Sediment Management and Slipper Pond

Revised September 2019

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Summary:

Is it necessary to remove sediment? The pond was created to hold tide water back to power Slipper Mill and was decommissioned in 1936. Since then it has become a major local landmark and is one of the West Sussex saline lagoons with SNCI status because of its fauna and flora.

When the tidal gates are opened the first impression is that there is major silting, the tide leaves the pond drained and its muddy bottom overlaying gravel is exposed..

The possibility of removing any major quantity of silt has been explored and would be a major and costly process beyond the means of the SMPPA and Peter Ponds.

Current conclusion is to continue to occasionally flushing the pond when there is a high flow in the Ems outside the breeding season..

Sediment:

Sediments can be classified in four groups – those derived from the break down of rocks etc., and those produced by biological or biological and chemical processes.
The results of the recent analysis of the deposits in the marina show that the principal component is physical.

Sources:

Sediment can enter the ponds from River Ems and Chichester Harbour and arise from the ecosystem within the pond itself.

River Ems:

The SCOPAC (Standing Conference On the Problems Associated with the Coastline) Report of 2003 states:

FL3 River Ems, Chichester Harbour
A suspended load input of 1,450 tonnes/km²/yr and bedload of between 268 and 541 tonnes/yr is estimated by Rendel Geotechnics and the University of Portsmouth (1996).

Suspended Load
Making **gross** assumptions the uniform silt input could be calculated thus:

Assume 50% of flow at Constant Spring is sent via the ponds
Assume 50% of suspended material remains in the ponds then
Possible deposition = 500t * 50% * 50% = 125t/yr.
Area of ponds= 35,000sq.m.
Silt deposit = 125/35,000t/m2 = 0.008t
Density of silt = 1.5t/cu.m.
'Uniform' depth = 0.008t/1.5 t.cu.m. = .005 m = 5mm

It is not apparent how much carries through the whole system and how much may drop out on the way down.

Bed Load
The bed load is much coarser and concentrated in the main channel as the flow rate over the shallows is too small to move it. When the stream reaches the ponds the drop in its speed allows settlement, the amount being dependent on the depth and speed of the water at the point in consideration.
When the tidal gates are left open the flow will carry the load out to sea adding to the scouring particularly at times of higher flow.
1 tonne per day potential sediment load is probable.

1 tonne/day = 365 t/year =365 t/1.5 t/cu.m. = 240 cu.m./yr
Assuming a 50% split at Constant Spring this equates to 120 cu.m.yr
(equates to the range of 268-541 t/re. In the SCOPAC report).

Assuming uniform 1m. wide deposit along the bed of Slipper and Pater Ponds
Depth = 120cu.m,. yr./500m. = 0.6m/yr.

These figures are vague as many assumptions have been made but equate to observations.

Harbour sediments

The marina is on a 10 yearly dredging cycle and currently regularly remove some 50 cm. of sediments, This is probably the best base data for harbour-borne suspension and relevant for both to both ponds in the main flow line. Clearly keeping the gates closed as much as possible will reduce input from this source.

Accumulation over 10 years = 0.50m
Annual rate = 0.50m/10yrs = .05m/year

Atmospheric

Whilst there is an accumulation of dust on exposed surfaces it is very small in terms of the problem and is being ignored for the purposes of this exercise.

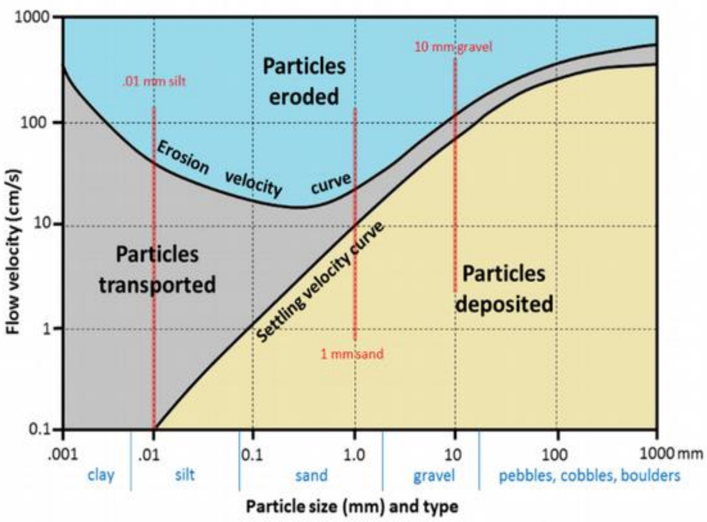
Biological:

Within the ponds the wildlife generates debris - plankton lives and decays with debris fall to the pond bed. Invertebrates, fish and birds contribute as well and attention must be drawn to the tube-worm growth which festoons any hard objects in the ponds. In overall terms their contribution is not seen as significant.
The river water contains much chalk which manifests itself as a typical hard-water white rim at high-water mark

Deposition and Erosion of Sediment

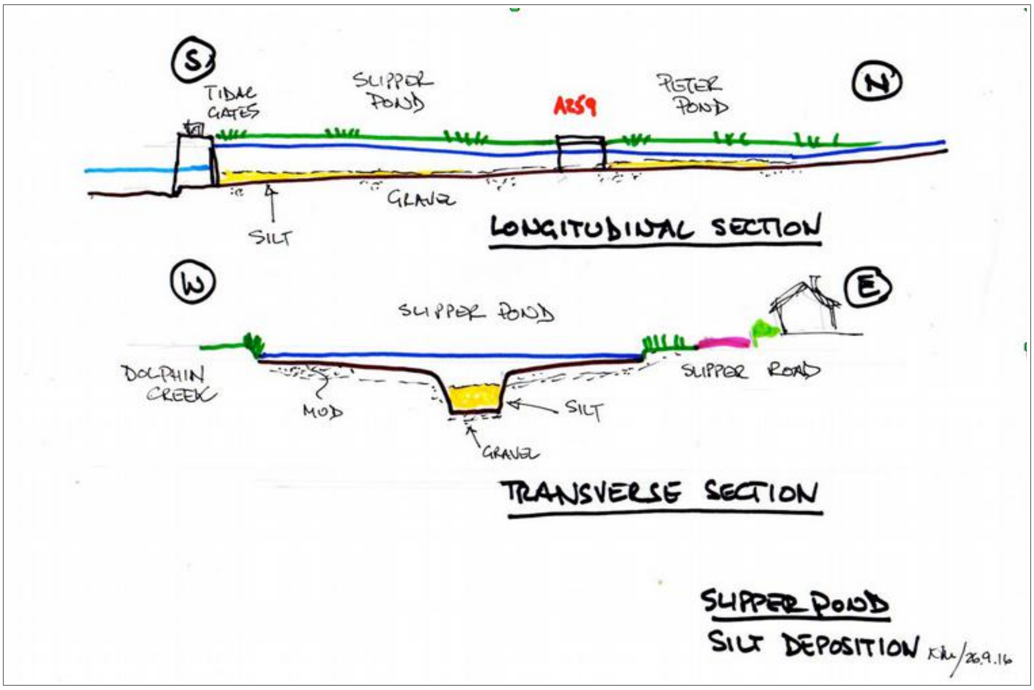
The deposition of sediment in rivers and ponds depends on its depth, concentration and its velocity. The deeper and slower the flow the more settles out. Because of the physical properties of the particles greater energy is needed to re-mobilise it and very fine material needs to be stirred mechanically to mobilise it.

The Hjulstom diagram illustrates the mechanism:



An Introduction to Physical Geography and the Environment – Ed. Holden

The varying depths of Slipper Pond reflects these properties – the accumulation of fine fresh silt in the shallows is small whilst the deeper water in the main channel attracts greater deposition.



Leaving the gates open has negligible effect in the shallows and sediments are only moved where the water is agitated and its velocity is sufficient. The shallow areas of the ponds are practically stable – the depth of silt-laden water is small so little is deposited. Conversely where the water is deeper there is more silt in suspension resulting in a greater accumulation. Wind generates waves in the exposed areas of the ponds and in the shallows their movement can be sufficient to mobilise and reposition it.

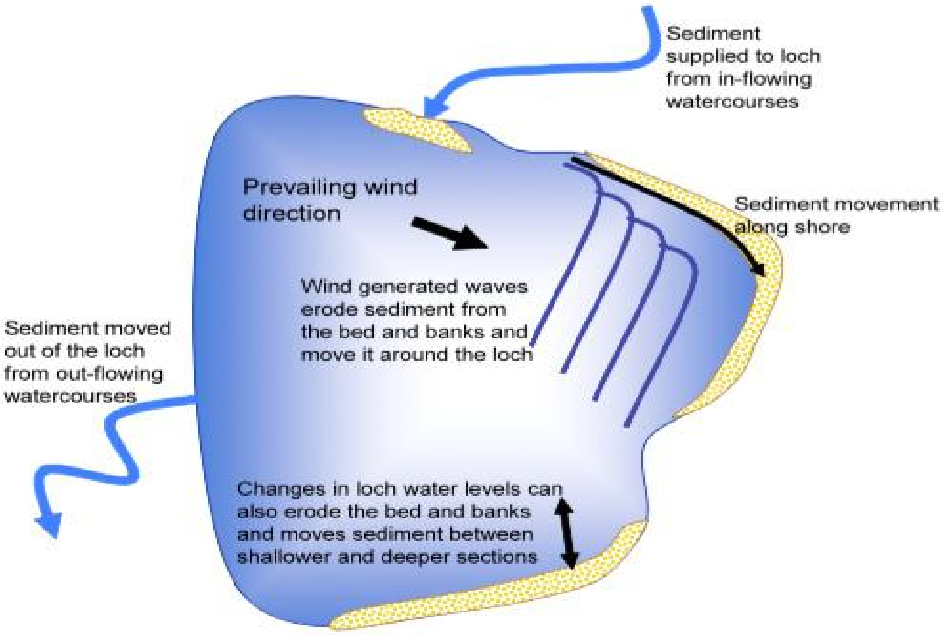


Figure 3: Sediment movement in lochs.

From Sediment Management – Scottish Environment Protection Agency

Actual Sediment Movement – March 2019

The high winds at the beginning of March 2019 generated small breaking waves about 20 cm high which were reflected by the North wall of the pond stirring up the silt in the shallows. The wind-generated currents in the pond mobilised all the material and the finer fraction was taken away. The currents in the pond circulated it and the majority of the material will have been been settled out in the deeper water of the main channel. This process is identical to panning for gold in which the heavier material is retained and the lighter debris discarded.

Pond bottom after storm – March 2019   East end of A259 Wall

The separation of the sand waves together with the exposed shells and pebbles demonstrate the agitation.

Record Photos

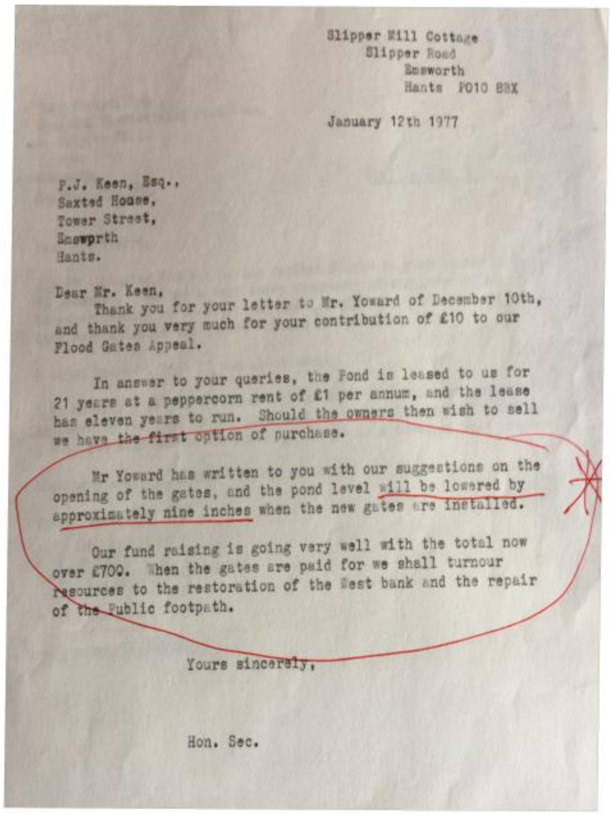
 2014	 2016
	

A detailed comparative view of old and recent photographs confirms that the bottom is covered in a bed of silt but that it is increasing very slowly if at all. Despite the encroachment of reeds the geometry of the main channel has not changed significantly and reflects the probable course of the original stream bed before its construction in 1760s.

Retained Water Level

The general water level in the pond is controlled by the sill effect of the Gates. Generally its is affected by the flow in the Lumley branch of the River Ems as well as leakage through the banks and bottom as well as past the gates and sluice. Spring Tides naturally push the gates open consequently raising the level.

In 1976 the whilst the gates were being rebuilt the crest level was lowered by 9 inches as required by the Authorities. The consequence was the pond margins becoming significantly shallower facilitating reed spread especially in Peter Pond.



Slipper Mill Cottage
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January 12th 1977

P.J. Keen, Esq.,
Saxted House,
Tower Street,
Emswprth
Hants.

Dear Mr. Keen,
Thank you for your letter to Mr. Yoward of December 10th, and thank you very much for your contribution of £10 to our Flood Gates Appeal.

In answer to your queries, the Pond is leased to us for 21 years at a peppercorn rent of £1 per annum, and the lease has eleven years to run. Should the owners then wish to sell we have the first option of purchase.

Mr Yoward has written to you with our suggestions on the opening of the gates, and the pond level will be lowered by approximately nine inches when the new gates are installed.

Our fund raising is going very well with the total now over £700. When the gates are paid for we shall turnour resources to the restoration of the West bank and the repair of the Public footpath.

Yours sincerely,

Hon. Sec.

From SMPPA archives

Peter Pond

The bed of the Ems has eroded through the relatively thin silt layer to the underlying gravels as shown in the above photo.

Conclusions:

The main threat of sedimentation is from the harbour so keeping the gates shut is to the ponds' advantage.

The current policy of opening the tidal gates outside the breeding season for limited periods during Spring Tides to take advantage of the associated high flow rates is to be pursued.

References:

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- Sediment Management – Scottish Environment Protection Agency (SEPA) - https://www.sepa.org.uk/media/151049/wat-sg-26.pdf
- MIT – an introduction to fluid motions sediment transport and current generated sedimentary structures https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-090-special-topics-an-introduction-to-fluid-motions-sediment-transport-and-current-generated-sedimentary-structures-fall-2006/syllabus/

Illustrations

- Unless noted by Nick Madinaveitia