EXPERT GROUP MEETING ON CUMULATIVE ENVIRONMENTAL IMPACTS OF DESALINATION ON THE MEDITERRANEAN. Brussels 23 June 2014.

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ENVIRONMENTAL FATE & IMPACTS OF SEAWATER DESALINATION IN SMCs

Once discharged to the near-shore marine environment, pollutants in brine reject will be subject to different degradation processes that can influence its (1) persistence, (2) partitioning, (3) transport, (4) bio-availability and (5) overall fate of the pollutants.

Mechanism of degradation:

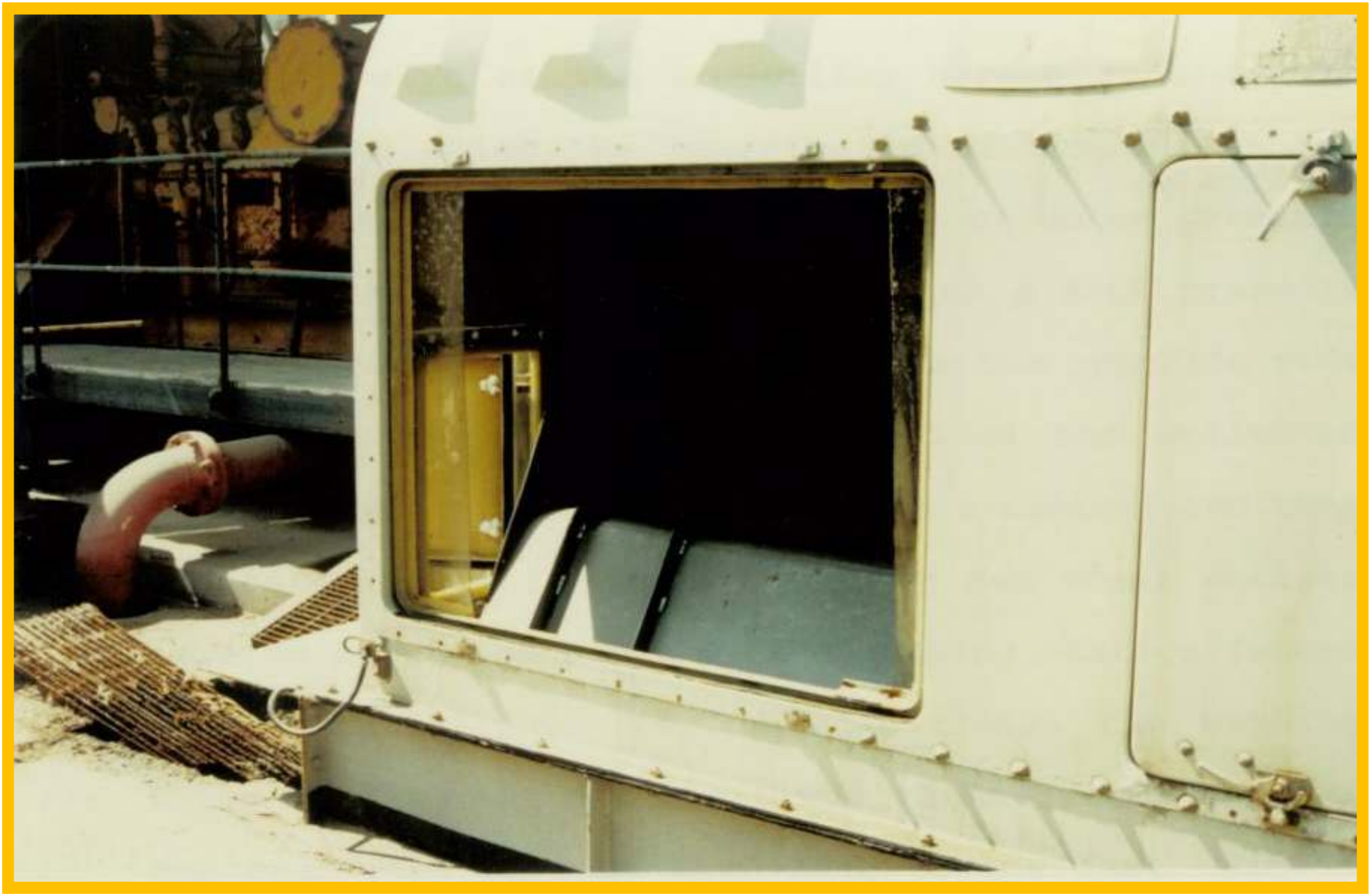
1. Aerobic biodegradation
2. Anaerobic biodegradation
3. Hydrolysis
4. Oxidation or reduction
5. Photo-oxidation
6. Volatilization

Environmental Impacts of Withdrawing Masses of Seawater into Desalination Plant Intakes

- Seawater intakes of desalination plants usually result in serious loss of eggs and larvae of fish and benthic invertebrate species, spores from algae and sea-grass, phytoplankton and zooplankton, as well as smaller marine organisms when these are drawn into the plant with the seawater.
- Experience from around the world indicates that large volume of seawater diverted for desalination from the Mediterranean Sea will have serious cumulative impacts on the near-shore marine ecology.

Forebay of a desalination plant intake

Screen bar 10cm wide at entrance of forebay



Housing of traveling screen mesh of <1cm^2

Dead Pelagic fish (Sardinella) in the forebay of desalination plant resulting from chlorination for bio-fouling control

Impingement:

- Impingement occurs when marine organisms become trapped on intake screens due to suction from the seawater intake velocity.

Entrainment:

- Entrainment occurs only when smaller marine organisms such as fish eggs, larvae and plankton not excluded by screen bars at the intake get drawn into the desalination plant with the feed-water.

- **The most noteworthy adverse environmental impacts of seawater desalination plants are likely to be caused by their intakes rather than their outlets.**

- In the life of marine organisms, temperature elevations from ambient values causes thermal stress that might result into an eco-toxicological effect such as disturbed enzyme activity, water balance and cellular chemistry.
- The impact of thermal pollution in enclosed bays might be much more significant and could be manifested by changes in community structure such as types of dominating organisms and by changes in the characteristics of the individual species such as lower tolerance and/or adaptation.

Environmental Impact & Fate of Salinity in the Near-Shore Marine Environment of the Mediterranean

- **Given the calculated salt concentration in brine reject discharged from different desalination technologies in the Mediterranean sea (78.00, 47.00 & 43.00 gm salt/m^3 desalinated water from RO, MED and MSF plants respectively), it is very likely that Posidonia oceanica sea grass within the immediate vicinity (mixing zone) of the desalination plants outfalls will be eradicated including all marine biota this sea grass is sustaining.**

Cumulative Impacts of Increased Salinity on Semi-Enclosed Marine Environment

- Semi-enclosed and shallow embayment's in the Mediterranean Sea are naturally characterized by a higher salt content due to the elevated rate of evaporation, lack of freshwater discharges, feeble tide waves and restricted dispersion and dilution. These factors when compounded with desalination plants brine discharges would suggest that the biota in many instances is living on the **extreme limits of its environmental tolerance** in enclosed near-shore areas and mixing zones in the Mediterranean.

Cumulative Environmental Impacts of Increased Salinity on Open Seawaters

1. The amount of seawater withdrawn for desalination is relatively minute when compared to the water mass of the open sea.
2. The amount and nature of salts discharged with the brine are identical in nature and composition to the salt content of the open sea.
3. The concentration factor of salts in the rejected brine increases on the average by no more than two.
4. In most of the desalination plants the outfalls are specifically engineered and equipped with diffusers to disperse and dilute the brine.
5. The salt resulting from natural evaporation from the Mediterranean, is several orders of magnitude compared to the calculated salt inputs from operating desalination plants.

Conclusion

- **For open seawater, It is safe to assume that potential increase in salinity due to brine reject from desalination plants in the Mediterranean should not give much reasons for concern. This is, particularly true if near-shore hydrographic circulation patterns are considered in the proper design of the plants discharge outlets.**

Fate and Environmental Impacts of Acids Anti-Scalants

1. The drop in pH is probably the most important single variable that influences the fate and transport of metals.
2. The pH controls metal speciation and potential binding with ligands (such as phosphate, sulfate, carbonate, humic substances, etc..
3. At low pH, the sorption of cationic metals decreases, leading to mobility increases.
4. The pH of the cooling water can also affect the nature of the oxidation by-products formed. The lower the pH of the effluent the lower will be the formation of THMs.
5. Fish are capable of avoiding acidic discharge plumes from desalination plant, less mobile organisms such as star fish, mollusks, horse fish, etc. will be directly affected by acid blow-down.

<u>Conclusion</u>: The extremely large carbonate buffering capacity of seawater will minimize the impact of acids on the environment and renders them negligible.

Fate and Environmental Impacts of Polyphosphates Anti-Scalants

- When present with other nutrients, phosphate causes an over abundant growth of algae that are unusual or non-indigenous to the area.

Fate and Environmental Impacts of Polymeric Anti-scalants

- Compared to a daily discharge of 62.00 Ton of residual polymeric anti-scalants in the near shores of Arabian Gulf, the daily discharge of 12.7 Ton of the polymeric anti-scalants in the Mediterranean is relatively small.
- After many years of practice, desalination officials deduced that discharged levels of polymer anti-scalants are way below the concentration levels that might cause any acute or chronic toxicity to marine organisms.
- polymeric anti-scalants were observed to be resistant to biodegradation and would have a half lifetime longer than one month. Based on these facts, polymeric anti-scalants, like humic substances, are likely to complex with metals by chelating and preventing them from precipitating and leading to increase in their mobility.

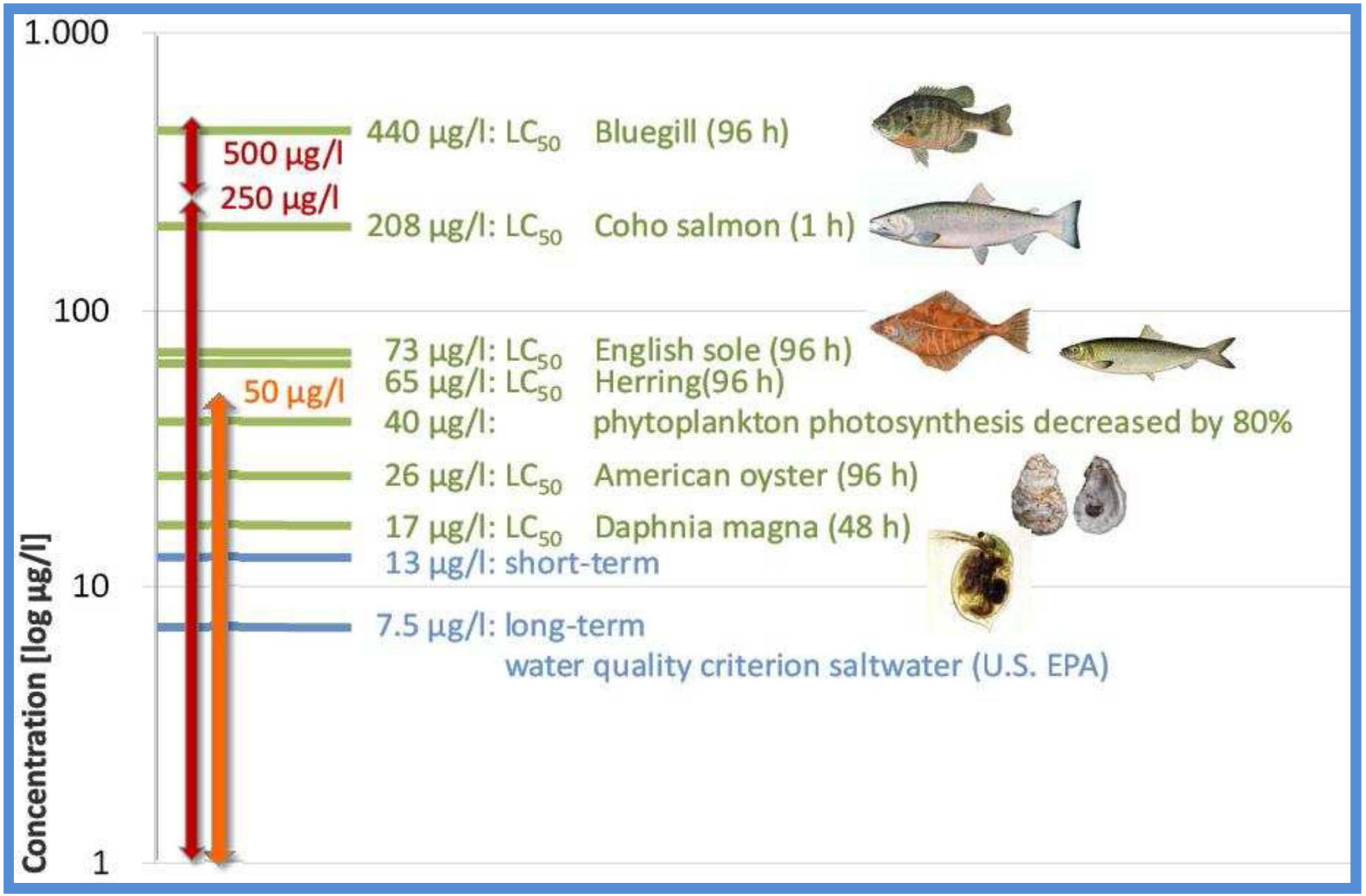
Fate and Environmental Impacts of Trace Metals in Desalination Brine Reject

- Some scientists are treating the low levels of trace metals discharged into the marine environment with brine reject as insignificant and don't pose any significant harm to the marine environment.
- Eclipsing heavy metals releases from desalination plants through dilution of brine reject with cooling waters doesn't change the fact that heavy metals are reaching, accumulating and permanently residing in different compartments of the marine environment.
- As long lasting pollutants, metals will last in different compartments of the marine environment forever. However, their ultimate sink is the marine sediment. The level of metals reflects the general status of the environment but it doesn’t necessarily reflect the bioavailability or toxicity of these metals.

Fate and Environmental Impacts of Residual Chlorine in Desalination Brine Reject

- Chlorine is proven to be very toxic at concentrations of a few micrograms only. The photosynthesis process of plankton can be seriously reduced at concentrations of only 20 µg/l. At levels of 50 µg/l the composition of marine organisms can change and their variety is reduced. The known lethal values for fish species range between 20 and several hundred µg/l.

Fate and Environmental Impacts of Residual Chlorine in Desalination Brine Reject



Chlorine toxicity levels for a range of marine species

Source: Höpner, et al., (2008)

Fate and Environmental Impacts of THMS in the Near-Shore Marine Environment

- Bromoform does not adsorb onto sediments to any great extent.
- Volatilization (followed by oxidation) is the major fate process for the removal of bromoform from the aquatic environment. On the other hand, biodegradation is slow but has a significant effect on the removal of bromoform
- Bioaccumulation potential of the THMs appears to be low, compared to many other chlorinated organic compounds.

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Thank you for your attention

Merci pour votre attention

For additional information please contact:
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