Balancing Type 1 and Type 2 Errors
December 9, 2004
Handout # 5

Some parameters will have to be assessed using the binomial method (even if we adopt the CIP). We need to discuss the balance between Type 1 and Type 2 errors when listing and delisting. Some parameters that could be assessed using the binomial method are:

- Ambient toxicity tests - values are yes/no for toxic condition
- Sample sets where most of the reported values are less than the laboratory reporting level.
- And until we can implement a statistical method that considers both the frequency and magnitude of exceedances, water quality parameters such as dissolved oxygen, pH and bacteria.

Listing Scenario:

Let's hypothesize that water bodies support their beneficial uses, and see what kinds of mistakes we might make if we use various combinations of sample sizes and exceedances to establish support.

Our null hypothesis, Ho is that the actual frequency of nonsupport in the water body is 10% or less...

Ho: Parameter exceeds criterion 10% or less of the time. Wb is not impaired.

And of course, the alternative Ha, is that the water body meets our definition of impaired...

Ha: Parameter exceeds criterion > 10% of the time. Water body is impaired.

We can make these types of errors when we use various combinations of sample size and exceedance to establish that support:

Type 1 error - probability of incorrectly rejecting Ho and falsely listing a water body as having >10% exceedance rate when, in fact, it is 10%, or less.
Type 2 error - probability of incorrectly accepting the Ho and thus missing an impairment and not listing when various exceedance rates greater than 10% occur in the water body.

Table 1a.

# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
4	Type I error (alpha) as %										
	10	34	05	00	00						
	Type II error (beta) as %										
	11	63	94	99	100						
	20	41	82	97	100						
	30	24	65	92	99						
	40	13	48	82	97						
	50	06	31	69	94						
5	Type I error (alpha) as %										
	10	41	08	01	00	00					
	Type II error (beta) as %										
	11	56	90	99	100	100					
	20	33	74	94	99	100					
	30	17	53	84	97	100					
	40	08	34	68	91	99					
	50	03	19	69	94	97					
6	Type I error (alpha) as %										
	10	47	11	02	00	00	00				
	Type II error (beta) as %										
	11	50	87	98	100	100	100				
	20	26	66	90	98	100	100				
	30	12	42	74	93	99	100				
	40	05	23	54	82	96	100				
	50	02	11	34	66	89	98				

# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
7	Type I error (alpha) as %										
	10	52	15	03	00	00	00	00			
	Type II error (beta) as %										
	11	44	82	97	100	100	100	100			
	20	21	58	85	97	100	100	100			
	30	08	33	65	87	97	100	100			
	40	03	16	42	71	90	98	100			
	50	01	06	23	50	77	94	99			
8	Type I error (alpha) as %										
	10	57	19	04	01	00	00	00	00		
	Type II error (beta) as %										
	11	39	78	95	99	100	100	100	100		
	20	17	50	80	94	99	100	100	100		
	30	06	26	55	87	94	99	100	100		
	40	02	11	32	59	83	95	99	100		
	50	00	04	14	36	64	86	96	100		
9	Type I error (alpha) as %										
	10	62	23	05	01	00	00	00	00	00	
	Type II error (beta) as %										
	11	35	74	93	99	100	100	100	100	100	
	20	13	44	74	91	98	100	100	100	100	
	30	04	20	46	73	90	97	100	100	100	
	40	01	07	23	48	73	90	97	100	100	
	50	00	02	09	25	50	75	91	98	100	

# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
10	Type I error (alpha) as %										
	10	65	26	07	01	00	00	00	00	00	00
	Type II error (beta) as %										
	11	31	70	91	98	100	100	100	100	100	100
	20	11	38	68	88	97	99	100	100	100	100
	30	03	15	38	65	85	95	99	100	100	100
	40	01	05	17	38	63	83	95	99	100	100
	50	00	01	05	17	38	62	83	95	99	100
11	Type I error (alpha) as %										
	10	67	30	09	02	00	00	00	00	00	00
	Type II error (beta) as %										
	11	28	65	89	97	100	100	100	100	100	100
	20	09	32	62	84	95	99	100	100	100	100
	30	02	11	31	57	79	92	98	100	100	100
	40	00	03	12	30	53	75	90	97	99	100
	50	00	01	11	11	27	50	73	89	97	99
12	Type I error (alpha) as %										
	10	72	34	11	03	00	00	00	00	00	00
	Type II error (beta) as %										
	11	25	61	86	96	99	100	100	100	100	100
	20	07	27	62	79	93	98	100	100	100	100
	30	01	09	31	49	72	88	96	99	100	100
	40	00	02	08	23	44	67	84	94	98	100
	50	00	00	07	07	19	39	61	81	93	98

# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
13	Type I error (alpha) as %										
	10	75	38	13	03	01	00	00	00	00	00
	Type II error (beta) as %										
	11	22	57	83	95	99	100	100	100	100	100
	20	05	23	50	75	90	97	99	100	100	100
	30	01	06	20	42	65	83	94	98	100	100
	40	00	01	06	17	35	57	77	90	97	100
	50	00	00	01	05	13	29	50	71	87	95
14	Type I error (alpha) as %										
	10	77	42	16	04	01	00	00	00	00	00
	Type II error (beta) as %										
	11	20	53	81	94	99	100	100	100	100	100
	20	04	20	45	70	87	96	99	100	100	100
	30	01	05	16	36	58	78	91	97	99	100
	40	00	01	04	12	28	49	69	85	94	98
	50	00	00	01	03	09	21	40	60	79	91
15	Type I error (alpha) as %										
	10	79	45	18	06	01	00	00	00	00	00
	Type II error (beta) as %										
	11	17	50	78	93	98	100	100	100	100	100
	20	04	17	40	65	84	94	98	100	100	100
	30	00	04	13	30	52	72	87	95	98	100
	40	00	01	03	09	22	40	61	79	90	97
	50	00	00	00	02	06	15	30	50	70	85
16	Type I error (alpha) as %										
	10	81	49	21	07	02	00	00	00	00	00
	Type II error (beta) as %										

	11	16	46	75	91	98	99	100	100	100	100
	20	03	14	35	60	80	92	97	99	100	100
	30	00	03	10	25	45	66	82	93	97	99
	40	00	00	02	07	17	33	53	72	86	94
	50	00	00	00	01	04	11	23	40	60	77
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
17	Type I error (alpha) as %										
	10	83	52	24	08	02	00	00	00	00	00
	Type II error (beta) as %										
	11	14	43	71	89	97	99	100	100	100	100
	20	02	12	31	55	76	89	96	99	100	100
	30	00	02	08	20	39	60	78	90	96	99
	40	00	00	01	05	13	26	45	64	80	91
	50	00	00	00	01	02	07	17	31	50	69
18	Type I error (alpha) as %										
	10	85	55	27	10	03	01	00	00	00	00
	Type II error (beta) as %										
	11	12	44	68	87	96	99	100	100	100	100
	20	02	10	27	50	72	87	95	98	100	100
	30	00	01	06	16	33	53	72	86	94	98
	40	00	00	01	03	09	21	37	56	74	87
	50	00	00	00	00	02	05	12	24	41	59
19	Type I error (alpha) as %										
	10	86	58	29	11	04	01	00	00	00	00
	Type II error (beta) as %										
	11	11	37	65	85	95	99	100	100	100	100
	20	01	08	24	46	67	84	93	98	99	100
	30	00	01	05	13	28	47	67	82	92	97
	40	00	00	01	02	07	16	31	49	67	81
	50	00	00	00	00	01	03	08	18	32	50
20	Type I error (alpha) as %										
	10	88	61	32	13	04	01	00	00	00	00

	Type II error (beta) as %										
	11	10	34	62	83	94	98	100	100	100	100
	20	01	07	21	41	63	80	91	97	99	100
	30	00	01	04	11	24	42	61	77	89	95
	40	00	00	00	02	05	13	25	42	60	76
	50	00	00	00	00	01	02	06	13	25	41
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
30	Type I error (alpha) as %										
	10	96	82	59	35	18	07	03	01	00	00
	Type II error (beta) as %										
	11	03	14	34	58	77	90	96	99	100	100
	20	00	01	04	12	26	43	61	76	87	94
	30	00	00	00	01	03	08	16	28	43	59
	40	00	00	00	00	00	01	02	04	09	18
	50	00	00	00	00	00	00	00	00	01	02
40	Type I error (alpha) as %										
	10	99	92	78	58	37	21	10	04	02	01
	Type II error (beta) as %										
	11	01	06	17	35	55	73	86	93	97	99
	20	00	00	01	03	08	16	29	44	59	73
	30	00	00	00	00	00	01	02	06	11	20
	40	00	00	00	00	00	00	00	00	01	02
	50	00	00	00	00	00	00	00	00	00	00
50	Type I error (alpha) as %										
	10	99	97	89	75	57	38	23	12	06	02
	Type II error (beta) as %										
	11	<1	02	08	19	34	52	69	82	91	96
	20	00	00	00	01	02	05	10	19	31	44
	30	00	00	00	00	00	00	00	01	02	04
	40	00	00	00	00	00	00	00	00	00	00
	50	00	00	00	00	00	00	00	00	00	00

Delisting Scenario:

Some water bodies have already been shown to not support the criteria. Let's hypothesize that there are likely to still not support, after all, water quality changes slowly. (If we are applying a new standard or new analytical method we might not want to use this pessimistic hypothesis, and rather presume the water body supports its uses, i.e., use listing scenario.)

Our null hypothesis, Ho, is that the actual frequency of exceedances in the water body continues to exceed 10%...

Ho: Parameter exceeds criterion > 10% of the time. Water body is impaired.

And of course the alternative, Ha, is that the water body is not impaired...

Ha: Parameter exceeds criterion 10% or less of the time. Wb is not impaired.

We make these errors when we use various combinations of sample size and exceedances to establish that nonsupport:

Type 1 error - probability of incorrectly rejecting Ho when it is in fact true and erroneously delisting a water body as having 10%, or less, exceedance rate.
Type 2 error - probability of incorrectly accepting the null hypothesis and not delisting a water body when actual exceedance rate is less than 10%.

Table 1b.

# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
4	Type I error (alpha) as %										
	10	66	95	100	100						
	Type II error (beta) as %										
	9 5 2	31 29 08	04 01 00	00 00 01	00 00 00						
5	Type I error (alpha) as %										
	10	59	92	99	100	100					
	Type II error (beta) as %										
	9 5 2	38 23 10	07 02 00	01 00 00	00 00 00	00 00 00					
6	Type I error (alpha) as %										
	10	53	86	98	100	100	100				
	Type II error (beta) as %										
	9 5 2	43 26 11	10 03 01	01 00 00	00 00 00	00 00 00	00 00 00				
7	Type I error (alpha) as %										
	10	48	85	97	100	100	100	100			
	Type II error (beta) as %										

	9 5 2	48 30 13	13 04 01	02 00 00	00 00 00	00 00 00	00 00 00	00 00 00			
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
8	Type I error (alpha) as %										
	10	43	81	96	99	100	100	100	100		
	Type II error (beta) as %										
	9 5 2	53 34 15	16 06 01	03 01 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00		
9	Type I error (alpha) as %										
	10	39	77	95	99	100	100	100	100	100	
	Type II error (beta) as %										
	9 5 2	57 37 17	19 07 01	04 01 00	01 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	
10	Type I error (alpha) as %										
	10	35	74	93	99	100	100	100	100	100	100
	Type II error (beta) as %										
	9 5 2	61 40 18	23 09 02	05 01 00	01 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00
11	Type I error (alpha) as %										
	10	32	70	91	98	100	100	100	100	100	100
	Type II error (beta) as %										
	9 5 2	65 43 20	26 10 02	07 02 00	01 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00
12	Type I error (alpha) as %										

	10	28	66	89	97	99	100	100	100	100	100
	Type II error (beta) as %										
	9 5 2	68 46 22	29 12 02	09 02 00	02 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
13	Type I error (alpha) as %										
	10	25	62	87	97	99	100	100	100	100	100
	Type II error (beta) as %										
	9 5 2	71 49 23	33 14 03	11 02 00	02 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00
14	Type I error (alpha) as %										
	10	23	58	84	96	99	100	100	100	100	100
	Type II error (beta) as %										
	9 5 2	73 51 25	36 15 03	13 03 00	03 00 00	01 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00
15	Type I error (alpha) as %										
	10	21	55	82	94	99	100	100	100	100	100
	Type II error (beta) as %										
	9 5 2	76 54 26	40 17 04	15 04 00	04 01 00	01 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00
16	Type I error (alpha) as %										
	10	19	51	79	93	98	99	100	100	100	100
	Type II error (beta) as %										

	9 5 2	78 56 28	43 19 04	17 04 00	05 01 00	01 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
17	Type I error (alpha) as %										
	10	17	48	76	92	98	99	100	100	100	100
	Type II error (beta) as %										
	9 5 2	80 58 29	46 21 04	19 05 00	06 01 00	01 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00
18	Type I error (alpha) as %										
	10	15	45	73	90	97	99	100	100	100	100
	Type II error (beta) as %										
	9 5 2	82 60 30	49 23 05	22 06 01	07 01 00	02 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00
19	Type I error (alpha) as %										
	10	14	42	71	86	96	99	100	100	100	100
	Type II error (beta) as %										
	9 5 2	83 62 32	52 25 05	24 07 01	09 01 00	02 00 00	01 00 00	00 00 00	00 00 00	00 00 00	00 00 00
20	Type I error (alpha) as %										
	10	12	39	68	87	96	99	100	100	100	100
	Type II error (beta) as %										

	9 5 2	85 64 33	55 26 06	27 08 01	10 02 00	03 00 00	01 00 00	00 00 00	00 00 00	00 00 00	00 00 00
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
30	Type I error (alpha) as %										
	10	04	18	41	65	82	93	97	99	100	100
	Type II error (beta) as %										
	9 5 2	94 79 45	87 45 12	51 19 02	28 06 00	13 02 00	05 00 00	02 00 00	00 00 00	00 00 00	00 00 00
40	Type I error (alpha) as %										
	10	01	08	22	42	63	79	90	96	98	99
	Type II error (beta) as %										
	9 5 2	98 87 55	89 60 19	71 32 05	49 14 01	29 05 00	15 01 00	06 00 00	02 00 00	01 00 00	00 00 00
50	Type I error (alpha) as %										
	10	01	03	11	25	43	61	77	88	94	98
	Type II error (beta) as %										
	9 5 2	99 92 64	95 72 26	84 46 08	67 24 02	47 10 00	29 04 00	16 01 00	08 00 00	03 00 00	01 00 00

Listing Scenario:

Ho: Parameter exceeds criterion 25% or less of the time. Wb is not impaired.
Ha: Parameter exceeds criterion > 25% of the time. Water body is impaired.

Type 1 error - probability of incorrectly rejecting Ho and falsely listing a water body as having >25% exceedance rate when, in fact, it is 25%, or less.
Type 2 error - probability of incorrectly accepting the Ho and thus missing an impairment and not listing when various exceedance rates greater than 25% occur in the water body.

Table 2a.

# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
4	Type I error (alpha) as %										
	25	68	26	05	00						
	Type II error (beta) as %										
	26 30 50	30 24 06	72 65 31	94 92 69	100 99 94						
5	Type I error (alpha) as %										
	25	76	37	10	02	00					
	Type II error (beta) as %										
	26 30 50	22 17 03	61 53 19	89 84 69	98 97 94	100 100 97					
6	Type I error (alpha) as %										
	25	82	47	17	04	00	00				
	Type II error (beta) as %										
	26 30 50	16 12 02	51 42 11	81 74 34	96 93 66	99 99 89	100 100 98				
7	Type I error (alpha) as %										
	25	87	56	24	07	01	00	00			
	Type II error (beta) as %										

	26 30 50	12 08 01	42 33 06	74 65 23	92 87 50	98 97 77	100 100 94	100 100 99			
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
8	Type I error (alpha) as %										
	25	90	63	32	11	03	00	00	00		
	Type II error (beta) as %										
	26 30 50	09 06 00	34 26 04	65 55 14	87 87 36	97 94 64	99 99 86	100 100 96	100 100 100		
9	Type I error (alpha) as %										
	25	92	70	40	17	05	01	00	00	00	
	Type II error (beta) as %										
	26 30 50	07 04 00	28 20 02	57 46 09	82 73 25	94 90 50	99 97 75	100 100 91	100 100 98	100 100 100	
10	Type I error (alpha) as %										
	25	94	76	47	22	08	02	00	00	00	00
	Type II error (beta) as %										
	26 30 50	05 03 00	22 15 01	50 38 05	75 65 17	91 85 38	98 95 62	100 99 83	100 100 95	100 100 99	100 100 100
11	Type I error (alpha) as %										
	25	96	80	54	29	11	03	01	00	00	00

	Type II error (beta) as %										
	26 30 50	04 02 00	18 11 01	42 31 11	69 57 11	87 79 27	96 92 50	99 98 73	100 100 89	100 100 97	100 100 99
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
12	Type I error (alpha) as %										
	25	97	84	61	35	16	05	01	00	00	00
	Type II error (beta) as %										
	26 30 50	03 01 00	14 09 00	36 31 07	62 49 07	82 72 19	94 88 39	98 96 61	100 99 81	100 100 93	100 100 98
13	Type I error (alpha) as %										
	25	98	87	67	42	21	08	02	01	00	00
	Type II error (beta) as %										
	26 30 50	02 01 00	11 06 00	30 20 01	55 42 05	77 65 13	91 83 29	97 94 50	99 98 71	100 100 87	100 100 95
14	Type I error (alpha) as %										
	25	98	90	72	48	26	11	04	01	00	00
	Type II error (beta) as %										
	26 30 50	01 01 00	09 05 00	25 16 01	49 36 03	71 58 09	87 78 21	95 91 40	99 97 60	100 99 79	100 100 91
15	Type I error (alpha) as %										
	25	99	92	76	54	31	15	06	02	00	00

	Type II error (beta) as %										
	26 30 50	01 00 00	07 04 00	21 13 00	43 30 02	65 52 06	83 72 15	93 87 30	98 95 50	99 98 70	100 100 85
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
16	Type I error (alpha) as %										
	25	99	94	80	60	37	19	08	03	01	00
	Type II error (beta) as %										
	26 30 50	01 00 00	05 03 00	17 10 00	37 25 01	59 45 04	78 66 11	90 82 23	97 93 40	99 97 60	100 99 77
17	Type I error (alpha) as %										
	25	99	95	84	65	43	23	11	04	01	00
	Type II error (beta) as %										
	26 30 50	01 00 00	04 02 00	14 08 00	32 20 01	54 39 02	73 60 07	87 78 17	95 90 31	98 96 50	100 99 69
18	Type I error (alpha) as %										
	25	99	96	86	69	48	28	14	06	02	01
	Type II error (beta) as %										
	26 30 50	00 00 00	03 01 00	12 06 00	27 16 00	48 33 02	68 53 05	84 72 12	93 86 24	98 94 41	99 98 59
19	Type I error (alpha) as %										
	25	100	97	89	74	53	33	17	08	03	01
	Type II error (beta) as %										

	26 30 50	00 00 00	03 01 00	09 05 00	23 13 00	43 28 01	63 47 03	80 67 08	91 82 18	96 92 32	99 97 50
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
20	Type I error (alpha) as %										
	25	100	98	91	77	59	38	21	10	04	01
	Type II error (beta) as %										
	26 30 50	00 00 00	02 01 00	08 04 00	20 11 00	38 24 01	58 42 02	75 61 06	88 77 13	95 89 25	98 95 41
30	Type I error (alpha) as %										
	25	100	100	99	96	90	80	65	49	33	20
	Type II error (beta) as %										
	26 30 50	00 00 00	00 00 00	01 00 00	03 01 00	08 03 00	17 08 00	30 16 00	46 28 00	63 43 01	77 59 02
40	Type I error (alpha) as %										
	25	100	100	100	100	98	96	90	82	70	56
	Type II error (beta) as %										
	26 30 50	00 00 00	00 00 00	00 00 00	00 00 00	01 00 00	03 01 00	07 02 00	15 06 00	25 11 00	38 20 00
50	Type I error (alpha) as %										
	25	100	100	100	100	100	99	98	95	91	84
	Type II error (beta) as %										
	26 30 50	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	01 00 00	03 01 00	07 02 00	13 04 00

Delisting Scenario:

Ho: Parameter exceeds criterion > 25% of the time. Water body is impaired.

Ha: Parameter exceeds criterion 25% or less of the time. Wb is not impaired.

Type 1 error - probability of incorrectly rejecting Ho when it is in fact true and erroneously delisting a water body as having 25%, or less, exceedance rate.

Type 2 error - probability of incorrectly accepting the null hypothesis and not delisting a water body when actual exceedance rate is less than 25%.

Table 2b.

# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
4	Type I error (alpha) as %										
	25	32	74	95	100						
	Type II error (beta) as %										
	24 15 10	67 48 34	24 11 05	05 01 00	00 00 00						
5	Type I error (alpha) as %										
	25	24	63	90	98	100					
	Type II error (beta) as %										
	24 15 10	75 56 41	35 16 08	09 03 01	01 00 00	00 00 00					
6	Type I error (alpha) as %										
	25	18	53	83	96	100	100				
	Type II error (beta) as %										
	24 15 10	81 62 47	44 22 11	15 05 02	03 01 00	00 00 00	00 00 00				
7	Type I error (alpha) as %										
	25	13	44	76	93	99	100	100			
	Type II error (beta) as %										

	24 15 10	85 68 52	53 28 15	22 07 03	06 01 00	01 00 00	00 00 00	00 00 00			
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
8	Type I error (alpha) as %										
	25	10	37	68	89	97	100	100	100		
	Type II error (beta) as %										
	24 15 10	89 73 57	61 34 19	30 11 04	10 02 01	02 00 00	00 00 00	00 00 00	00 00 00		
9	Type I error (alpha) as %										
	25	08	30	60	83	95	99	100	100	100	
	Type II error (beta) as %										
	24 15 10	92 77 61	67 40 23	37 14 05	15 03 01	04 01 00	01 00 00	00 00 00	00 00 00	00 00 00	
10	Type I error (alpha) as %										
	25	06	24	53	78	92	98	100	100	100	100
	Type II error (beta) as %										
	24 15 10	94 80 65	73 46 26	44 18 07	20 05 01	07 01 00	02 00 00	00 00 00	00 00 00	00 00 00	00 00 00
11	Type I error (alpha) as %										
	25	04	20	46	71	89	97	99	100	100	100
	Type II error (beta) as %										

	24 15 10	95 83 69	78 51 30	51 22 09	26 07 02	10 02 00	03 00 00	01 00 00	00 00 00	00 00 00	00 00 00
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
12	Type I error (alpha) as %										
	25	03	16	39	65	84	95	99	100	100	100
	Type II error (beta) as %										
	24 15 10	96 86 72	82 56 34	58 26 11	32 09 03	14 02 00	05 00 00	01 00 00	00 00 00	00 00 00	00 00 00
13	Type I error (alpha) as %										
	25	02	13	33	58	79	92	98	99	100	100
	Type II error (beta) as %										
	24 15 10	97 88 76	86 60 38	64 31 13	38 12 03	18 03 01	07 01 00	02 00 00	00 00 00	00 00 00	00 00 00
14	Type I error (alpha) as %										
	25	02	10	28	52	74	89	96	99	100	100
	Type II error (beta) as %										
	24 15 10	98 90 77	88 64 42	69 35 16	44 15 04	23 05 01	09 01 00	03 00 00	01 00 00	00 00 00	00 00 00
15	Type I error (alpha) as %										
	25	01	08	24	46	69	85	94	98	100	100
	Type II error (beta) as %										
	24 15 10	98 91 79	91 68 45	74 40 18	50 18 06	28 06 01	13 02 00	05 00 00	01 00 00	00 00 00	00 00 00
16	Type I error (alpha) as %										
	25	01	06	20	40	63	81	92	97	99	100
	Type II error (beta) as %										

	24 15 10	99 93 81	93 72 49	78 44 21	56 21 07	33 08 02	16 02 00	07 01 00	02 00 00	01 00 00	00 00 00
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
17	Type I error (alpha) as %										
	25	01	05	16	35	57	77	89	96	99	100
	Type II error (beta) as %										
	24 15 10	99 94 83	94 75 52	81 48 24	61 24 08	39 10 02	20 03 00	09 01 00	03 01 00	01 00 00	00 00 00
18	Type I error (alpha) as %										
	25	01	04	14	31	52	72	86	94	98	99
	Type II error (beta) as %										
	24 15 10	99 95 85	95 78 55	84 52 27	66 28 10	44 12 03	25 04 01	12 01 00	05 00 00	01 00 00	00 00 00
19	Type I error (alpha) as %										
	25	00	03	11	26	47	67	83	92	97	99
	Type II error (beta) as %										
	24 15 10	99 95 86	96 80 58	87 56 29	70 32 12	49 14 04	30 05 01	15 02 00	06 00 00	02 00 00	01 00 00
20	Type I error (alpha) as %										
	25	00	02	09	23	41	62	79	90	96	99
	Type II error (beta) as %										
	24 15 10	100 99 88	97 82 61	89 60 32	74 35 13	54 17 04	34 07 01	18 02 00	08 01 00	03 00 00	01 00 00
30	Type I error (alpha) as %										
	25	00	00	01	04	10	20	35	51	67	80
	Type II error (beta) as %										

	24 15 10	100 99 96	100 95 82	99 85 59	95 68 35	88 48 18	76 29 07	60 15 03	43 07 01	28 03 00	16 01 00
# Samples	Exceedance Rate for Criterion in Waterbody (as %)	Number of Sample Exceedances									
		1	2	3	4	5	6	7	8	9	10
40	Type I error (alpha) as %										
	25	00	00	00	00	02	04	10	18	30	44
	Type II error (beta) as %										
	24 15 10	100 100 99	100 99 92	100 95 78	99 87 58	98 74 37	94 57 21	88 39 10	78 24 04	65 14 02	50 07 01
50	Type I error (alpha) as %										
	25	00	00	00	00	00	01	02	05	09	16
	Type II error (beta) as %										
	24 15 10	100 100 99	100 100 97	100 99 89	100 95 75	100 89 57	99 78 38	97 64 23	94 48 12	88 33 06	79 21 02