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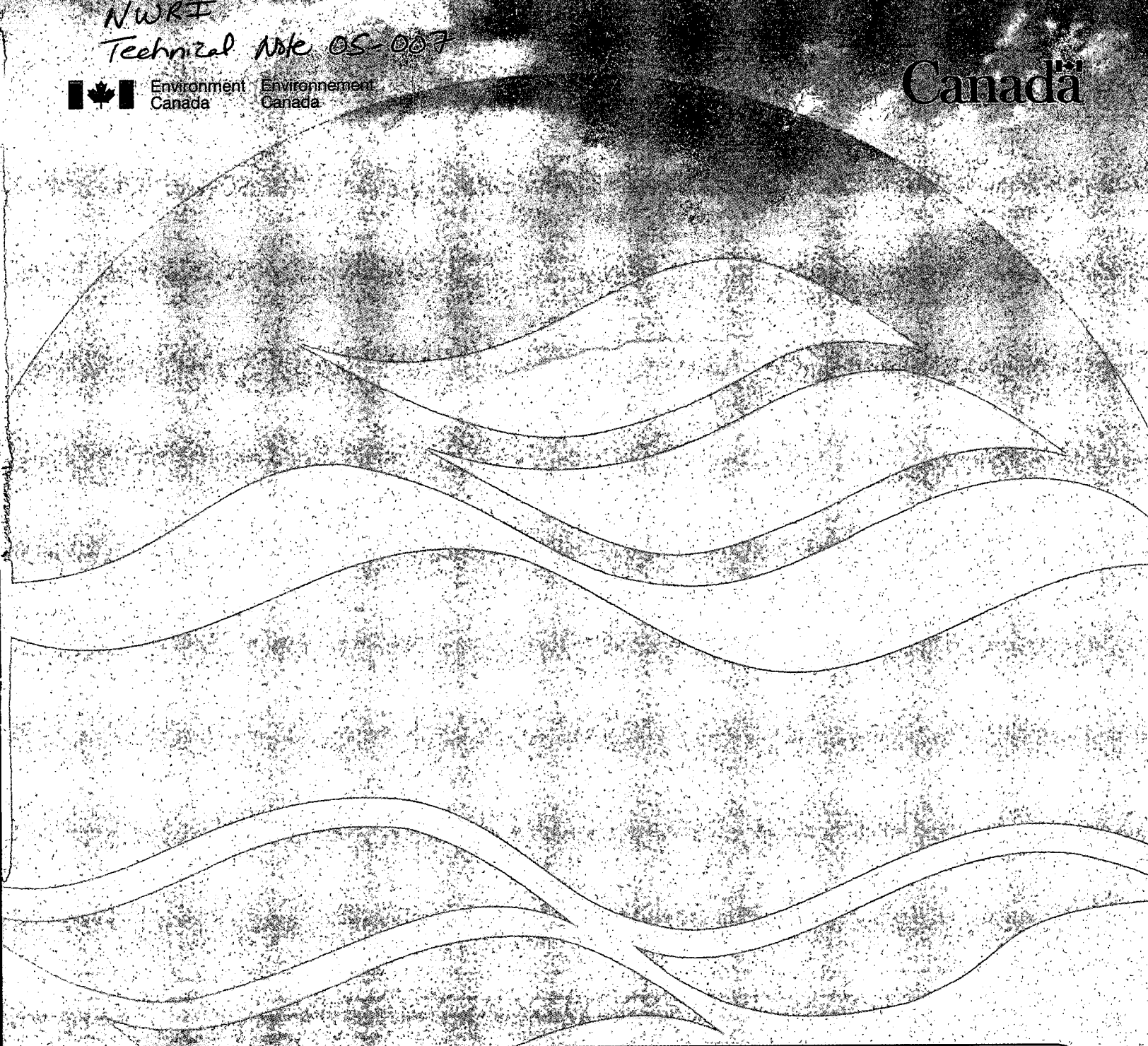

HALTON WASTE MANAGEMENT SITE EAST STORMWATER POND PARTICLE CHARACTERIZATION AND FLOCCULANT ADDITION RESULTS UPDATE

Ian G. Droppo and Kirsten Exall

NWRI Technical Note No.AEMRB-TN05-007

Halton Waste Management Site East Stormwater Pond

Particle characterization and flocculant addition results update

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Preamble

The East Pond surface water (stormwater) pond at the Halton Waste Management Site collects surface runoff from roads and a capped section of the landfill. Samples from the East Pond are occasionally high in concentrations of certain metals. It has been suggested that this relates to poorly settled suspended solids in the pond, and that addition of a flocculant to the pond could improve solids settleability, thereby improving removal of associated metals. A flocculant of unknown composition, United 228 Flocculant Concentrate, has been supplied to municipality staff. The efficiency of this flocculant, in terms of improving solids aggregation and settling, could depend on the method of addition. In particular, the efficiency of flocculants is often dependent on the mixing provided during addition. No such mixing mechanism is available for the stormwater pond at this point and according to site staff, surface application is the intended method of distribution. Jar tests were conducted at NWRI using pond water to evaluate the effect of mixing on flocculation with United 228 or another polymer. Characteristics of the primary particles and flocs in the pond, such as size, settling velocity, and porosity, were also studied. The results of these tests will assist the site operators in determining further courses of action.

Bassin Est de rétention des eaux pluviales – site de gestion des déchets de Halton
Caractérisation des particules et ajout de floculant – mise à jour des résultats

Ian G. Droppo et Kirsten Exall

Préambule

Le bassin Est de rétention des eaux de surface (eaux pluviales) au site de gestion des déchets de Halton recueille le ruissellement des routes et d'une section recouverte du site d'enfouissement. Des échantillons provenant du bassin Est présentent parfois des concentrations élevées de certains métaux. Il a été avancé que cet état de choses est lié à la présence dans le bassin de solides en suspension mal décantés, et que l'ajout d'un floculant pourrait y améliorer la décantabilité des solides, ce qui aiderait à en enlever les métaux associés. Un floculant de composition inconnue, appelé *United 228 Flocculant Concentrate*, a été fourni au personnel de la municipalité. L'efficacité de ce floculant, pour ce qui d'améliorer l'agrégation et la décantation des solides, pourrait dépendre de la méthode d'ajout. En particulier, l'efficacité des floculants est souvent fonction du degré de mélange assuré pendant l'ajout. On ne dispose pas actuellement de mécanisme de mélange pour le bassin de rétention et, selon le personne du site, c'est l'application en surface qui est la méthode de distribution prévue. Des essais de floculation ont donc été menés à l'INRE sur l'eau du bassin, pour évaluer les effets du mélange sur la floculation, pour le produit United 228 ou un autre polymère. On a également examiné les caractéristiques des particules primaires et des flocs dans le bassin, comme la taille, la vitesse de décantation et la porosité. Les résultats de ces tests aideront les exploitants de site à déterminer les approches à adopter.

Update on results of June 24 sampling

Water samples were collected from near surface and 60 cm depths at locations near the inlet, centre and outlet of the pond on June 24, 2005. According to data from monitoring stations in Toronto, Hamilton, and Oakville, there had not been a significant rainfall (e.g., over 3 mm in a single day) in over a week as of that date. Total suspended solids (TSS) concentrations were measured in duplicate with filters of two pore sizes, 1.2 microns and 0.45 microns; results are shown in Table 1, below. The TSS concentrations were relatively low (averaging ~32 mg/L), varying little at the three locations in the pond and increasing slightly with depth. The higher measured concentrations with the finer pore size filter (0.45 μm) indicate that the suspended solids are quite fine, a fact which is supported by particle size analysis (Table 2). Primary particle sizes (the individual particles) are consistent between sampling sites with d_{50} values around the clay fraction. Effective floc size (aggregate particles suspended within the pond) (Figure 1) were similar at the centre and outlet sampling sites but showed a larger size at the inlet. As there was no influent to the pond, such a difference is possible due to wind generated bed resuspension (prevailing wind was from the outlet to the inlet resulting in a possible accumulation of resuspended sediment close to the inlet and adequate mixing to allow for particle particle interaction and flocculation). The slightly higher concentrations at depth (Table 1) and the reasonable quiescent settling velocities (on average around 1 mm s^{-1}) (Figure 2) may support the possibility of wind resuspension. The flocs suspended within the pond were of a low density and high porosity suggesting high water content. It should, however, be realized that this preliminary analysis is based only on single samples and further work would be required to confirm such a hypothesis.

Table 1: TSS concentrations (in mg/L) at various locations in the East Pond, June 24. 2005

	Surface		60 cm depth	
	1.2 μm filter	0.45 μm filter	1.2 μm filter	0.45 μm filter
Inlet	26	32	32.5	39.5
Centre	27	32	31.5	30
Outlet	27	36	28.5	36

Table 2: Particle size (by volume) of the natural suspended floc (composite particle) and individual primary particles following sonication.

	Median particle size (floc) (μm)	Median particle size (primary particles) (μm)
Inlet	41.2	5.85
Centre	21.0	5.39
Outlet	24.8	5.35

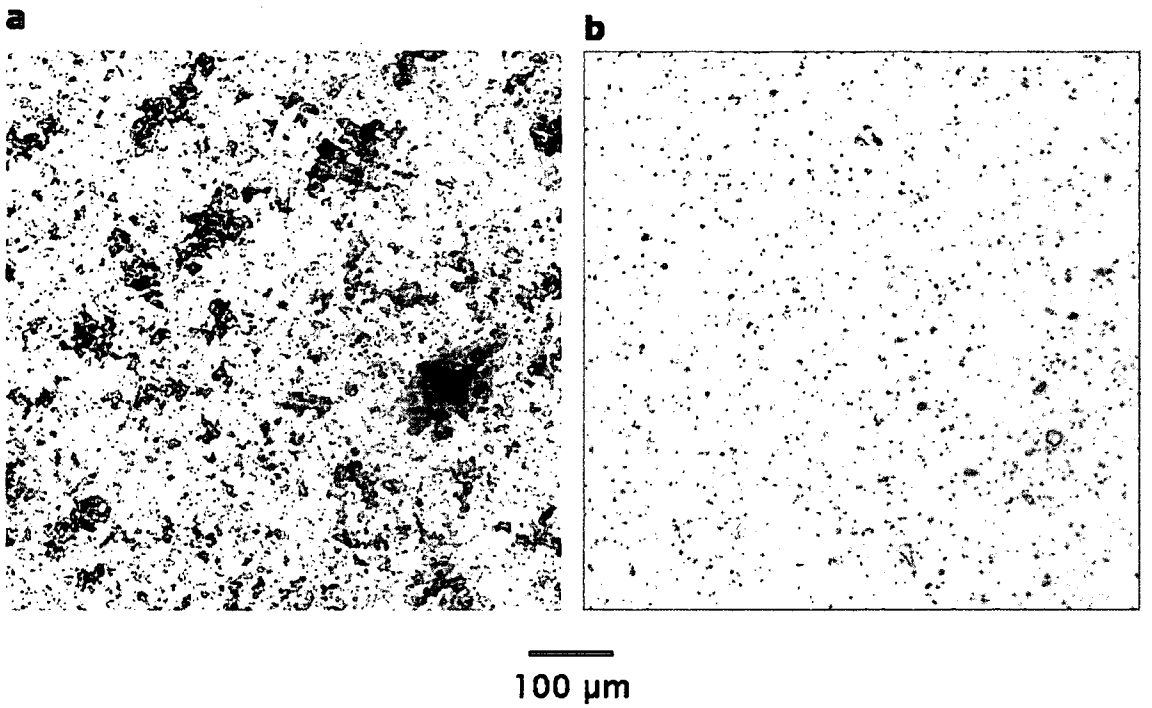

Figure 1: Representative micrographs of a) the effective floc particles, and b) the sonicated primary particles which make up the flocculated particles.

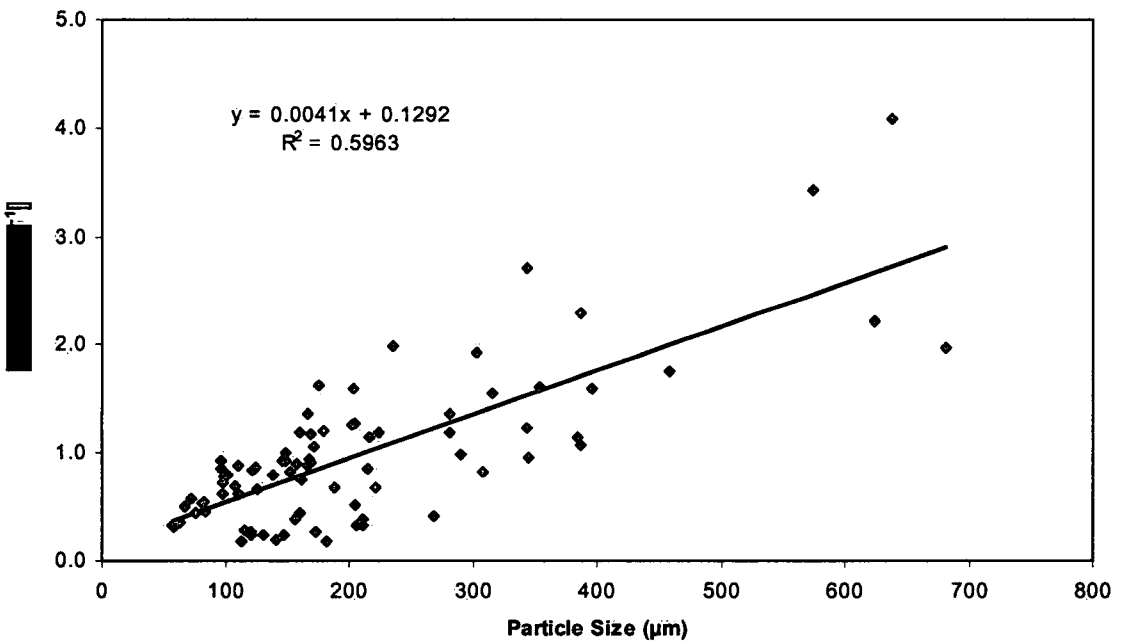

Figure 2: Settling velocity of suspended flocculated sediment collected at all 3 sites (samples combined to provide enough sediment for statistically significant analysis).

Laboratory jar tests with pond water were conducted with United 228 (United Laboratories) and a polyacrylamide flocculant from CIBA Specialty Chemicals, using various conditions of flocculant dosage and mixing. Supplier instructions on the United 228 label suggested a working dosage of approximately 100 mg/L for sewage treatment. In these studies, United 228 was added to a beaker at dosages of 0.1 to ~100 mg/L, mixed with a paddle at 30 rpm or 100 rpm, then left to settle for 20-30 minutes. No dosage of polymer or mixing speed resulted in TSS reductions; in fact, high polymer concentrations resulted in slightly increased TSS concentrations. Similar results were observed with the polyacrylamide at dosages that have been previously applied in treatment of stormwater, 0.2-1 mg/L. At the very low initial TSS levels seen in water of the East Pond, the addition of flocculant has little beneficial effect on suspended solids in the pond, as can be seen in Figure 3 below, regardless of mixing rate. As mixing during polymer addition is generally considered to be the optimal method of application, it can be expected that polymer addition without mixing would be similarly ineffective.

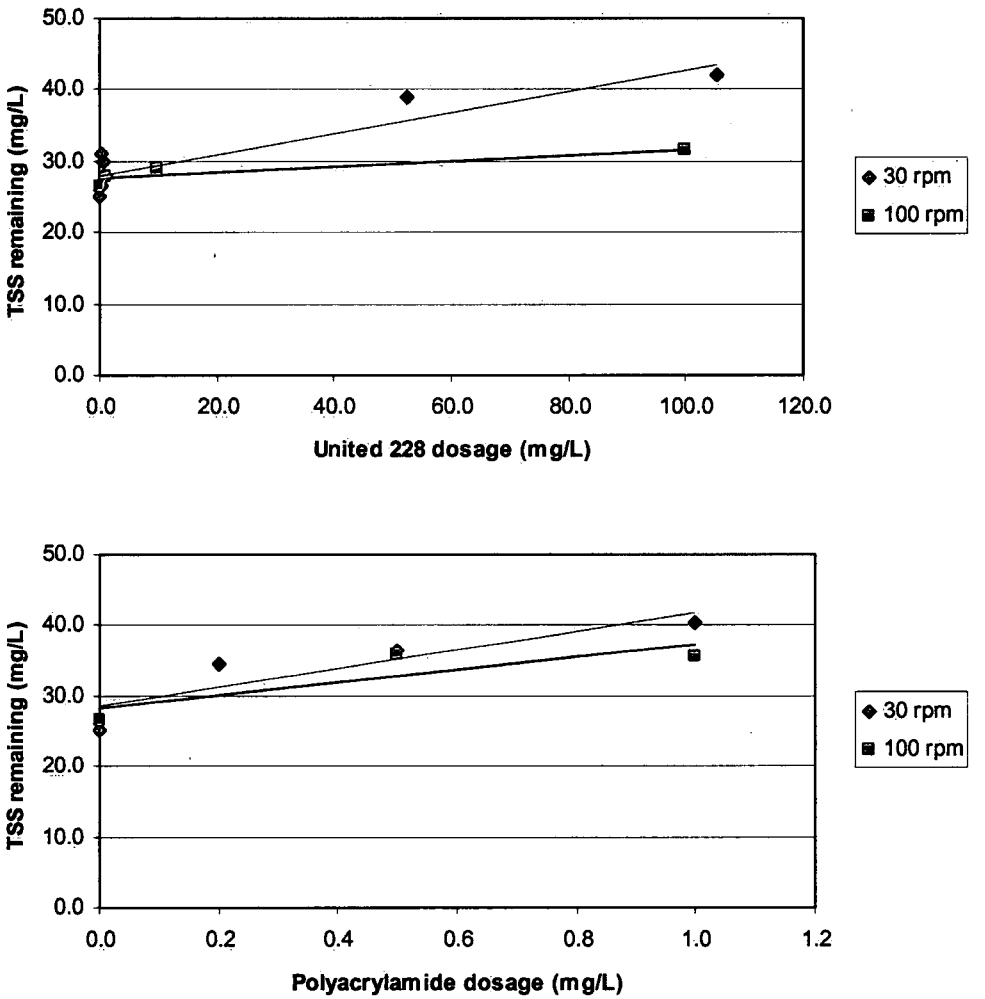

Figure 3. Residual TSS after jar tests with United 228 and polyacrylamide at two mixing speeds.

The addition of polymer may enhance the settling of incoming solids during a storm event when concentrations are higher, or improve the stability of the sediment bed in the pond; however, the hydraulics of the system will need to be better understood to optimize addition of polymer for these purposes. More in-depth analysis of residence time, circulation and turbulence in the pond would be needed. This would entail a more extensive temporal and spatial sampling program in collaboration with the Halton Region. It is important to note that completion of further work would depend on the availability of both NWRI staff time and funds.

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