February 2005

GENERAL USE LEVEL DESIGNATION FOR PRETREATMENT (TSS)
PILOT USE LEVEL DESIGNATIONS FOR BASIC (TSS) AND OIL TREATMENT

for

Hydro International's Downstream Defender®

Ecology's Decision: Based on Hydro International's application submissions and recommendations by the Technical Review Committee (TRC), Ecology hereby issues the following Use Level Designations for the Hydro International Downstream Defender®:

1. **General Use Level Designation (GULD) for pretreatment, as defined in the Ecology Manual Volume I, (a) ahead of infiltration treatment, or (b) to protect and extend the maintenance cycle of a Basic or Enhanced Treatment device (e.g., sand or media filter). This GULD applies to Downstream Defender units sized in accordance with Table 1 (below) at the Water Quality design flow rate as determined using the Western Washington Hydrology Model (WWHM).**
2. **Pilot Use Level Designation (PULD) for basic (TSS) treatment. This PULD applies to Downstream Defender units sized in accordance with Table 2 (below) at the Water Quality design flow rate as determined using the WWHM.**
3. **Pilot Use Level Designation (PULD) for oil and grease treatment. This applies to Downstream Defender units sized in accordance with Table 2 (below) at the Water Quality design flow rate as determined using the WWHM.**
4. **The pretreatment GULD designation has no expiration date, but it may be amended or revoked by Ecology.**
5. **Both PULDs expire on December 31, 2006 unless extended by Ecology.**
6. **All designations are subject to the conditions specified below.**
7. **Properly designed and operated Downstream Defender systems may also have applicability in other situations (example: low-head situations such as bridges or ferry docks), for TSS and oil/grease removal where, on a case-by-case basis, it is found to be infeasible or impracticable to use any other approved practice. Local jurisdictions should follow established variance or exception procedures in approving such applications.**
8. **Ecology finds that the Downstream Defender, sized in accordance with Table 1 could also provide:**
    - **Water quality benefits in retrofit situations.**
    - **The first component in a treatment train.**
    - **Effective removal of deicing grit/sand.**

Applicant: Hydro International.
Ms. Pam Deahl, P.E., Vice President

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Application Documents:

- Application letter from Ms. Deahl dated November 23, 2004
- "Downstream Defender-Submittal to WA State Department of Ecology", Hydro International, November 2004. *Note: This submittal includes reports on 7 studies on the Downstream Defender reported from 1997-2002.*
- "Downstream Defender Testing Using Feed Sand with Mean Particle Size of 50 microns", Hydro International, December 2004
- "Comparison: Downstream Defender and Vortechs", Hydro International, November 2004
- "The Development of a Mathematical Model for the Prediction of the Residence Time Distribution of a Vortex Hydrodynamic Separator," R.M. Alkhaddar et. al., 2001.

A CD-ROM of the submittal reports may be requested from Hydro International.

Applicant's Use Level Requests:

- Functional equivalence of the Downstream Defender to other vortex enhanced sedimentation technologies.
- General Use Level Designation (GULD) for pretreatment.
- Pilot Use Level Designations (GULD) for Basic and Oil Treatment.

Applicant's Performance Claims: Based on full-scale laboratory trials, a 4-ft diameter Downstream Defender will achieve at least an 80% TSS removal efficiency for 125 micron mean particle size sand, at an operating flow rate of 583 gpm and 50% TSS removal efficiency for 50 micron mean particle size sand at an operating flow rate of 980 gpm.

Based on full-scale laboratory trials, a 4-ft. diameter Downstream Defender will achieve at least 80% TSS removal efficiency for 50 micron mean particle size sand at an operating flow rate of 400 gpm.

The Downstream Defender increases retention time and removal efficiency compared to a simple swirl-type device. Its three-dimensional geometry and internal components decrease turbulence and ensure that any fluid element passes through an extended flow path to get from the inlet to the outlet. This geometry is increased proportionately in all three dimensions, as units get larger In addition, the components create isolated zones outside of the separation chamber where solids are directed and stored and are protected from re-entrainment. These areas also increase in all three dimensions as the units get larger but are kept separate from the treatment volume. Therefore, the removal efficiency of any size cannot be accurately predicted by simply applying the same surface-loading rate of another size. When scaling up to larger

units, residence times must be maintained in order to achieve consistent solids removal. An independent peer-reviewed study concludes that the appropriate scaling law for Hydro International's separators approaches theoretical volumetric loading and can be calculated by:

$Q = Q_{test} (D/ D_{test})^{2.85}$, where:

Q = flow rate at which a different sized device achieves the same performance
Q_{test} = flow rate of tested device (583 gpm)
D = internal diameter in feet of the different sized device
D_{test} = diameter of the tested device (4 feet)

The maximum allowed pretreatment flow rates for Downstream Defenders are based on 80% removal of 125 micron mean particle size sand (Table 1). The maximum allowed basic and oil treatment flow rates are based on 80% removal of 50 micron mean particle size sand (Table 2). Both tables are shown below :

Table 1 Pretreatment Flow Rates	
D = unit diameter (feet)	Q = 583 $(D/4)^{2.85}$ (gpm)/cfs
4	583/1.3
6	1851/4.1
8	4203/9.4
10	7939/17.7

Table 2 Basic/Oil Treatment Flow Rates	
D = unit diameter (feet)	Q = 400 $(D/4)^{2.85}$ (gpm)/cfs
4	400/0.9
6	1270/2.8
8	2884/6.4
10	5447/12.1

Use Conditions. Downstream Defenders shall be designed, installed, and maintained to comply with these conditions :

- Downstream Defender systems must be designed, assembled, installed, operated, and maintained in accordance with Hydro International's applicable manuals and documents and the Ecology Decision and Conditions specified herein.
- Local jurisdictions must file a "Pilot Level Technologies Notice of Intent" form with Ecology prior to authorizing the Downstream Defender for a PULD application for TSS or oil removal. All facilities installed under a PULD must monitor, at a minimum, TSS and oil and grease in accordance with the Ecology-approved QAPP.
- On or before June 30, 2005 Hydro International shall submit a QAPP that meets the TAPE requirements for attaining a GULD for TSS and oil and grease removals.
- Discharges from the Downstream Defender system shall not cause or contribute to water quality standards violations in receiving waters.
- Hydro International shall complete all required testing and submit a TEER on TSS and oil removal for TRC and Ecology review by December 2006.
- Hydro International may request Ecology to grant deadline or expiration date extensions, upon showing cause for such extensions.

Technical Review Committee Recommendations: The TRC, based on the weight of the evidence and using its best professional judgment, finds that:

- Pretreatment guidelines are needed to assess facilities performing at less-than-Basic treatment levels, but adequate to serve as presettling facilities ahead of infiltration treatment.

The TRC recommends guidelines be set at 50% removal of 50-micron particles and 80% removal of 125-micron particles. The TRC further recommends these guidelines be applied uniformly to this and all future technology submissions, developed and included in Ecology's stormwater manual.

- The Downstream Defender system, sized in accordance with Table 1 above should provide, at a minimum, equivalent performance to a presettling basin as defined in *Stormwater Management Manual for Western Washington (August 2001), Volume V, Chapter 6*.
- Hydro International has also submitted laboratory data on material with a mean particle size of 50 microns. Hydro International should be given the opportunity to demonstrate, through additional laboratory and field testing, whether the Downstream Defender can attain Ecology's Basic Treatment performance goal for TSS removal of typical particle size distributions.
- Hydro International should be given the opportunity to demonstrate, through additional laboratory and field testing, whether the Downstream Defender can attain Ecology's Oil Treatment performance goal.

Findings of Fact:

- Full-scale laboratory test have been conducted on a 4-ft diameter Downstream Defender. Appendix 5 of the submittal includes independent Maine DEP OK-110 laboratory results verifying the company's performance claim. The submittal also documents the removal of portions of heavy metals and nutrients associated with fine particles.
- The submittals also demonstrate that the Downstream Defender provides significantly better protection from pollutant re-entrainment compared to simple swirl-type devices (SVS). Therefore, Hydro International considers the Downstream Defender to be an advanced vortex separator (AVS).
- Full-scale laboratory test have been conducted on a 4-ft diameter Downstream Defender verifying the company's performance claim on material with a mean particle size of 50 microns.
- Laboratory testing using 15 and 30-inch diameter systems derived a scaling factor of 2.85, which is used to determine flow rates for untested models.
- The system is easily maintained using a vacuum truck.
- There are over 2000 Downstream Defender systems installed nationwide, with over 150 in the Pacific Northwest.

Technology Description:

Design Manual and technical bulletins can be downloaded from company's web site.

Recommended Research and Development:

Ecology encourages Hydro International to pursue continuous improvements to the Downstream Defender. To that end, the following actions are recommended:

- Sufficient field-testing data are not currently available to reliably ascertain the Downstream Defender's ability to remove the finer particles (based on the TAPE) comprising TSS found on local highways, parking lots, and other high-use areas. Design of future facilities should consider:

a. Sizing for specific applications based on actual particle size distribution in the target runoff. Ecology's TAPE can be used as guidance on the expected particle size distributions for Basic Treatment.
b. Testing the system in conjunction with a filter as part of a treatment train.

- Sufficient laboratory testing has not been completed to verify the 2.85 scale factor's correctness for larger system diameters. Additional data for larger (such as 60 or 72-inch diameter) systems should be obtained and compared with the 15 and 30-inch systems previously tested and modeled.

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