COVENTRY
UNIVERSITY

Laboratory Tests
Conducted in the School of The Built Environment
Coventry University, UK
on

X-CEPTOR CONCRETE BYPASS INTERCEPTOR
also known as STORMCEPTOR in North America

for
CSR Humes (UK) Ltd., Pontyclun, CF7 9YX
May-August 1996

Priority Street Coventry CVI 5FB Telephone 0203 631313

Subject: University of Coventry Stormceptor@ Testing Results

Please find enclosed the final report regarding the University of Coventry testing results for the Stormceptorg System. The University of Coventry (United Kingdom) tested the effectiveness of a full scale concrete Stormceptor in removing oil, sand, and peat. The unit that was tested incorporated the disc insert design and conforms to the UK production sizes. The UK Stormceptor sizes are smaller than those produced in North America.

The Stormceptor was tested at full treated flowrate (just before by-passing). Oil was introduced upstream of the unit at a consistent rate of 4100 mg/1 for a 20 minute period. Samples were taken at the outlet during the last 5 minutes to determine the oil removal performance. The same procedure was also performed with inorganic sediment (sand, S.G.=2.2) and organic sediment (peat, S.G.--0.45). The results can be summarized as follows:

Off removal	**97.8%**
Inorganic sediment removal (sand)	**83%**
Organic sediment removal (peat)	73%

These results exemplify the benefits of using Stormceptor as a source control technique in an urban stormwater quality control strategy. Please do not hesitate to contact us (1800-565-4801 in Canada or 1-800-763-4703 in the United States) if you require further information regarding this monitoring project.

Sincerely yours,

Graham Bryant, P.Eng. M.Sc.
Director of Engineering

Laboratory Tests On
X-CEPTOR CONCRETE BYPASS INTERCEPTOR
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for
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May-June 1996

SUMMARY

School of The Built Environment, Coventry University established a purpose -built test rig to assess the performance of the X-Ceptor Concrete Bypass Interceptor under steady flow condition s (9 I/s) with the addition of oil or inorganic/organic sediment. The X-Ceptor Bypass Interceptor is also known as the, Stormceptor in North America.

Two flow tests were performed on the X-Ceptor in accordance with the draft European Standard prEN858 -1:1992 for the oil retention tests with oil added continuously during each test at a rate of 5ml/l (4100mg/1) and four flow tests were developed to assess the trapping efficiency with sand added at a rate of 210mg/l (three flow tests) and with peat added at a rate of 154mg/l (one flow test).

The results obtained showed that the X-Ceptor was capable of limiting the through-flow of oil to some 90mg/l (mean of 10 samples with a standard deviation of 8.7mg/1). This performance is in line with that required of Clas s 2 Oil Interceptors in the UK, limiting the through-flow of oil to

less than 100mg/l.

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1. INTRODUCTION

1.1 The School of The Built Environment, Coventry University was invited to tender for laboratory testing of the X-Ceptor Concrete Bypass Interceptor (Stormceptor) in February 1996. The tests were to investigate the X-Ceptor's effectiveness at oil retention andsediment trapping. The test procedures for oil retention performance assessment were to conform to the draft European Standard prEN858-1:1992 and additional tests for sediment trap efficiency were to be proposed during the test period.

1.2 A purpose-built rig was established for the testing of the X-Ceptor at the School's Hydraulics Laboratory, although because of its size (overall height 2.5m, outside diameter 2.24m, overall weight 6.7 tonnes) the X-Ceptor was positioned outside the Laboratory adjacent to a doorway.

1.3 During the test period, May-August 1996, 10 samples of the effluent from the X-Ceptor were obtained and analysed for oil discharge; 13 other samples were analysed for inorganic suspended solids discharge; and a further 10 samples were analysed for organic suspended solids discharge.

2. TEST EQUIPMENT

2.1 The test equipment consisted of:

- an inlet/mixing tank: 1050mm internal diameter with a 150mm diameter outlet, 300mm above the invert (see Plate 1). Water, oil and organic sediment were added separately to this tank, as prescribed by the particular test procedure, to achieve mixing prior to discharge to the X-Ceptor;
- a 2m, 150mm diameter connecting pipe from the inlet tank to the upper unit of the X-Ceptor;
- the X-Ceptor; and
- an outlet tank with calibrated orifice, controlling discharge to waste (see Plate 2).

2.2 The X-Ceptor consists of two units:

- the treatment chamber, nominal volume 3000 litres, internal diameter 1.785m and depth 1.25m; and
- the bypass chamber, internal diameter 1.785m which sits on top of the -treatment chamber and is connected to it by two openings:
  - -low-flow inlet, adjacent to the 150mm inlet pipe to the X-Ceptor and surrounded by a circular weir, which provides for overflow (the bypass operation) when inflow exceeds 9.8 I/s; and
  - -large diameter riser from the treatment chamber which feeds flows to the outlet (see Plate 3).

2.3 The water supply to the test equipment was provided from the storage tank on the roof of the Hydraulics Laboratory. The flow rate was set by reference to the water level in the outlet tank. Prior to commencement of the experiments the outlet tank (with orifice) was set up in the Hydraulics Laboratory so that a range of flow rates could be provided to it and the depth of water in the tank be measured under steady conditions. The flow rate was measured by collecting a measured volume of the outflow from the orifice in a known time.

This test procedure was repeated for a range of flow rates (7.8 - 11 I/s) and a calibration graph produced.

2.4 The test equipment, as per para. 2. 1., was installed in preparation for the tests and the required test flow rate was established. This was a process of slow, careful adjustment of a control valve on the overhead supply pipe to the inlet/mixing tank. The control valve was opened and the system was allowed to stabilise giving a certain depth of water in the outlet tank equivalent to a steady flow of 9 I/s. Over a period of hours the control valve was adjusted to achieve steady flow conditions at 9 I/s, shown by the outlet tank water depth. A second upstream valve on the supply pipe was used as an on/off valve: the control valve was left untouched during the, tests.

3. TEST PROCEDURE

3.1 Each test was conducted over minimum period of 20 minutes with the water flow rate constant at 9 I/s. This ensured that the volume contained within the treatment chamber was exchanged at least four times during a test, in accordance with prEN858-1:1992.

3.2 Any additive (oil, inorganic or organic solids) was continuously supplied to the test equipment throughout the test and sampling of the effluent leaving the X-Ceptor (Stormceptor) was begun only after 15 minutes: samples were then taken at I minute intervals.

3.3 The oil and the organic sediment were added to the inlet tank to provide for mixing time before entry to the X-Ceptor: both these additives, being less dense than water were not likely to accumulate within the inlet tank under the turbulent conditions. The inorganic sediment was added to the X-Ceptor directly above the low-flow inlet to the treatment chamber, upstream of the bypass weir. This procedure prevented any accumulation of sediment upstream of the X-Ceptor and ensured that all sediment passed rapidly to the treatment chamber.

3.4 The oil was added to the inlet tank at a constant rate of 2.7 litres/minute (concentration 5ml/l (4100mg/1) in the water). This was achieved through an air pressure system which forced the oil from its storage drum to the delivery point (see Plate 1). Calibration of the air pressure control valve ensured a constant rate of oil delivery. Checks at the start and end of tests showed that a consistent rate of delivery seemed to be maintained: checks could not be made during each test as the oil supply was to be continuous throughout the test period.

3.5 Both the inorganic and the organic sediments were added manually in prepared nominal volumes (250ml and 920ml respectively), over 30-second intervals, giving concentrations in the flow of 210mg/l and 154mg/l respectively, thought to be typical of highway stormwater runoff in moderate/highly polluted conditions.

3.6 Samples of the effluent from the X-Ceptor were collected at the point of free discharge from the outlet pipe prior to entry into the outlet tank. Sample volumes were from 0.5 - I litre, from which the test results were obtained by standard methods.

PLATE 1: General view inside the Hydraulics Laboratory showing the drum of test oil (right); the inlet/mixing tank on the red frame with the oil feed pipe and grey water supply pipe (centre); and the X-Ceptor unit in the doorway.

PLATE 2: View of the X-Ceptor and outlet tank standing outside the Hydraulics Laboratory: discharge from the unit falls freely onto the surface of the water in the outlet tank.

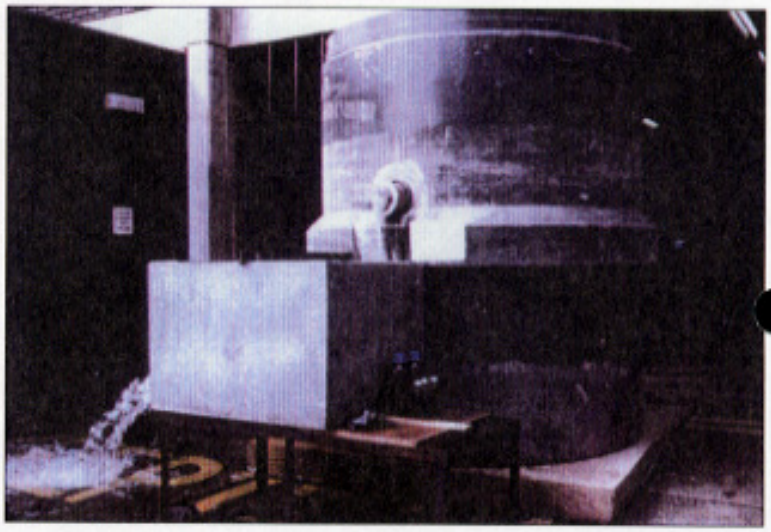

PLATE 3: A view inside the bypass chamber during tests with organic sediment additions, revealing the bypass overflow weir, the small diameter inlet and large diameter outlet pipes from the treatment chamber.

PLATE 4: View of the inlet to the X-Ceptor with flow contained behind the overflow weir at 9l/s. Note the marked difference in colour between the red, oil polluted inflow and the near-clear waters just prior to outlet, having passed through the treatment chamber.

PLATE 5: View of inlet during tests with the addition of organic sediment (peat) showing vortex above inlet pipe to treatment chamber.

PLATE 6: View of inlet following drain down after inorganic sediment retention test.

4. TEST ANALYSES

4.1 A Nicolet-250 Fourier Transfer Infrared spectrometer (FTIR) was employed in all of the analytical procedures to determine the quantities of oil present in the effluent from the X-Ceptor. The method of analysis of oil in the effluent samples was based upon ASTM D-3921-81 and the work was conducted in the laboratories of the School of Natural and Environmental Sciences, Coventry University. Details of the oil used in the tests is given in Appendix I and was the best suited, commercially available oil to th at required under prEN 858-1:1992 Annex B : Shell Gas Oil, Gas Oil UN 1202.

4.2 The suspended solids concentration and the relative density analyses were conducted in accordance with BS3680 : Part IOD : 1986.

5. TEST RESULTS: OIL

5.1 Two sets of results were obtained for the oil interception performance of the X -Ceptor (Stormceptor): tests R I and R2 were 20 -minute duration and the five results given for each test were obtained from samples collected at 1 -minute intervals in the last five minutes of the test. (See Appendix I and Plate 4).

TABLE 1: MEAN EFFLUENT OIL CONCENTRATIONS FROM THE X-CEPTOR BYPASS INTERCEPTOR (also known as the STORMCEPTOR in North America) IN TESTS AT COVENTRY UNIVERSITY, UK, AUGUST 1996

Test No.	Oil Concentration in outflow, mg/I		
	Test Series Mean **mg/1**	**Standard Deviation mg/1**	No. **of Samples**
Rl	88.4	5.9	5
R2	92.3	11.2	5
Overall	90.4	8.7	10

6. TEST RESULTS: SEDIMENT

6. 1 Four sets of results were obtained for the suspended solids interception performance of the X-Ceptor (Stormceptor): tests S I and S3 were 20 -minute duration and the results given for each test -were obtained from samples collected at I -minute intervals in the last five minutes of the test (the last two samples in Test S3 were lost through accidental s pillage); test P1 lasted 25 minutes and the ten results were obtained at 1 -minute intervals in the last ten minutes (see Appendix II).

6.2 Prior to these tests with sediment, the treatment chamber was filled to a depth of 300mm with the same type of sand used in tests S I to S3. The X-Ceptor was then operated for one hour to allow the dust in the sand bed to wash through the system (see Plates 5 and 6).

6.3 The following table summarises the results obtained:

TABLE 2: MEAN EFFLUENT SUSPENDED SEDIMENT CONCENTRATIONS AND PERCENTAGE RETENTION OF SEDIMENTS FROM THE X-CEPTOR BYPASS INTERCEPTOR (also known as the STORMCEPTOR in North America) IN TESTS AT COVENTRY UNIVERSITY, UK, MAY-JUNE 1996

Test No.	**Sediment**	**Suspended Sediment Concentrations, mg/l**		**Percentage Retention, %**	
		Test **Series Mean mg/I**	**Standard Deviation mg/I**	Test Series **Mean** %	**Standard Deviation** %
S1	Sand	47	9	78	4
S2	Sand	30	5	86	3
S3	Sand	29	2	87	1
Overall(S)	Sand	36	11	83	5
P1	Peat	43	6	73	4

7. CONCLUSIONS

7.1 The two flow tests performed with the addition of oil at a concentration of 4100mg/l showed that the X-Ceptor Oil Interceptor (also known as Stormceptor in North America) was capable of reducing the concentration in the effluent to some 90mg/l on average. This performance is in line with that required of Class 2 Oil Interceptors in the UK, limiting the through-flow of oil to less than 90mg/l.

7.2 The four flow tests performed with the addition of inorganic and organic sediment showed that the X-Ceptor was capable of effective trapping, with some 80% of the inorganic and 70% of the organic sediment being retained within the treatment chamber.

7.3 This first series of tests in the U.K. on the X-Ceptor provide very satisfactory early indications of the efficiency of this device.

APPENDIX I

COVENTRY UNIVERSITY, UK
School of The Built Environment
Test Results on X-Ceptor Bypass Interceptor,
also known as Stormceptor in North America,
August 1996

TEST RESULTS FROM X-CEPTOR ON OIL RETENTION

Test No.	Sample	Oil Concentration in outflow mg/I
RI	1	95.33
	2	86.66
	3	93.10
	4	86.61
	5	80.38
R2	1	104.41
	2	88.27
	3	96.26
	4	97.70
	5	75.07

APPENDIX II

COVENTRY UNIVERSITY, UK
School of The Built Environment
Test Results on X-Ceptor Bypass Interceptor,
also known as Stormceptor in North America,
May-June 1996

TEST RESULTS FROM X-CEPTOR ON SUSPENDED SOLIDS RETENTION

Determination of suspended solids and relative densities carried out in accordance with
BS 3680: Part IOD : 1986

1. SAND

Flow through separator: 540 I/min
Average dry weight of sand added per minute: 113.89 g/min
Dry weight of sand per litre of water added: 210 mg/I
Relative density of sand: 2.20

Test No.	Suspended Sediment Concentrations, mg/I	Percentage Retention In the X-Ceptor, %
SI	49	77
	54	75
	33	85
	54	75
	47	78
S2	35	84
	23	89
	25	89
	34	84
	31	86
S3	29	87
	31	86
	27	88

2. PEAT

Flow through separator: 540 I/min
Average dry weight of peat added per minute: 89.92 g/min
Dry weight of peat per litre of water added: 154 mg/l
Relative density of peat: 0.45

Test No.	**Suspended Sediment Concentration, mg/l**	**Percentage Retention in the X-Ceptor,** %
P1	47	70
	55	65
	38	76
	50	68
	36	77
	39	75
	40	74
	36	77
	46	71
	43	73

APPENDIX III

COVENTRY UNIVERSITY, UK
School of The Built Environment
Test Results on X-Ceptor Bypass Interceptor, also known as Stormceptor in North America, May-June 1996

RESULTS FROM DRY SIEVING OF SAND USED IN TESTS

Sieve Size microns	**Retained %**	**Cumulative % Passing**
1000	0.34	99.66
600	2.16	97.50
425	11.88	85.62
300	24.45	61.17
212	27.99	33.18
150	17.03	16.15
63	13.11	3.04
Passing	3.04	-