0.012301291	0.012301291	0.01230129	0.0171747
Ruas 4	2	-0.00032						
	2.5		-0.001882901	-0.001882901	-0.001882901	-0.0018829	-0.0018829	-0.002198
Ruas 5	2	0						
	2.5		0.000115143	0.000115143	0.000115143	0.000115143	0.00011514	0.0001151

	t6	$c^{r5}$	k1	k2	k3	k4	k mean	$c^{r6}$
Ruas 1	2.5	0.161612						
	3		0.111783602	0.129084296	0.129084296	0.151298827	0.12990327	0.2915155
Ruas 2	2.5	-0.07031						
	3		-0.081590369	-0.081590369	-0.081590369	-0.08159037	-0.08159037	-0.151903
Ruas 3	2.5	0.017175						
	3		0.031254644	0.031254644	0.031254644	0.031254644	0.03125464	0.0484294
Ruas 4	2.5	-0.0022						
	3		-0.006990199	-0.006990199	-0.006990199	-0.0069902	-0.0069902	-0.009189
Ruas 5	2.5	0.000115						
	3		0.000840399	0.000840399	0.000840399	0.000840399	0.0008404	0.0009555

	$t7$	$c^{t6}$	$k1$	$k2$	$k3$	$k4$	$k \text{ mean}$	$c^{t7}$
Ruas 1	3	0.291516						
	3.5		0.191311242	0.219835265	0.219835265	0.256460835	0.22118552	0.5127011
Ruas 2	3	-0.1519						
	3.5		-0.154835972	-0.154835972	-0.154835972	-0.15483597	-0.15483597	-0.306738
Ruas 3	3	0.048429						
	3.5		0.071104505	0.071104505	0.071104505	0.071104505	0.0711045	0.1195339
Ruas 4	3	-0.00919						
	3.5		-0.020675496	-0.020675496	-0.020675496	-0.0206755	-0.0206755	-0.029864
Ruas 5	3	0.000956						
	3.5		0.003669154	0.003669154	0.003669154	0.003669154	0.00366915	0.0046247

Initial Condition

x	c (t0)
0	0
1	0
2	0
3	0
4	0
5	0

x	c (t1)
0	0
1	0.006487353
2	0
3	0
4	0
5	0

x	c (t2)
0	0
1	0.019324
2	-0.002368
3	0
4	0
5	0

Kondisi pertama

x	c (t1)
0	0
1	0.0171886
2	0
3	0
4	0
5	0

x	c (t3)
0	0
1	0.043253
2	-0.0102
3	0.000864
4	0
5	0

x	c (t4)
0	0
1	0.08624306
2	-0.029326312
3	0.00487342
4	-0.000315461
5	0

x	c (t5)
0	0
1	0.1616123
2	-0.070312
3	0.0171747
4	-0.002198
5	0.0001151

Kondisi pertama

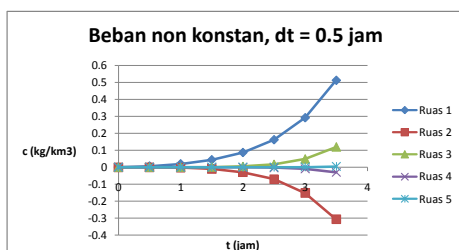
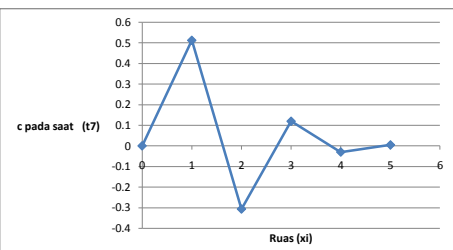
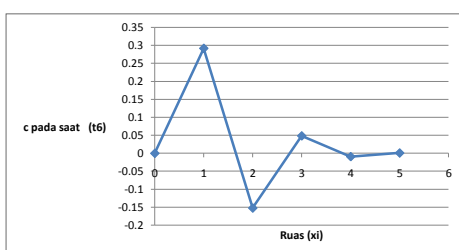
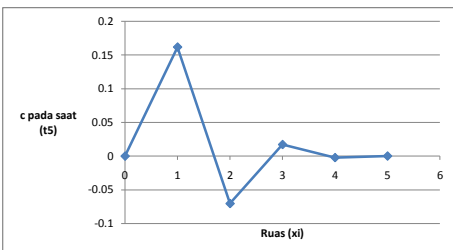
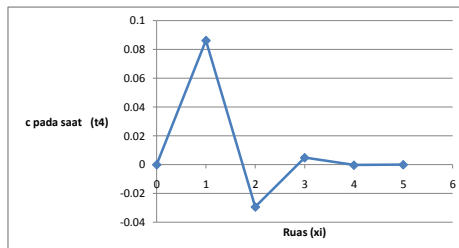
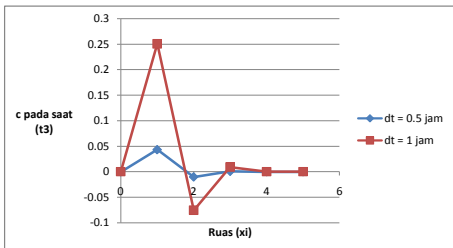
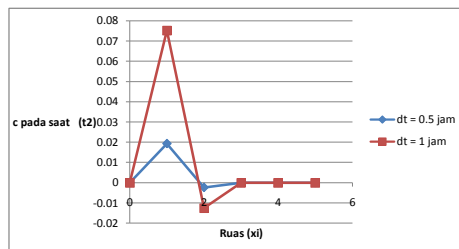
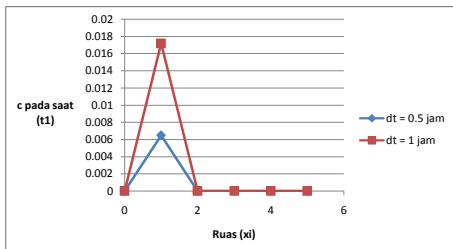
x	c (t2)
0	0
1	0.0752566
2	-0.012548
3	0
4	0
5	0

x	c (t6)
0	0
1	0.291516
2	-0.1519
3	0.048429
4	-0.00919
5	0.000956

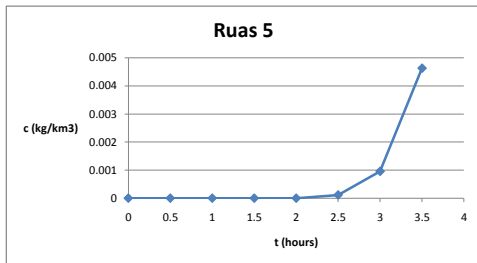
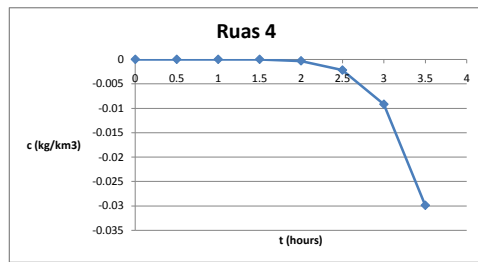
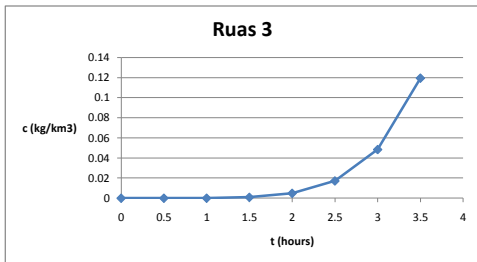
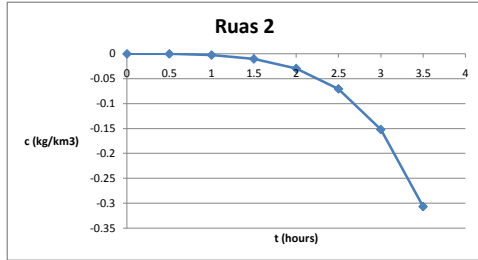
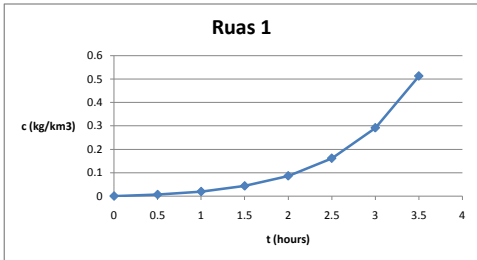
x	c (t7)
0	0
1	0.512701058
2	-0.306738483
3	0.11953386
4	-0.029864057
5	0.004624697

Kondisi pertama

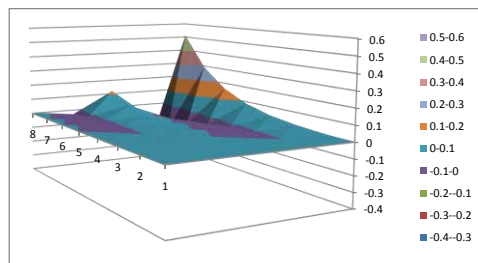
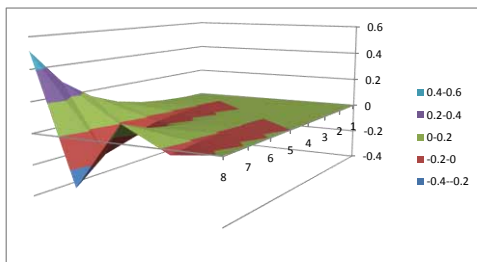
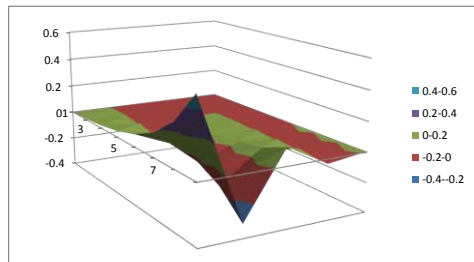
x	c (t3)
0	0
1	0.251055
2	-0.07577
3	0.00916
4	0
5	0



Ruas 1		Ruas 2		Ruas 3		Ruas 4		Ruas 5	
t	c	t	c	t	c	t	c	t	c
0	0	0	0	0	0	0	0	0	0
0.5	0.006487	0.5	0	0.5	0	0.5	0	0.5	0
1	0.019324	1	-0.002367884	1	0	1	0	1	0
1.5	0.043253	1.5	-0.010202551	1.5	0.0008643	1.5	0	1.5	0
2	0.086243	2	-0.029326312	2	0.0048734	2	-0.000315	2	0
2.5	0.161612	2.5	-0.070312142	2.5	0.0171747	2.5	-0.002198	2.5	0.00011514
3	0.291516	3	-0.151902512	3	0.0484294	3	-0.009189	3	0.00095554
3.5	0.512701	3.5	-0.306738483	3.5	0.1195339	3.5	-0.029864	3.5	0.0046247



	x=1	x=2	x=3	x=4	x=5
t=0	0	0	0	0	0
t=1	0.006487353	0	0	0	0
t=2	0.019324015	-0.002367884	0	0	0
t=3	0.043252518	-0.010202551	0.000864278	0	0
t=4	0.08624306	-0.029326312	0.00487342	-0.00031546	0
t=5	0.161612267	-0.070312142	0.017174712	-0.00219836	0.00011514
t=6	0.291515535	-0.151902512	0.048429356	-0.00918856	0.00095554
t=7	0.512701058	-0.306738483	0.11953386	-0.02986406	0.0046247





## **Lampiran 8**

**Formulasi Numerik dengan  $x = 0.5$  km dan  $t = 0.5$  jam  
menggunakan Beban Non Konstan pada Model Matematis**

Lampiran 8

Ruas Sungai	dx (km)	A (km <sup>2</sup> )	V (km <sup>3</sup> )	W (kg/h)	W/V (kg/km <sup>3</sup> h)	u (km/h)	D (km <sup>2</sup> /h)	Δt (h)
Ruas 1	5	10	100	e <sup>Δt</sup>	0.01e <sup>Δt</sup>	8	7	0.5
Ruas 2 - Ruas 5	5	10	100	0	0	8	7	0.5

Model Teoritis 
$$\frac{dc}{dt} = \frac{W(t)}{V} - u \frac{\partial c}{\partial x} + D \frac{\partial^2 c}{\partial x^2}$$

Initial

$c_0^{t0}$	0	Boundary	$c_0^{t1}$	0	$c_0^{t8}$	0
$c_1^{t0}$	0		$c_0^{t2}$	0	$c_0^{t9}$	0
$c_2^{t0}$	0		$c_0^{t3}$	0	$c_0^{t10}$	0
$c_3^{t0}$	0		$c_0^{t4}$	0	$c_0^{t11}$	0
$c_4^{t0}$	0		$c_0^{t5}$	0	$c_0^{t12}$	0
$c_5^{t0}$	0		$c_0^{t6}$	0		
$c_6^{t0}$	0		$c_0^{t7}$	0		

Boundary

$c_6^{t1}$	0	$c_6^{t4}$	0	$c_6^{t7}$	0	$c_6^{t10}$	0
$c_6^{t2}$	0	$c_6^{t5}$	0	$c_6^{t8}$	0	$c_6^{t11}$	0
$c_6^{t3}$	0	$c_6^{t6}$	0	$c_6^{t9}$	0	$c_6^{t12}$	0

	t1	$c_0^{t0}$	k1	k2	k3	k4	k mean	$c_0^{t1}$
Ruas 1	0	0						
	0.5		0.005	0.006420127	0.006420127	0.008243607	0.00648735	0.0064874
Ruas 2	0	0						
	0.5		0	0	0	0	0	0
Ruas 3	0	0						
	0.5		0	0	0	0	0	0
Ruas 4	0	0						
	0.5		0	0	0	0	0	0
Ruas 5	0	0						
	0.5		0	0	0	0	0	0

	t2	$c_0^{t1}$	k1	k2	k3	k4	k mean	$c_0^{t2}$
Ruas 1	0.5	0.006487						
	1		0.01161703	0.013958424	0.013958424	0.016964833	0.01406926	0.0205566
Ruas 2	0.5	0						
	1		-0.004281653	-0.004281653	-0.004281653	-0.00428165	-0.00428165	-0.004282
Ruas 3	0.5	0						
	1		0	0	0	0	0	0
Ruas 4	0.5	0						
	1		0	0	0	0	0	0
Ruas 5	0.5	0						
	1		0	0	0	0	0	0

	t3	$c_0^{t2}$	k1	k2	k3	k4	k mean	$c_0^{t3}$
Ruas 1	1	0.020557						
	1.5		0.023681417	0.027541723	0.027541723	0.032498455	0.02772446	0.0482811
Ruas 2	1	-0.00428						
	1.5		-0.015793824	-0.015793824	-0.015793824	-0.01579382	-0.01579382	-0.020075
Ruas 3	1	0						
	1.5		0.002825891	0.002825891	0.002825891	0.002825891	0.00282589	0.0028259
Ruas 4	1	0						
	1.5		0	0	0	0	0	0
Ruas 5	1	0						
	1.5		0	0	0	0	0	0

	t4	$c_0^{t3}$	k1	k2	k3	k4	k mean	$c_0^{t4}$
Ruas 1	1.5	0.048281						
	2		0.044704039	0.051068608	0.051068608	0.059240877	0.05136989	0.099651
Ruas 2	1.5	-0.02008						
	2		-0.041909131	-0.041909131	-0.041909131	-0.04190913	-0.04190913	-0.061985
Ruas 3	1.5	0.002826						
	2		0.014719278	0.014719278	0.014719278	0.014719278	0.01471928	0.0175452
Ruas 4	1.5	0						
	2		-0.001865088	-0.001865088	-0.001865088	-0.00186509	-0.00186509	-0.001865
Ruas 5	1.5	0						
	2		0	0	0	0	0	0

	t5	$c_0^{t4}$	k1	k2	k3	k4	k mean	$c_0^{t5}$
Ruas 1	2	0.099651						
	2.5		0.080085942	0.090579342	0.090579342	0.104053136	0.09107607	0.190727
Ruas 2	2	-0.06198						
	2.5		-0.095545309	-0.095545309	-0.095545309	-0.09554531	-0.09554531	-0.15753
Ruas 3	2	0.017545						
	2.5		0.049772216	0.049772216	0.049772216	0.049772216	0.04977222	0.0673174
Ruas 4	2	-0.00187						
	2.5		-0.012549657	-0.012549657	-0.012549657	-0.01254966	-0.01254966	-0.014415
Ruas 5	2	0						
	2.5		0.001230958	0.001230958	0.001230958	0.001230958	0.00123096	0.001231

	t6	$c_0^{t5}$	k1	k2	k3	k4	k mean	$c_0^{t6}$
Ruas 1	2.5	0.190727						
	3		0.138036351	0.155337045	0.155337045	0.177551575	0.15615602	0.3468831
Ruas 2	2.5	-0.15753						
	3		-0.198370968	-0.198370968	-0.198370968	-0.19837097	-0.19837097	-0.355901
Ruas 3	2.5	0.067317						
	3		0.13695672	0.13695672	0.13695672	0.13695672	0.13695672	0.2042741
Ruas 4	2.5	-0.01441						
	3		-0.051752807	-0.051752807	-0.051752807	-0.05175281	-0.05175281	-0.066168
Ruas 5	2.5	0.001231						
	3		0.01015383	0.01015383	0.01015383	0.01015383	0.01015383	0.0113848

	t7	c <sup>t6</sup>	k1	k2	k3	k4	k mean	c <sup>t7</sup>
Ruas 1	3	0.346883						
	3.5		0.230980769	0.259504792	0.259504792	0.296130362	0.26085505	0.6077381
Ruas 2	3	-0.3559						
	3.5		-0.385412902	-0.385412902	-0.385412902	-0.3854129	-0.3854129	-0.741314
Ruas 3	3	0.204274						
	3.5		0.331853661	0.331853661	0.331853661	0.331853661	0.33185366	0.5361278
Ruas 4	3	-0.06617						
	3.5		-0.167634166	-0.167634166	-0.167634166	-0.16763417	-0.16763417	-0.233802
Ruas 5	3	0.011385						
	3.5		0.049590674	0.049590674	0.049590674	0.049590674	0.04959067	0.0609755

Initial Condition

x	c (t0)
0	0
1	0
2	0
3	0
4	0
5	0

x	c (t1)
0	0
1	0.006487353
2	0
3	0
4	0
5	0

x	c (t2)
0	0
1	0.0205566
2	-0.004282
3	0
4	0
5	0

Kondisi pertama

x	c (t1)
0	0
1	0.0171886
2	0
3	0
4	0
5	0

x	c (t3)
0	0
1	0.048281
2	-0.02008
3	0.002826
4	0
5	0

x	c (t4)
0	0
1	0.099650964
2	-0.061984607
3	0.017545168
4	-0.001865088
5	0

x	c (t5)
0	0
1	0.190727
2	-0.15753
3	0.0673174
4	-0.014415
5	0.001231

Kondisi pertama

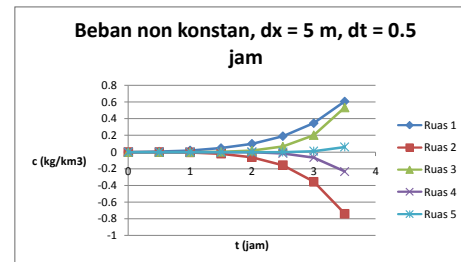
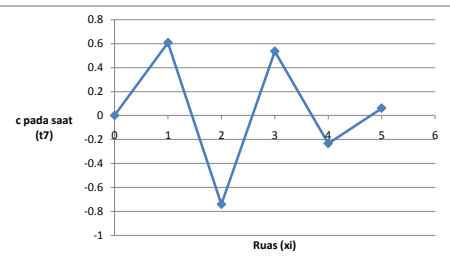
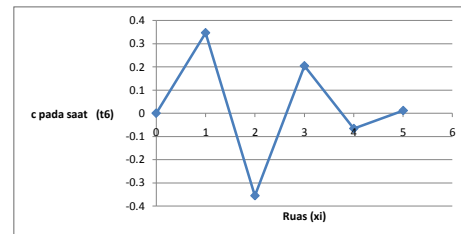
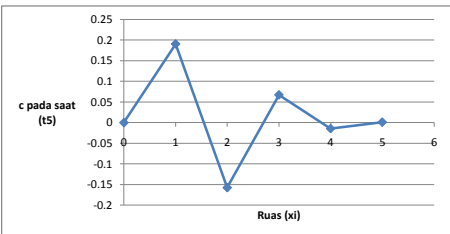
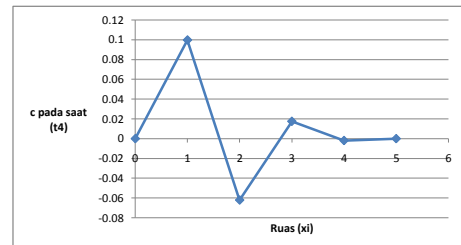
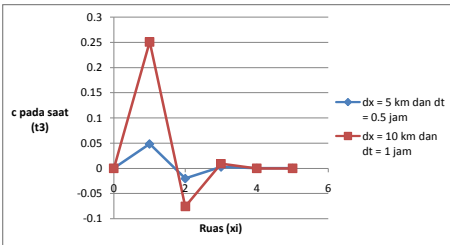
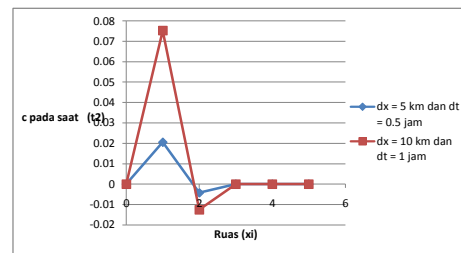
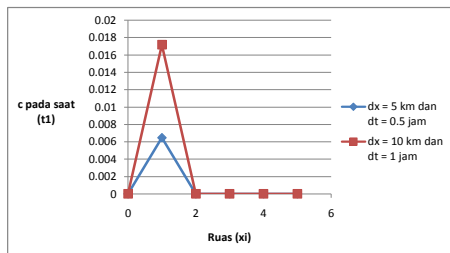
x	c (t2)
0	0
1	0.0752566
2	-0.012548
3	0
4	0
5	0

x	c (t6)
0	0
1	0.346883
2	-0.3559
3	0.204274
4	-0.06617
5	0.011385

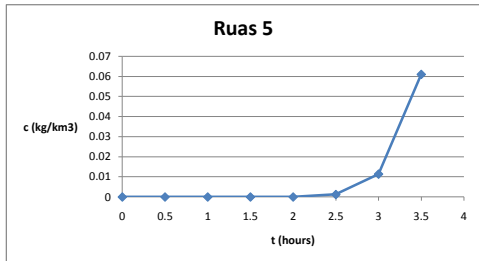
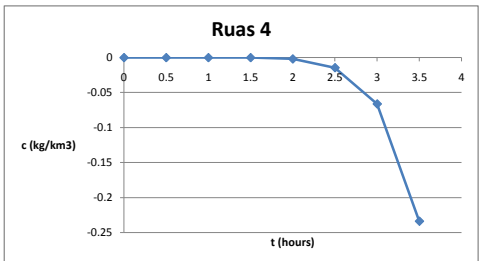
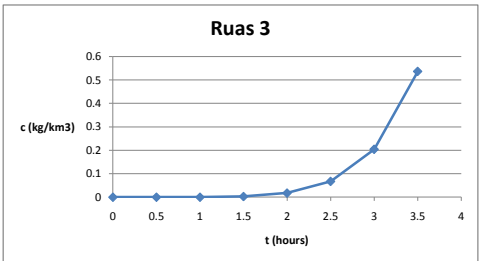
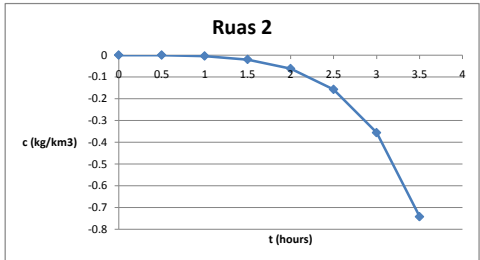
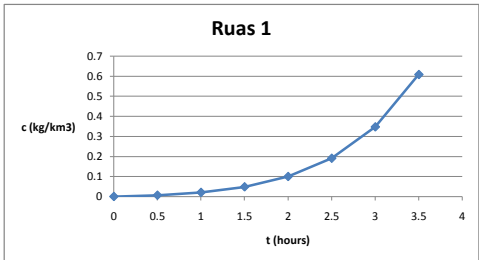
x	c (t7)
0	0
1	0.607738106
2	-0.741313787
3	0.536127766
4	-0.233801717
5	0.060975461

Kondisi pertama

x	c (t3)
0	0
1	0.251055
2	-0.07577
3	0.00916
4	0
5	0



Ruas 1	t	c	Ruas 2	t	c	Ruas 3	t	c	Ruas 4	t	c	Ruas 5	t	c
	0	0		0	0		0	0		0	0		0	0
	0.5	0.006487		0.5	0		0.5	0		0.5	0		0.5	0
	1	0.020557		1	-0.004281653		1	0		1	0		1	0
	1.5	0.048281		1.5	-0.020075476		1.5	0.0028259		1.5	0		1.5	0
	2	0.099651		2	-0.061984607		2	0.0175452		2	-0.001865		2	0
	2.5	0.190727		2.5	-0.157529916		2.5	0.0673174		2.5	-0.014415		2.5	0.00123096
	3	0.346883		3	-0.355900884		3	0.2042741		3	-0.066168		3	0.01138479
	3.5	0.607738		3.5	-0.741313787		3.5	0.5361278		3.5	-0.233802		3.5	0.06097546



	x=1	x=2	x=3	x=4	x=5
t=0	0	0	0	0	0
t=1	0.006487353	0	0	0	0
t=2	0.020556612	-0.004281653	0	0	0
t=3	0.048281073	-0.020075476	0.002825891	0	0
t=4	0.099650964	-0.061984607	0.017545168	-0.00186509	0
t=5	0.190727039	-0.157529916	0.067317384	-0.01441474	0.00123096
t=6	0.346883056	-0.355900884	0.204274105	-0.06616755	0.01138479
t=7	0.607738106	-0.741313787	0.536127766	-0.23380172	0.06097546

