Application of Feedback EMMP Approaches to the Management of Dredging Activities in Sensitive Temperate and Tropical Coastal Environments

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Origins of (Adaptive) Feedback EMMP

ØRESUNDSBRON®

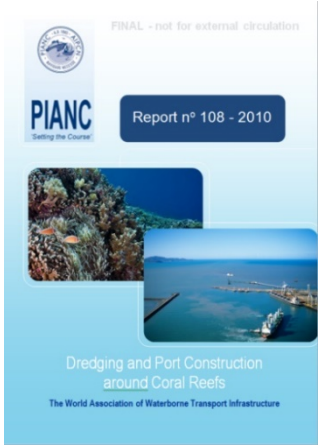
Singaporean / Malaysian Port Developments

Images

http://www.seanews.com.tr/malaysia-s-port-of-tanjung-pelepas-sets-aside-funds-for-more-cranes-in-2016/157017/
http://ifonlysingaporeans.blogspot.com/2015/06/pasir-panjang-terminals-35b-expansion.html
https://archerrecruitment.com/news/we-are-not-done-building-singapore-yet-lawrence-wong
https://sgx.i3investor.com/blogs/singaporestockmarketnews/16764.jsp

Feedback (Adaptive) EMMP Credentials

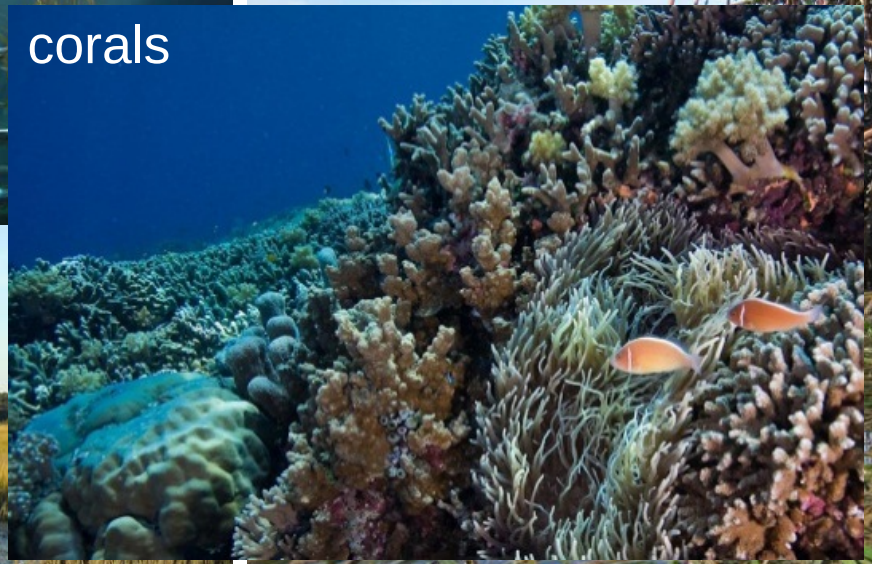
- Approach endorsed / recognized by
  - WODCON XVIII (2007) (Best Practice)
  - UNEP, and
  - IFC's Environmental, Health, and Safety Guidelines for Ports, Harbors, and Terminals www.ifc.org/ehsguidelines



Applied in:

- Denmark
- Sweden
- Germany
- Indonesia
- Singapore
- Malaysia
- Brunei
- Australia
- New Zealand
- …

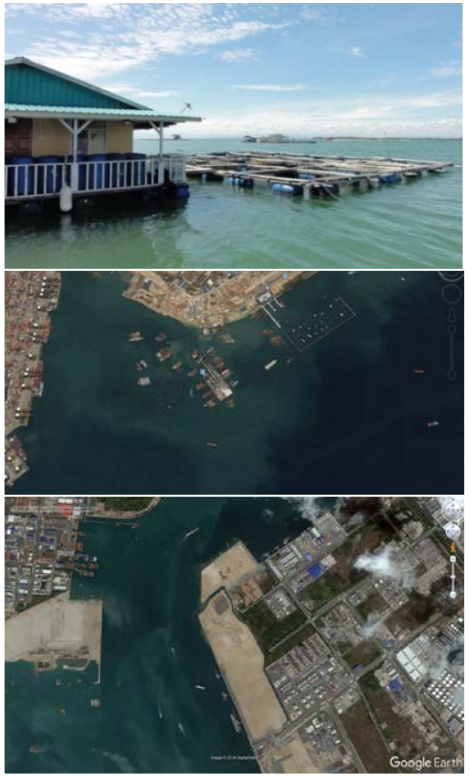
Sediment Plume Related Environmental Impacts



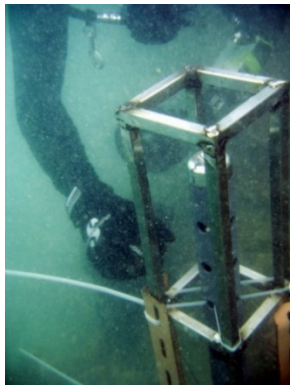
Sediment Plume Related Environmental Impacts

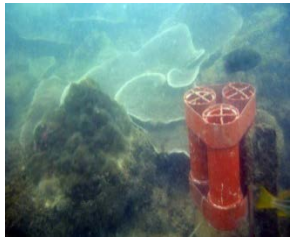
Suspended sediments and sedimentation also cause socio-economic Impacts such as:

- loss of fisheries - natural fisheries and aquaculture operations
- loss of operational efficiency and higher operational maintenance cost to powerplants and process water installations
- increased maintenance costs for port and harbours due to incremental sedimentation in channels and at berths
- impacts to recreational experiences and facilities, i.e. with corresponding economic losses to hotels and marinas, due to aesthetic changes in water quality, and in some rare cases…
- impacts to international relations arising from sediment plume / sedimentation intrusion across international borders.



Traditional Sediment Plume Environmental Monitoring and Management Plans (EMMPs)





- A traditional sediment plume management program would typically include:
  - Static (i.e. fixed location) monitoring of turbidity
    - Typically at receptors predicted to be impacted according to the EIA
  - Static (i.e. fixed location) monitoring of habitats
    - Typically at receptors predicted to be impacted according to the EIA
  - Periodic Monitoring of water quality
    - Typically close to the work area / prescribed distance from activities
- Typical management criteria would be worded as:
  - *Concentration 200m from the dredger shall not exceed 100mg/l*
  - *Reduction in live coral cover / eelgrass biomass shall not exceed 5%*

Traditional EMMPs: Why They Don’t Work

- In general, the traditional approach tends to falter because it fails to recognize a number of key pieces of the puzzle, e.g.:
  - the importance between background vs. incremental TSS
  - spatial variability of sediment plumes and sedimentation
  - the linkage between operations and impact – or change in operation and mitigation
  - response lag-times associated with habitat monitoring
  - the tools and ‘language’ needed to communicate with the Contractor generating the ‘sources’
  - inability to differentiate between sources within a work area or between one work area and another

Feedback EMMPs

a ‘Feedback EMMP’:

- Speaks the language of a contractor
- Recognizes the spatial and temporal variability of sediment plumes and sedimentation
- Isolates TSS / Sedimentation source contributions
- applies receptor specific tolerance limits based upon magnitude duration loading
- Addresses response lag-times
- Allows for a transparent (incl. stakeholders) proactive management process
- Provides comprehensive accounting of daily impact

Feedback EMMP Includes All Pieces of the Puzzle

Traditional "Reactive" EMMP

Fixed receptor monitoring stations (Physical and biological parameters)

+

Trigger Limits

+

Respond when Trigger is Exceeded

Proactive "Feedback" EMMP

All the features of Traditional EMMP

+

Spill Budget

+

Hindcast Modelling / Dedicated Trigger Limits

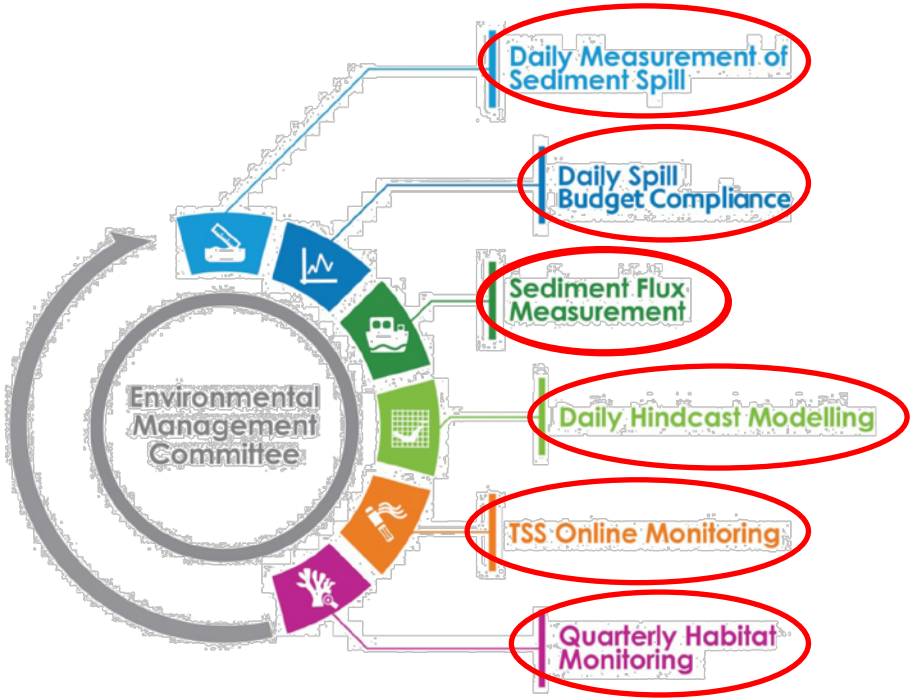
+

Feedback

(Updating of spill control limits based on receptor monitoring)

Feedback EMMP: Four Tiered Levels of Control

- Provides 4 feedback tiers of Control
  1. Spill Budget compliance
  2. Receptor (EQOs) compliance
  3. Real-time Monitoring to provide, validate or correct compliance analyses
  4. Habitat Monitoring to provide feedback on tolerance limits



- The tiers reinforce each other…

Feedback EMMP: Stages

Before Start of Dredging / Reclamation:

- Deploy and calibrate Control Monitoring Instrumentation
- Establish baseline (3-12 months)
- Identify receptors (key species) for monitoring
- Establish tolerance / alert limits and EQOs
- Calibrate & validate numerical models
- Assess impact of work plan (update of EIA) and determine draft spill budget based on contractors actual plan and equipment
- If non-compliant update overall work plan and finalize spill budget for start of works

Mobilization / EMMP Specifications

During Dredging / Reclamation (Control):

- Daily spill monitoring and control against spill budget
- Daily hindcast modelling to document spatial extent of realized spill and control against EQO's at each receptor
- Realtime / periodic control monitoring (alert limits)
- Identify mitigating actions, if required
- Review and update spill budget

Daily

Monthly/Quarterly

After Completion of Dredging / Reclamation:

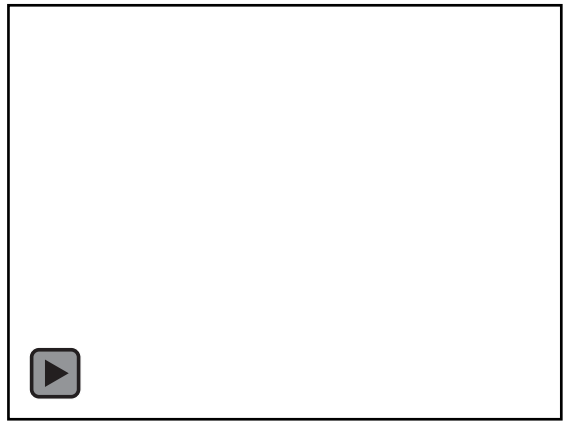
- Control monitoring continues for 3 – 6 month post-construction period
- Environmental Audit prepared to compare impacts to EIA

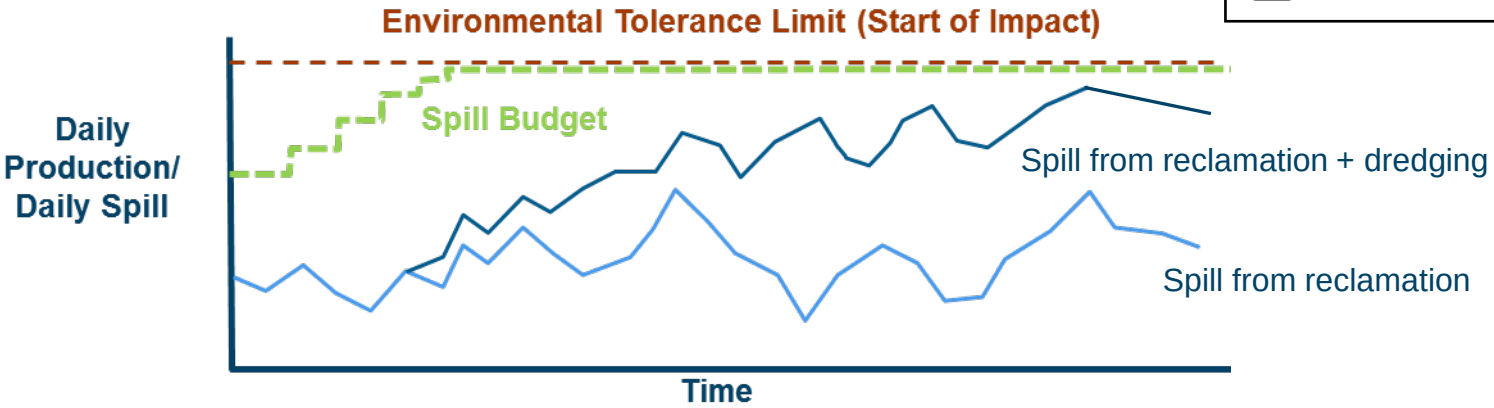
Post Project Audit

Feedback EMMP: Before the Start of Dredging / Reclamation

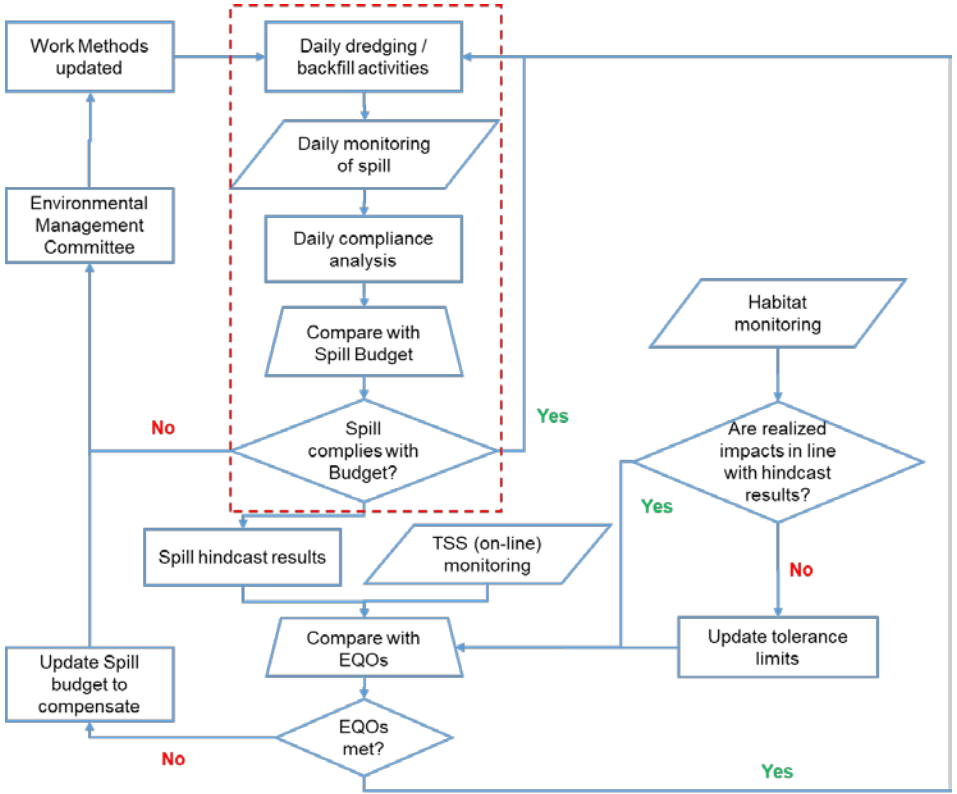
Spill = Portion of (fine) sediments that are released or mobilized at source from dredge or reclamation activities

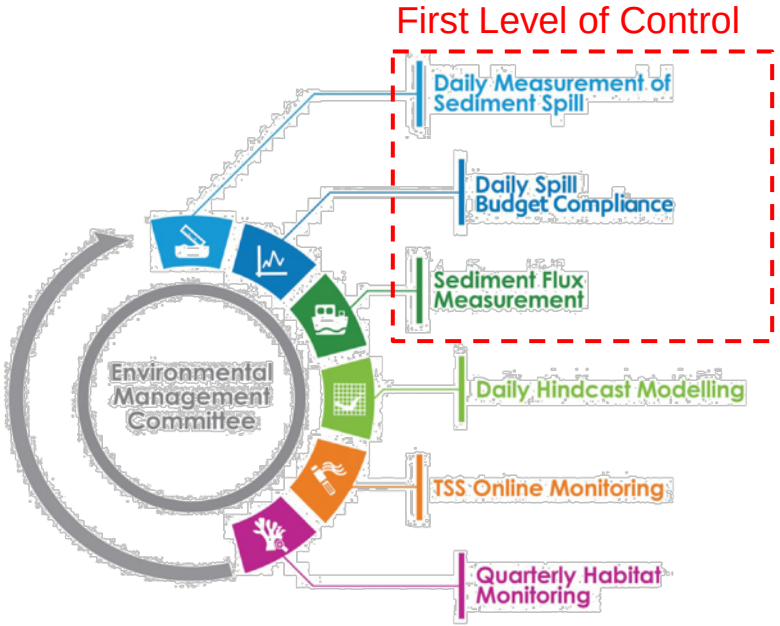
Spill Budget = Maximum amount of sediment spill (fine sediments) that can be released in the waters but still meet the EQOs for the project





Feedback EMMP: First Level of Control - Spill Budget

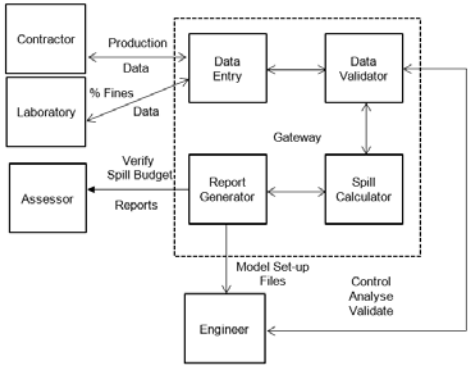


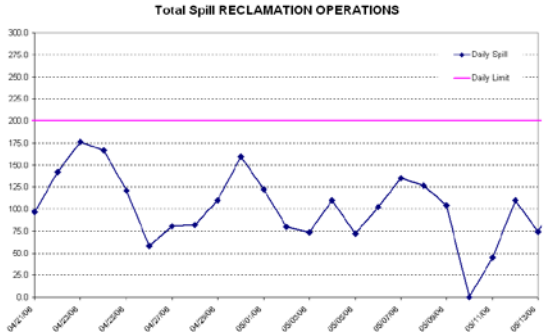


Feedback EMMP: Spill Budget Compliance

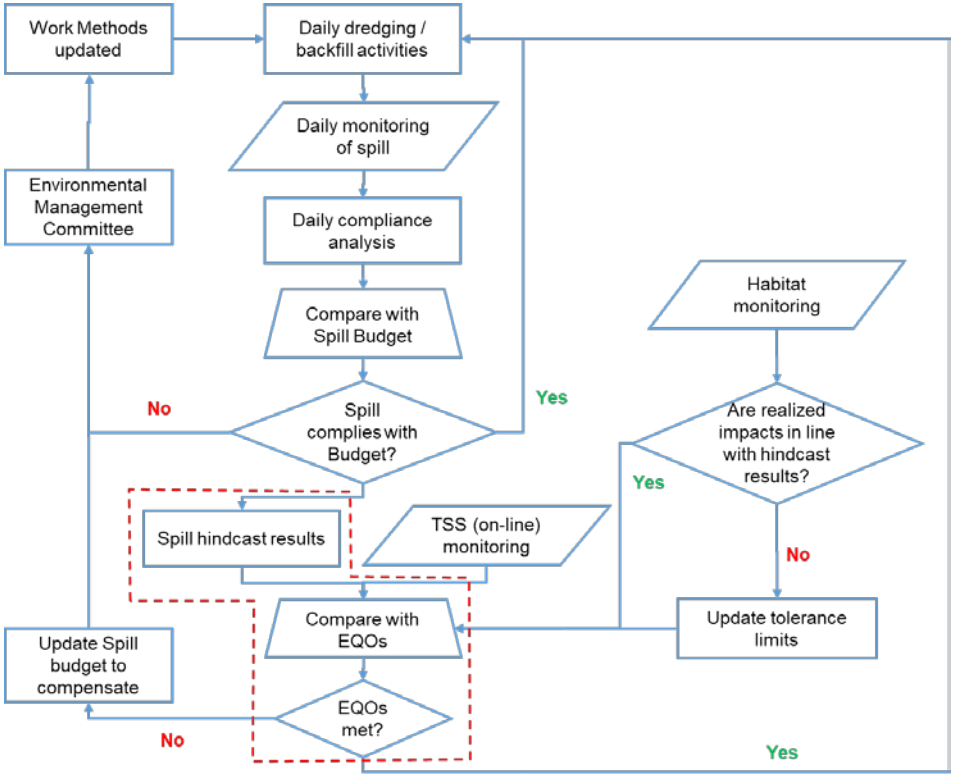
- Daily sediment samples and work activity information is collected from the dredge contractor
  - This information undergoes / is used:
    - laboratory analyzes
    - to calculate actual daily sediment spill
- These results are used to determine Spill Budget compliance and generate a daily compliance report

- Input also used for hindcast TSS and sedimentation modelling (2nd Tier)

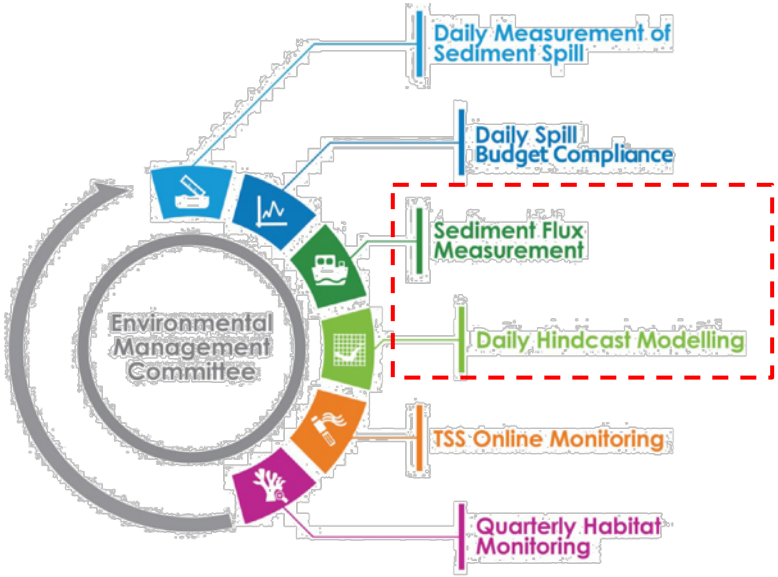




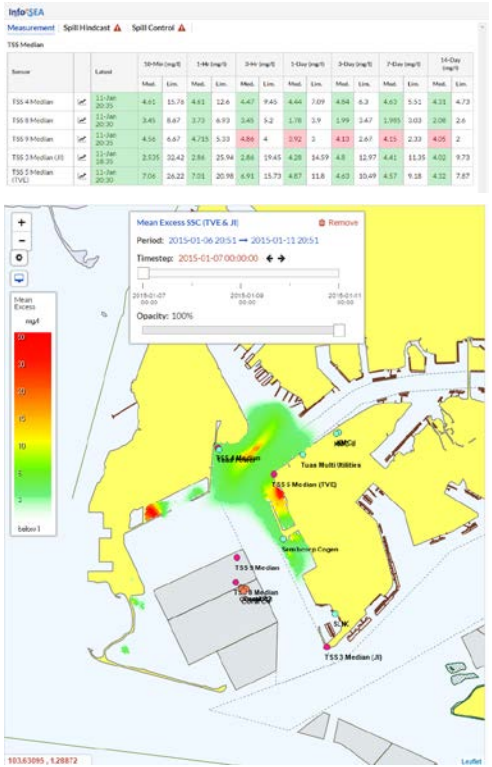
Feedback EMMP: Second Level of Control – Receptor Compiance



Second Level of Control

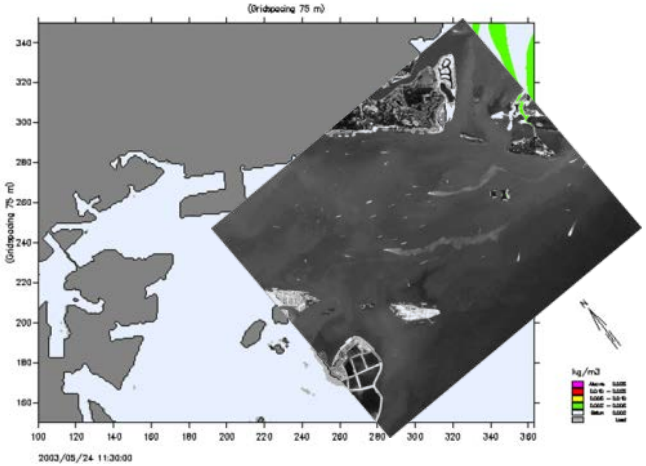


Feedback EMMP: Second Level of Control – Receptor Compliance



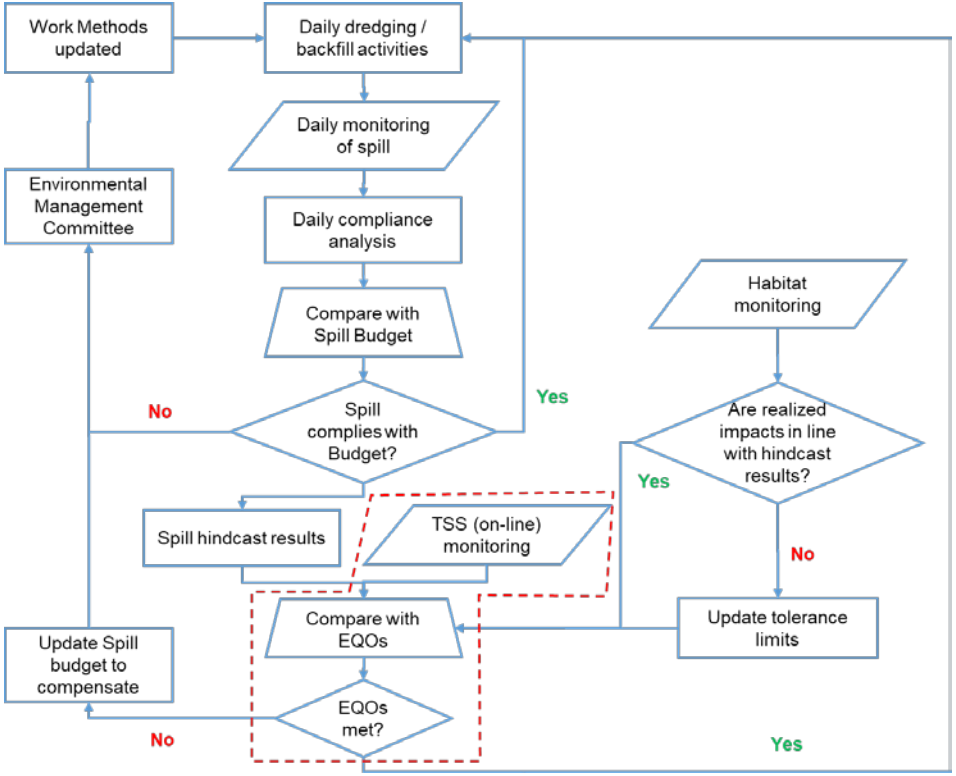
Hindcast modelling is a critical component for the Feedback EMMP

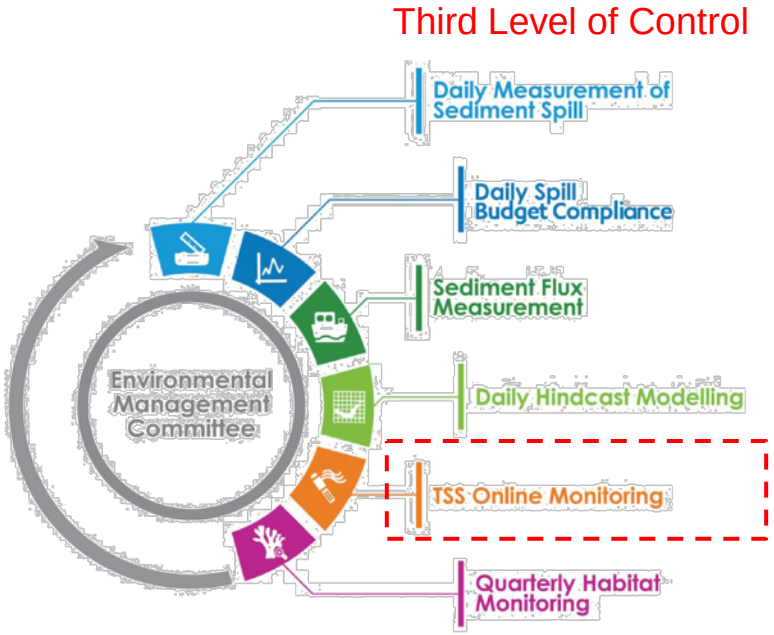
- measured spill of fine sediments from every dredging trip is simulated using the numerical model
- model results are compared against the receptor locations and site specific tolerance limits on a daily basis



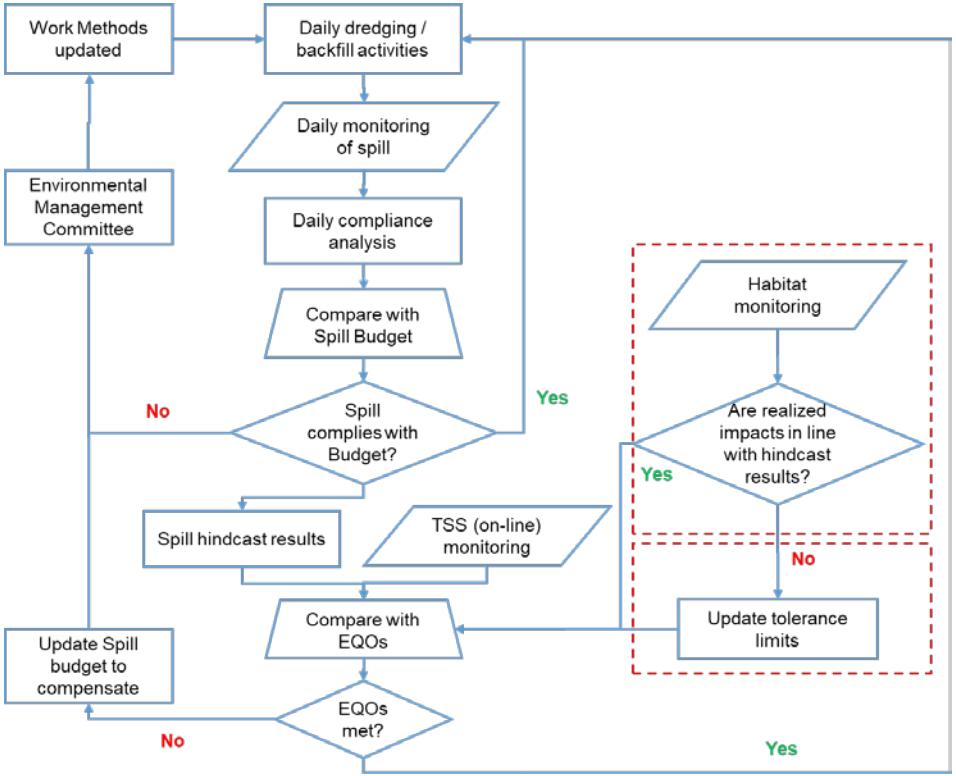
- this highlights potential impacts to any of the receptors before they occur, allowing proactive management measures

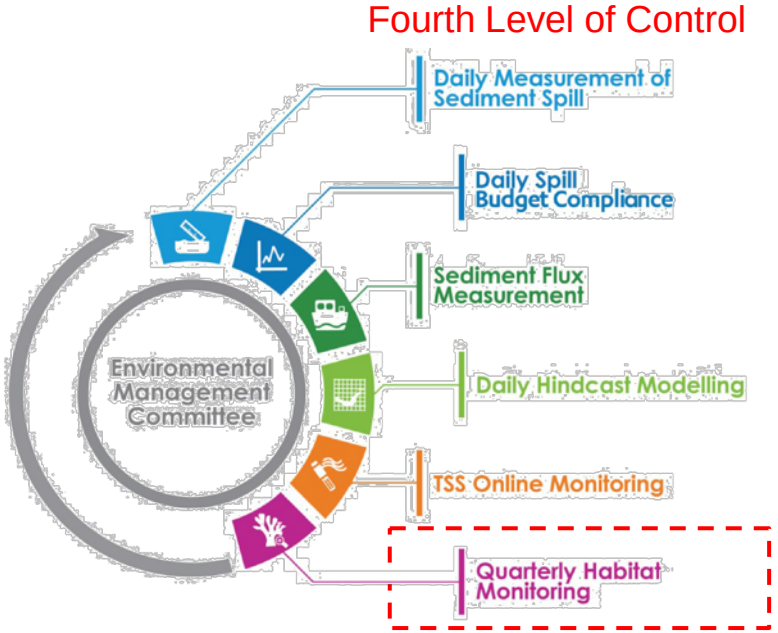
Feedback EMMP: Third Level of Control - Real Time Monitoring





Feedback EMMP: Update Tolerance Limits and Spill Budget





Feedback EMMP: Non-Compliance Loop

Possible Mitigation Responses

- Stop works – In extreme cases – but mechanism (spill budget) available to justify re-commencement
- Slow the dredging operations (reduce spill budget)
- Use of tidal windows, reduction in production
  - Dredging / reclamation operations during flood or ebb tides
  - Dredging / reclamation operations during spring or neap tides
  - Dredging / reclamation operations during day and night time
- Change in dredge location (if possible)
  - Migratory, spawning / breeding seasons
- Deploy mitigation measures (e.g. silt screens) that are assessed (quantifiably) to address the issue

Feedback EMMP: The Take away

- The **Feedback EMMP** is a proactive adaptive management approach
- It is highly flexible, allowing for changes in dredging equipment, timing, duration, etc.
- It allows for segregation of impacts from different components of the work, from adjacent projects and from natural events
- Traditional monitoring of turbidity, sensitive habitat health and water quality are still integral, but the data collection can be targeted at the right (and less) locations and is used to validate and / or update the Spill Budget and tolerance limits and less as direct operational triggers for environmental management

Feedback EMMP: The Take Away

- Because of the level of documentation [What has been spilled and where it has gone] Feedback EMMP significantly reduces developer (or Contractor depending on contract mechanism] environmental liability
- Allows changes in boundary conditions to be taken into account via adjustments to tolerance limits and thereby spill budgets
- It allows a fully tiered response as you know what specific aspects of the work are causing the ‘problem’ and you can document that the response will be effective before you implement
- In general Feedback EMMP is no more expensive that traditional approaches as less sensors and less academic biological monitoring compensating for the cost of increased level of control afforded by the spill budget and hindcast controls

Thank you

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