APPENDIX 2B: LIFE CYCLE ANALYSIS FOR CHLORINATION AND UV DISINFECTION

1. Cost Info-Disinfection

(A) Chlorination

Items	Cost (in Thousand HK$)
Total Capital	**988.65**
Chlorination & Dechlorination Units	120.00
Misc. E&M Costs	20.00
Civil Costs	620.50
ADD 30% Overheads & Profits	228.15
Annual O&M costs	**121.34**
Annual Chemical Costs	115.34
Other O&M Costs	6.00

Total Net Present Value of 15 years Project Cycle (in '000 HK$) 2,232.75

(B) UV Radiation

Items	Cost (in Thousand HK$)
Total Capital	**1,180.17**
UV Lamps & Control	760.00
Misc. E&M Costs	76.00
Civil Costs	71.83
ADD 30% Overheads & Profits	272.35
Annual O&M costs	**43.13**
Electricity Costs	8.21
Misc. Parts Replacement Costs (per year)	3.00
UV Lamps Replacement Costs (per year)	21.12
Electronic Ballast Replacement Costs (per year)	10.79

Total Net Present Value of 15 years Project Cycle (in '000 HK$) 2,353.72

Note:
1. Facilities are sized based on the average flow of 1,580m^3/day and peak flow of 4,740m^3/day.
2. Assume 10mg/l of sodium hypochlorite and 4mg/l sodium bisulphite are used for chlorination and dechlorination respectively.
3. Unit rates for sodium hypochlorite (at 10%) and sodium bisulphite (at 97% powder) are assumed as HK$1.8/kg and HK$5/kg respectively.
4. Assume UV dose of 30mJ/cm^2 at 65%/1cm UV transmittance.
5. Labour cost is excluded from the operational cost estimate for both technologies.

2. Disinfection

(A) Chlorination

Peak Flow = 4,740m^3/d for 15 mins, i.e. V = 49.4m^3
Size = 3.5H x 8.4W x 7.2L (External)
3H x 7.4W x 6.2L (Internal) - w/ internal partition
(Assume Internal partition = 3H x 5.2W x 0.3L x 8 nrs)

Civil Capital Cost

Concrete	Vol. (E) - (I)	111.48
	ADD 10% Wastage	11.15
		122.63
		125.00 m^3 say
Formwork		482.40
	ADD 10% Wastage	48.24
		530.64
		530.00 m^2 say
Reinforcement	4% of Concrete =	5.00 m^3
		39.25 tons
		60.00 tons say
	Total Civil Costs =	620,500.00

Chemical Costs

	Av. Flow (m^3/day)	Dosage (mg/L)	Unit Cost (HK$/kg)	Annual Chemical Cost (HK$)
Sodium Hypochlorite	1580	10	18.00	$103,806.00
Sodium Bisulphite	1580	4	5.00	$11,534.00
			Total	$115,340.00

(B) UV Radiation

Civil Capital Cost

Peak Flow =	4,740m^3/d	for 2 mins, i.e. V = 6.6m^3	
Size =	1.6H x 1.2W x 6L (External)		
OR	1.9H x 1.7W x 6L (Internal) – open ends		
Concrete	Vol. (E) – (I)	7.86	
	ADD 10% Wastage	0.79	
		8.65	
		10.00	m^3 say
Formwork		47.50	
	ADD 10% Wastage	4.75	
		52.25	
		55.00	m^2 say
Reinforcement	4% of Concrete =	0.40	m^3
		3.14	tons
		5.00	tons say
	Total Civil Costs =	55,250.00	
	Miscellaneous, say 30% of total =	16,575.00	
	Total =	71,825.00	

Energy Costs

Input Power	2.90	KW
Energy Consumption	8,468.00	KWH/yr
Electricity Cost	8,213.96	HK$/yr

UV Lamps Replacement Costs (per year)

UV Lamp Service Life	1	yr
UV Lamp Cost	2,400.00	HK$/lamp
No. of lamps Required	8	
Total Material Costs	19,200.00	HK$/yr
Factor for Labour Costs	10%	
Total Replacement Costs	21,120.00	HK$/yr

Electronic Ballast Replacement Costs (per year)

Ballast Service Life	3	yr
Ballast Cost	7,360.00	HK$/lamp
No. of Ballast Required	4	
Factor for Labour Costs	10%	
Total Replacement Costs	10,794.67	HK$/yr

3. Life-Cycle Disinfection

Discounted Cash Flow Analysis – Chlorination

Assumptions	
Discount Rate	3.0%
Inflation Rate	1.0%
Service Years of E&M Works	15
Service Years of Civil Works	30
Period of Study (after the Completion of the Project)	15

[All costs are in thousands of HK$]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Financial Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Capital Costs																				
Total Annual Cost		247.16	247.16	247.16	247.16															
Total Annual Cost at MOD		249.63	252.13	254.65	257.20															
Annual O&M Costs																				
Annual recurrent cost						121.34	121.34	121.34	121.34	121.34	121.34	121.34	121.34	121.34	121.34	121.34	121.34	121.34	121.34	121.34
Annual recurrent cost at MOD						127.53	128.80	130.09	131.39	132.71	134.03	135.38	136.73	138.10	139.48	140.87	142.28	143.70	145.14	146.59
Replacement Costs																				
Replacement Costs (Every 15 years)																				182.00
Replacement Costs at MOD (Every 15 years)																				219.88
Salvage Value																				
Salvage Value																				-403.33
Salvage Value at MOD																				-487.26
Cost Calculation																				
Discounting factor		0.971	0.943	0.915	0.888	0.863	0.837	0.813	0.789	0.766	0.744	0.722	0.701	0.681	0.661	0.642	0.623	0.605	0.587	0.570
PV of Total Annual Captial Cost		242.36	237.66	233.04	228.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PV of Annual recurrent cost		0.00	0.00	0.00	0.00	110.01	107.87	105.78	103.72	101.71	99.73	97.80	95.90	94.04	92.21	90.42	88.66	86.94	85.25	83.60
PV of Replacement cost		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	125.39
PV of Salvage Value		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-277.88
Total PV of costs to Year 15 after commissioning ($ Thousand)	2,232.75	242.36	237.66	233.04	228.52	110.01	107.87	105.78	103.72	101.71	99.73	97.80	95.90	94.04	92.21	90.42	88.66	86.94	85.25	83.60

Discounted Cash Flow Analysis - UV Disinfection

Assumptions	
Discount Rate	3.0%
Inflation Rate	1.0%
Service Years of E&M Works	15
Service Years of Civil Works	30
Service Years of UV Lamps	1
Period of Study (after the Completion of the Project)	15

[All costs are in thousands of HK$]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Financial Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Capital Costs																				
Total Annual Cost		295.04	295.04	295.04	295.04															
Total Annual Cost at MOD		297.99	300.97	303.98	307.02															
Annual O&M Costs																				
Annual recurrent cost						43.13	43.13	43.13	43.13	43.13	43.13	43.13	43.13	43.13	43.13	43.13	43.13	43.13	43.13	43.13
Annual recurrent cost at MOD						45.33	45.78	46.24	46.70	47.17	47.64	48.12	48.60	49.08	49.58	50.07	50.57	51.08	51.59	52.10
Replacement Costs																				
Replacement Costs (Every 15 years)																				1,086.80
Replacement Costs at MOD (Every 15 years)																				1,312.97
Salvage Value																				
Salvage Value																				-46.69
Salvage Value at MOD																				-56.40
Cost Calculation																				
Discounting factor		0.971	0.943	0.915	0.888	0.863	0.837	0.813	0.789	0.766	0.744	0.722	0.701	0.681	0.661	0.642	0.623	0.605	0.587	0.570
PV of Total Annual Capital Cost		289.31	283.70	278.19	272.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PV of Annual recurrent cost		0.00	0.00	0.00	0.00	39.10	38.34	37.60	36.87	36.15	35.45	34.76	34.09	33.42	32.78	32.14	31.51	30.90	30.30	29.71
PV of Replacement cost		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	748.77
PV of Salvage Value		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-32.17
Total PV of costs to Year 15 after commissioning ($ Thousand)	2,353.72	289.31	283.70	278.19	272.79	39.10	38.34	37.60	36.87	36.15	35.45	34.76	34.09	33.42	32.78	32.14	31.51	30.90	30.30	29.71