

Ready for remediation



THE BAY OF ÖRSERUM PROJECT

65 years of effluent from the paper mill

The inner bed of the Bay of Örserum is contaminated with considerable quantities of the environmental effluents PCB (Polychlorinated biphenyls) and mercury. These substances were released from the Westervik Paper Mill during the latter part of the 65 years the mill produced paper and cardboard. Mercury was used for more than 20 years as a pesticide to avoid microbial growth in machines and tubes. The PCB effluent arose from the lump paper taken in by the plant and used as raw material in production. The contaminated sediments also contains PAH (Polycyclic Aromatic Hydrocarbons). The source of the PAH effluent is not known to date.

The production of paper started in 1915 and continued until 1980. A longer cease in production between the years of 1919–1923 was caused by difficulties in obtaining raw materials and the lack of markets for sales. The Mill however produced high quality cardboard as early as 1916 that was sold in Sweden and even exported.

No cleansing

The Mill released effluent of high fibre content throughout its entire life cycle. During the first decades the effluent was released into the bay completely untreated. In 1954 the Mill was obliged

to treat its effluent. Building a bank that cut off the inner part of the Bay of Örserum solved this problem. The effluent was then released into the basin inside the bank. Great quantities of fibre residue settled here, while the overflow of water was led out from the basin into the bay.

A basin of fibres

Ten years later the basin was completely filled with excess fibre and fibre rich effluent was led into the Bay of Örserum again. This resulted in decision of the Department of Health in Västervik that the Mill was obliged to clean the then highly polluted bay. At this stage the Mill was sold to the PLM Group who also inherited the environmental obligations placed on the plant.

The “liberal” view on the treatment of industrial effluent during the 70’s is clearly visible in the Court verdicts dealt out to the Mill during the PLM era. In 1970 the Paper Mill was allowed to continue to release effluent into the Bay of Örserum for “a test period of three years”. In 1976 the Mill received a new permit, which was extended to 1980. The owners, PLM then decided to shut down the factory.



A birds-eye view from the 1960's clearly shows the extensive pollution in the Bay of Örserum.
PHOTO RIKETS ALLMÄNNA KARTVERK



PHOTO FROM THE ARCHIVES OF
KULBACKENS MUSEUM

Lump paper was usually transported by rail. The photo shows lump being unloaded by a forklift truck in 1951.

The first remediation did not suffice

Between 1978 and 1979 the inner area of the Bay of Örserum was cleansed in accordance with the Court verdict from 1976. This was a considerable undertaking at that time. Approximately 200 000 m³ of fibre-polluted mud flats were dredged from the inner areas of the Bay of Örserum.

The dredged masses were pumped on shore and treated. The principle idea was to separate the water from the fibres by centrifuging. Being as the fibre content represented a considerable amount of waste from the papermaking process and had a realizable economic value, the fibres could be recycled and used in production.

The environmental objective was to remove the mercury from the Bay of Örserum. It also became apparent that the spill water from the centrifuging process that was released back to the bay contained only small quantities of mercury. The greater part, more than 99 % had fastened in the fibres and the mud.

Landfill

The fibre-rich mud masses were deposited on shore close to the basin inside the original dam. The fibres have been there ever since. The plan to recycle this resource material was scrapped for economic reasons. That which remains is an environmental problem of fibre-rich masses

that contain 674 kg PCB, 170 kg PAH and 348 kg mercury.

The remediation of 1978–1979 only comprised the inner area of the Bay of Örserum, approximately 15 of the total of 37 hectares. The work involved cost some 8,3 million SEK in 1979.

The great quantities of fibre that were deposited on shore above the basin contained considerable quantities of water. This caused the “hill” of fibres to partly flow out into the basin inside the bank.

Now that the fibre-rich masses have dried out there is a risk that they will now be spread by the wind.



PHOTO THORSTEN JANSSON

PCB and mercury now evaporate into the air from the old deposit of fibre-rich masses.



This is the old basin in the inner area of the Bay of Örserum into which the effluent from the Paper Mill was released. The basin is now a “bottomless” pit of fibres and loose mud.

750 kg of mercury and 1400 kg PCB in the bay

The Bay of Örserum is situated in an area that is classified as being of national interest for outdoor activity. Just around the corner is one of Sweden's largest and most popular camping sites, the Lysingsbadet, with its extensive summer activities such as bathing, fishing, boating, sailing, golf, summer cottages and its archipelago.

It is therefore of national interest that the continued dissipation of environmental pollutants from the Bay of Örserum is stopped.

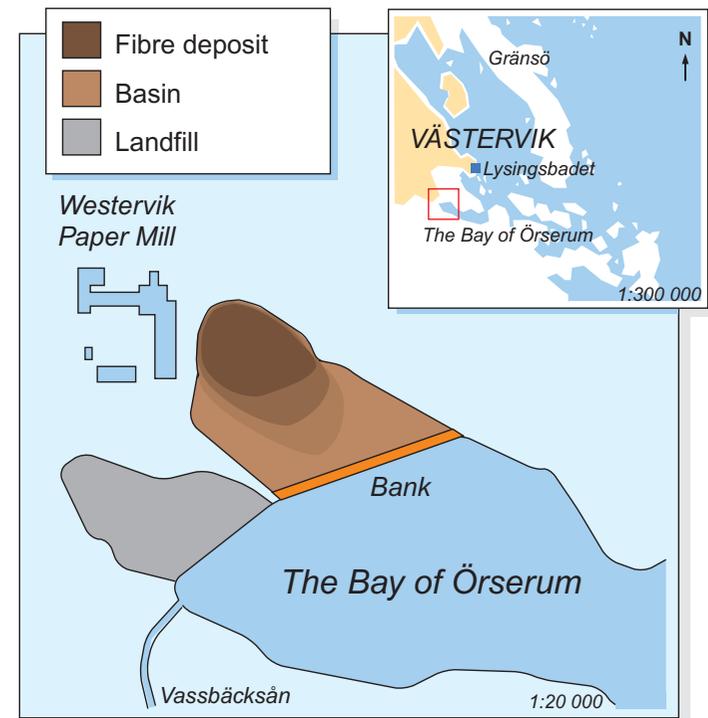
Research has shown that there is 1 400 kg PCB and 750 kg of mercury spread out in the area as a result of the effluent from the paper mill over a period of several decades. The quantity of PAH is approximately 550 kg.

The major part of the contaminants is contained in the old basin and in the great quantities of fibre that were deposited on shore above the basin from the remediation of 1978–1979. Almost all the remaining quantities are situated in the sediment of the Bay of Örserum. There is also a smaller quantity of PCB and mercury (a few kgs) to be found in a landfilled area in the western end of the bay, next to the basin. This landfill contains, however, a considerable quantity of PAH, some 150 kg.

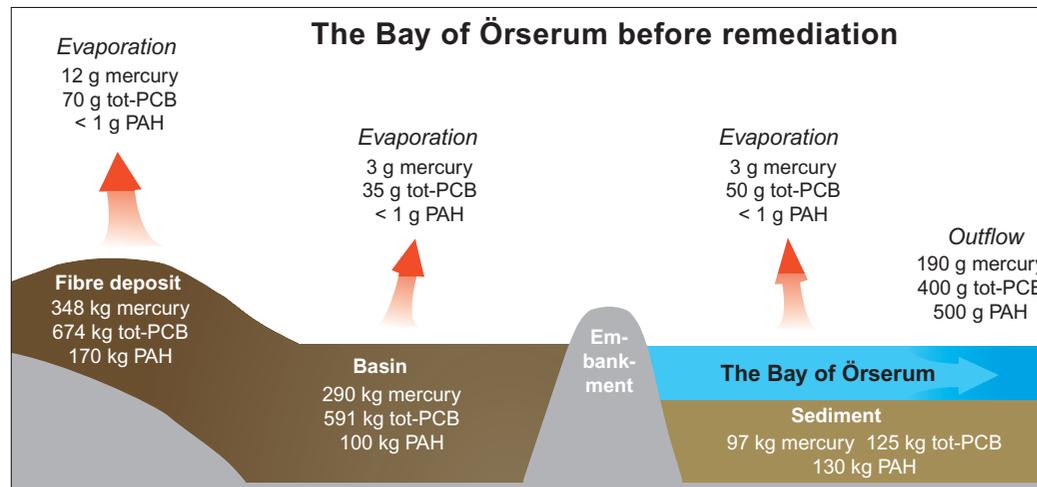
Despite the large quantities of PCB,

PAH and mercury in the basin and in the fibre-rich masses, very little has leaked out into the bay. The quantities of contaminants that evaporate from the bay to the air are also small. The greatest environmental problem is that of the transportation of environmental pollutants from the coast out into the Baltic Sea. This pollutant transfer is caused by wind and waves stirring up the sediment and moving contaminated particles out of the bay into the sea.

Calculations show that 400 g PCB, 500 g PAH and 190 g mercury leak out of the Bay of Örserum each year.



GRAPHICS NIKLAS JANSSON



The values of evaporation and outflow have been calculated from investigations done in 1999-2000.

GRAPHICS THORSTEN JANSSON

FACTS ON Mercury

Mercury is an element that has been widely used in chemical pesticides. The farming industry used mercury as a cereal seed treatment to prohibit mould and insects. The chemical pulp and paper industry has used mercury-based compounds to prohibit mould and mildew in pipes and machinery. Mercury was also found to act as a conserving agent in grinding paste. Cereal seed treated with mercury was shown in the sixties to be the cause of extensive bird casualties. Rachel Carlson's book "Silent Spring" became a clear warning signal and all use of mercury in the pulp industry was prohibited in 1967. The use of mercury started in the early fifties.

Half a kilo of PCB leaks out into the Baltic each year

Samples of sediment indicate the pollution history

Considerable investigation of the seabed in and outside the Bay of Örserum clearly shows the pollution of PCB, mercury and PAH from the Westervik Paper Mill. Tests conducted on the sediment at two positions in the bay and two outside show that the levels of mercury and PCB are considerably lower outside the bay.

The sediment has been dated from the 18th century up until today. The sediment cores that have been analysed at each centimetre in depth show that the environmental pollution exists in all levels as far down as 20 cm, with the highest levels between 8 and 12 cm. This indicates that the pollution has started to develop in the bay bed from the middle of the 20th century. The levels increased steadily until the 1980's when the plant was closed down and have thereafter decreased.

The investigations show that the deposition of fibres and mercury started the contamination in and outside the

bay. The levels of PCB increase at a later stage, approximately at the same time as the increase in the Baltic Sea.

There are a number of indications that certain types of PAH may have originated from sources other than the paper mill.

The results of the analysis clearly show the production methods used at the plant. During the first decades there was no cleansing at all – the effluent ran straight out into the bay. In the 1950's an embankment was built that collected fibre and some other types of contaminants in the basin. The basin was filled after some ten years of use, and the effluent again ran directly out into the bay. The release of environmental pollution was therefore highest from the 1960's until the plant shut down. There is however a small margin of error in the determination of the dates due to the effect of the wind, currents and waves that may have mixed up the sediment. Even allowing for

this uncertainty, the analysis clearly shows the effect of the paper mill on the marine environment in and around the Bay of Örserum.

It was important to establish the spread of environmental pollution before the remediation process started in the Bay of Örserum. 24 different PAH substances, (see the facts on these substances) and seven different types of PCB have been analysed in the sediment.

Note:

The age determination of the sediment has been established by measuring the quantity of radioactive Cesium 137 and Plutonium 239 from the Tjernobyl disaster, from nuclear tests carried out during the 1960's and the content of the natural isotope Lead 210.

FACTS ON PAH

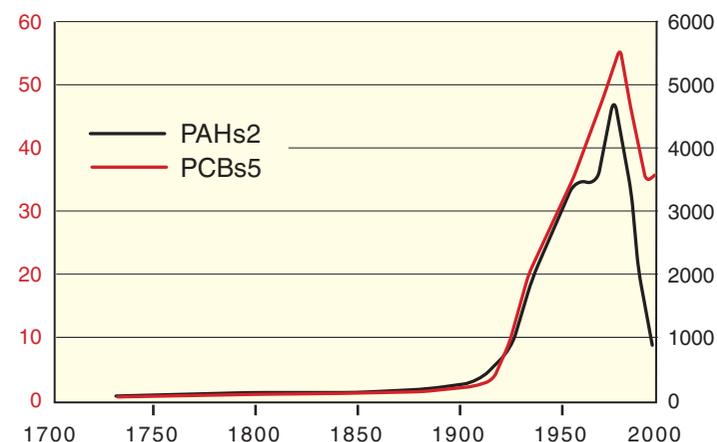
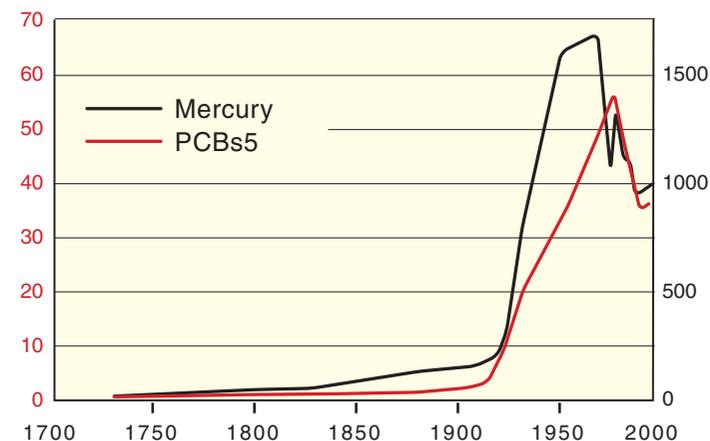
PAH, Poly Aromatic Hydrocarbons are a group of substances that have been creating more and more attention due to the suspicion that they are possible environmental pollutants. PAH arises when oil, coal and wood are inefficiently burned. Increased automotive traffic and the burning of fossil fuels during the 20th century have increased levels that are now noticeable

in our natural environment. Important and significant sources of PAH are melting plants, refineries and district heating plants fired by bio-fuels. Boats with two-stroke engines cause considerable marine pollution. PAH contains cancerogenous substances and are suspected to be the cause of disturbance in the fertility of fish species in the Baltic.

FACTS ON PCB

PCB is the general abbreviation for a large group of chlorine-based substances that have been used in industry as adhesives, mastics, transformer oils and paint. During the 1980's it was discovered that PCB had found its way into the environment. Lump recycled in many paper mills, including that in Västervik, was found to contain PCB. The substance is to be found in

the surface coating of self-copying paper. PCB has been found to be a powerful environmental pollutant. It is deemed to be the cause of infertility in otters and seals in the Baltic in the 1980's. The use of PCB was prohibited in 1972, but remains for the most part in the environment or in the components in which it was used.



The curves show the levels of PCBs5, PAHs2 och mercury in the coast sediment outside Västervik. The levels are measured in nanograms per gram dry weight (ng/g dw). Note that the scales are different for the different substances. The deeper levels show a raise in level due to turbulence in the sediment. The notation PAHs2 and PCBs5 contain two types of PAH and five types of PCB. This means that the curves show only 20-25 % of the total quantity of PCB in the sediment.

GRAPHICS THORSTEN JANSSON

Pollution safely contained

Approximately 170 000 m³ of the sediment in the Bay of Örserum will be dredged. The dredging process will be carried out using a dredger that first cuts out the bottom sediment and then sucks it and the surrounding water up in order to minimise re-suspension of the sediment. The resulting masses will be pumped ashore where the water will be drained off and purified and thereafter pumped back into the bay. The resulting masses are then sufficiently solid as to be landfilled.

The landfill to be used is the old basin behind the embankment, in other words land that is already polluted. The embankment will be strengthened in order to avoid collapse due to overload before the masses are replaced.

Long Term deposition

The landfill is to be regarded as long-term deposition of the polluted masses. In order so as not to repeat the mistakes of the first attempt in 1978–1979 the landfill will be covered over. The cover is intended to ensure that further pollution from the evaporation of PCB and mercury does not occur, and to stop storm water from seeping through the landfill and causing pollution by leakage. The cover will consist of several layers using a technique that has been used in several

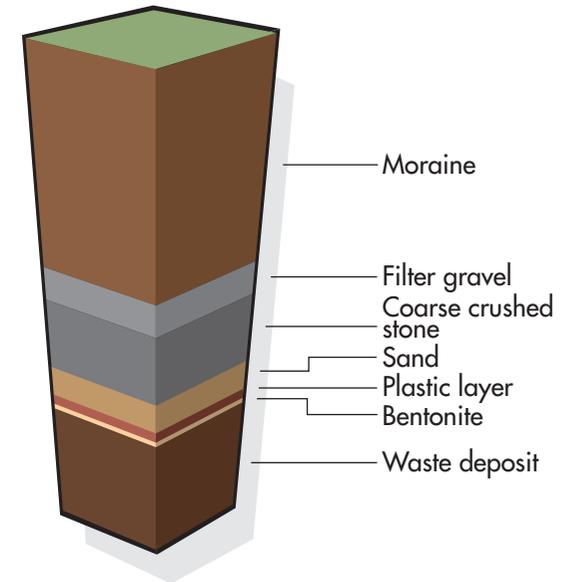
similar remediation projects and in covering environmentally dangerous waste. The technique can be compared with that of a well made up bed with a two metre thick blanket of multiple layers.

This design will create a safe deposit for the waste materials and at the same time not prohibit the future “peeling off” of the cover in order to purify the masses at a later date with new, as yet unknown, technology. Improvement in this field is developing rapidly in many countries. The most advanced technology available at the moment is too expensive and such funds are not available for such large quantities as those of the Bay of Örserum. Calculations show that a landfill designed as proposed will leak a small quantity of pollutants during a long period of time. Even if the protective cover is damaged, the pollutant leakage will be so slow as to allow the environment to cope with the problem.

The landfilled area to the west of the basin will be covered with a similar, but simplified construction and sealed off from the Bay of Örserum. The leakage here will therefore continue to be quite modest though polluted particles will not be able to spread into the bay.

Both the long- and short-term environmental benefits will be considerable. These measures are expected to decrease

Principle of the waste covering



GRAPHICS NIKLAS JANSSON

the leakage of the environmental pollutants PCB by 90 percent and mercury by 70 percent from the Bay of Örserum.

Evaporation into the air will almost completely decrease.



“Here but no further” – this is where the PCB and mercury from the bay is to be deposited.

Well proven techniques will be used to isolate the environmental pollutants

Environmental legislation decides responsibility

The judicial process that is used to determine who is responsible for the pollution of the Bay of Örserum has determined that it is not reasonable to demand compensation from the company PLM, the last owners. This decision is based on the fact that the company has already cleaned the bay from paper fibres once and that the paper mill was run in accordance with authority approvals.

The question of responsibility has been judged in accordance with Swedish Environmental Legislation. The legislature contains regulations that apply to all areas, buildings, premises and structures that are so polluted that they are a threat to the health and well being of the population or the environment. The regulations apply to pollution above, in or under the ground, in marine areas or groundwater, in sediment, buildings, or other structures. The cause of the pollution has no consequence whatsoever.

Those responsible

The Swedish Environmental Legislation states that it is, in the first instance, always the party that has caused the pollution that is responsible. Those responsible are required to take such actions as to counteract or prevent any risk for personal health or damage to the environment. It is often the case that the operation concern-

ed is run by another party than that which caused the pollution. It may also be the case that several parties are involved.

The authorities may then impose an injunction on any one of the involved parties, giving them the responsibility of carrying out necessary investigation or to take measures as to alleviate the pollution in question. The imposed party then has the possibility of suing the other parties in a court process. This is known as joint responsibility.

After the 30th June 1969

The responsibility involved applies to pollution that has arisen after the 30th June 1969 and is still a danger to personal health or the environment when the Environmental Legislation come into force on the 1st January 1999. There is no period of limitation in this case. The lapse of time after the 1st January 1999 has therefore no consequence on the degree of responsibility for those involved.

Secondary responsibility may be placed on the owner of the premise as to carrying out necessary investigation or to taking appropriate measures. It is often the case that there is no responsible party, for example when the company that caused the pollution has gone bankrupt and the company dissolved. The responsibility placed on the owner of the premises is subordin-



The beautiful archipelago just a few kilometres from the Bay of Örserum.
PHOTO THORSTEN JANSSON

ate to that of the operative party and is limited to takeovers that have taken place after the 1st January 1999.

The extent of the treatment required and the degree of responsibility is decided in a joint due diligence enquiry, in which all relevant circumstances are weighed in. Examples of the circumstances that may be involved are:

- ✓ **when the pollution took place**
- ✓ **if the operative party has followed given permits and regulations**
- ✓ **the degree of involvement of the operative party**
- ✓ **if the pollution has been caused by accepted behaviour**



The path to the "throwing of the first sod"

In the end of the 1980's the County Council of Kalmar suspected that there could be quantities of PCB in the Bay of Örserum being as the Westervik Paper Mill had released its process effluent into the bay for many years. The source of PCB was self-copying paper that had been used as raw materials. The Local Authority was asked to investigate and analyse fish from the area. The results showed a high content of PCB. This was later confirmed by tests from the soil in the area and the sediment of the bay. The Västervik Local Authority and the County Council started to plan for the remediation of the Bay of Örserum.

- In 1994 the Local Authority carried out a preliminary study of how the sediment of the Bay of Örserum could be treated. The study was sent to the County Council who, in turn, gave high priority to The Bay of Örserum Project in their presentation of important remediation projects in the County of Kalmar to the National Board for Environmental Protection.
- In 1995 the National Board for Environmental Protection approved a three million SEK grant to the County Council in order to determine who was responsible for the pollution and to estimate the risk for the spread of PCB and mercury into the surroundings. The County Council invited the Västervik Local Authority to take over the grant and carry out the project. The Board of the Local Authority appointed a governing body and a project group. These groups included representatives from the National Board for Environmental Protection, the County Council and the Västervik Local Authority. A number of reports and investigations were presented during the period 1996–98.
- In the autumn 1998 the Västervik Local Authority applied for a grant from the Ministry of Environment from the programme for local investment. The government on the 8th April 1999 approved the Local Authority application for state assistance with the refurbishment process for 68 million SEK.
- The Board of the Local Authority approved the Bay of Örserum Project on the 31st May 1999 and appointed a governing body, which was in turn to appoint a project group, and approved the relevant funds for the project. A number of investigations to identify the environmental situation in the estuary and extensive planning and programming activities were started in the autumn of 1999. The investigations showed that the environmental pollutants had spread even further than that which was previously known, causing the project to be more expensive than originally estimated. The National Board for Environmental Protection approved a further grant of 40 million SEK.
- The dredging and landfill works were put out to tender in the summer of 2000. Contracts for the works were signed in November of 2000. The work started in the summer of 2001 and is expected to be complete in the autumn of 2003.



The first symbolic sod of earth was thrown up on Friday the 4th December 2000 (insert on the front page). Those present were the Mayor of Västervik, Anita Boman and the main contractor, Vägverket Produktion Syd. A number of contractors, consultants, civil servants and other dignitaries were also invited.

PHOTO THORSTEN JANSSON

PHOTO CHRISTER RAMSTRÖM



The dredging of the Bay of Örserum started in April 2002. The operation is carried out from a dredger that carefully sucks up the sediment. The slurry is pumped on shore through a buoyant pipe.



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