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

Norfolk, VA – June 2018

Tom Foster – President & Regional Director Americas Josh van Berkel – Director of Environmental Projects



Origins of (Adaptive) Feedback EMMP



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.l3investor.com/blogs/singaporestockmarketnews/16764_jsp

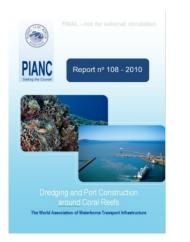


Feedback (Adaptive) EMMP Credentials

- 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

Of er monit and in responses the s comp and i upon reda provi mark

Speci meth with Such Tuin





STRACT	into account specific habitat tolerance limits for varying magnitudes and durations of	Regional Director Southeast Asia, DHI Water & Environment (S) Pte Ltd to this research.
tional methods for environmental	for varying magnitudes and durations of sediment ination. Extinements to sediment	S Environment corrected to this research. This namer was first presented at WODCON
	sedment loading. Retinements to sedment okime models were undertaken to enhance	This paper was first presented at WODCON XVIII in tune 2007 and was published in the
agement of marine reclamation works		
to sensitive habitats have generally	their ability to hindcast impacts from the	conference Proceedings. It is reprinted here
provided the level of control necessary	contractors' complex reclamation schedules.	in a slightly revised version with permission.
noure preservation of these habitats.	Methods for segregation of impacts and	
aning the level of control necessary to	assessment of cumulative impacts were also	
re authorities and non-governmental	integrated into the hindcast procedures.	INTRODUCTION
nisations (NGOs) of compliance with	Finally, the article describes the updating	
conmental quality objectives, requires	of tolerance limits and confirmation of spill	The tropical waters in Singapore provide
tifuble compliance tarpets covering	budgets via targetied habitat monitoring.	excellent conditions for marine life, owing
iple temporal and spatial scales.		to relatively constant tropical water
	To date, the EMMPs have been able to	temperatures and frequent frish ocean
gual importance to allow feedback of	document compliance of the works to all	through flow from both the South China
itoring results into compliance targets	pre-project environmental quality objectives	Sea and Melaka Straits. Coral, seagrass and
work methods are effective and careid	at a level of reliability that cannot be reluted	mannerse habitats have been found to be
onse mechanisms. This article describes	by third parties. This has minimized the	relatively rich in Singapore. The diversity of
accessful implementation of	developers' and contractors' extoduce to	the coral habitats in Singapore is confirmed
prohensive Environmental Monitoring	public controlaints and Exhibities associated	by the fact that of the 105 coral general
Management Plans (EMMP), based	with an imparted imparts. The D.M.th.	existing world wide (Varon et al. 2000).
such feedback principles, which allow	have then advaced the sectionation activities.	55 genera are documented in Singapore
mation activities to proceed in close	to proceed in an efficient manner, whilst	waters alone (fun et al. 2008), compared
inity to Singapore's most important	ensuring protection of the environment.	to 12 genera found in the Caribbean.
ne habitats under third party scruting	making protote of the elastimeter.	For seatrast habitats, 12 species out of \$7
us umuna more care barly strend.	The author withes to acknowledge the	known species are found in Singapore
If c focus is placed on describing the	important contributions of Thomas M. Fosture	Warott et al. 2008, whereas 24 out of
hock utilized to quantify compliance	informational or more an include	54 true and minor manetus stacket have
daily spill budget targets and how	Abox. For constant and added to deal instat.	been fixed in Sensapore to far (Thomirson
daily spill budget targets and how targets and compliances are appended.	Abox, For core test and subject to device teget, core researcher is underlagen over to the dart of	been tound in singapore to far chomericon. 1999). These numbers document the high
targets and compliances are assessed. Inprove reliability the spill budgets take	cora resulton s undertaien prior to the start of reclaracions works.	1999). These numbers document the high divergity of marine habitats in a relatively
reprove resubility, the spill budgets take	ACATACIAN MORE	dwersity of manne habitats in a reubwery

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 socioeconomic 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...



Monthly/Quarterly Daily

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

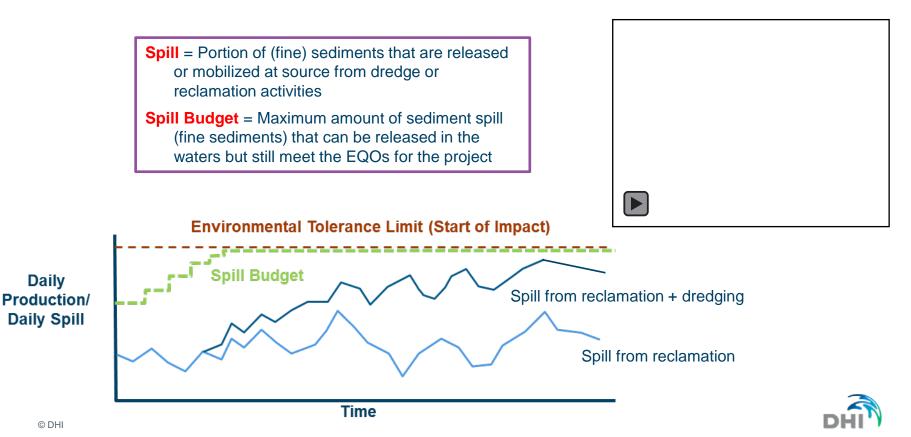
After Completion of Dredging / Reclamation:

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

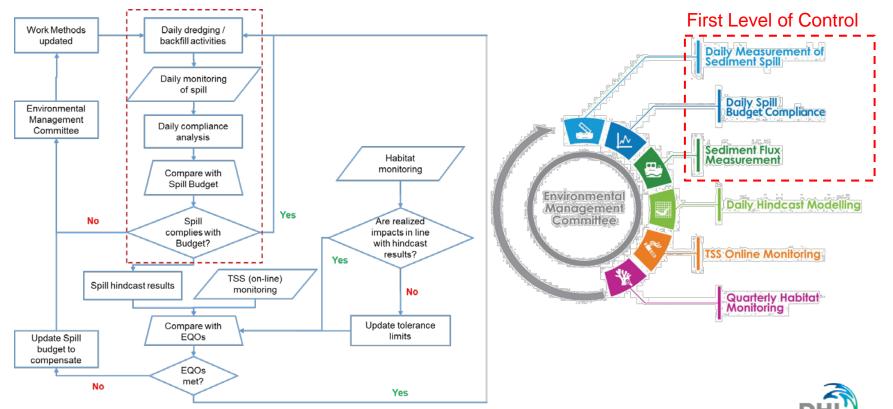
Post Project Audit



Feedback EMMP: Before the Start of Dredging / Reclamation



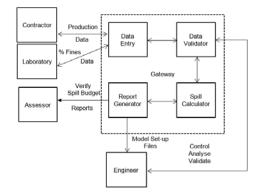
Feedback EMMP: First Level of Control - Spill Budget



Feedback EMMP: Spill Budget Compliance

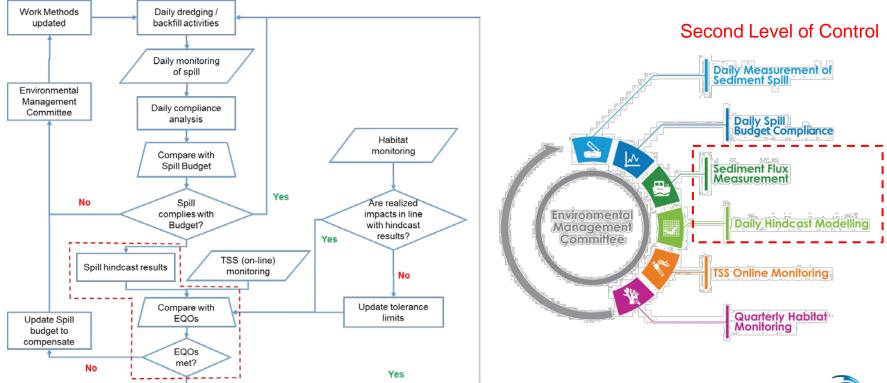
- Daily sediment samples and work activity information is collected from the dredge contractor
 - This information undergoes / is used:
 - laboratory analyzes
 - to calculate actual daily sediment spill
- These results are used to determine Spill Budget compliance and generate a daily compliance report

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



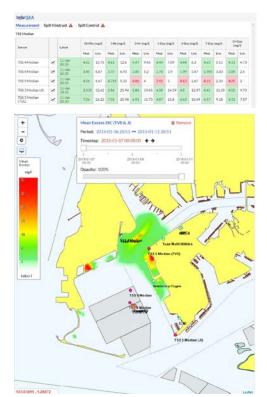


Feedback EMMP: Second Level of Control – Receptor Compiance



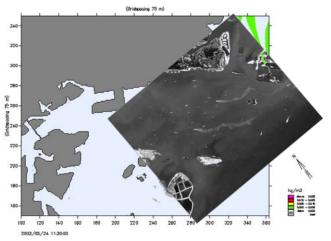


Feedback EMMP: Second Level of Control – Receptor Compliance



Hindcast modelling is a critical component for the Feedback EMMP

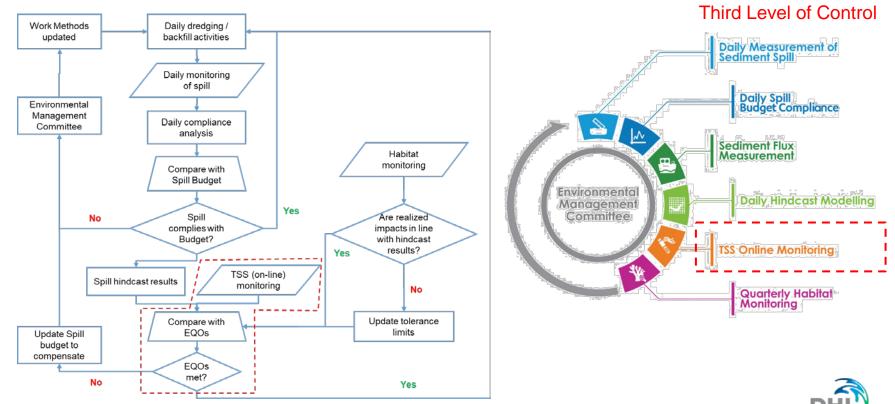
- measured spill of fine sediments from every dredging trip is simulated using the numerical model
- model results are compared against the receptor locations and site specific tolerance limits on a daily basis



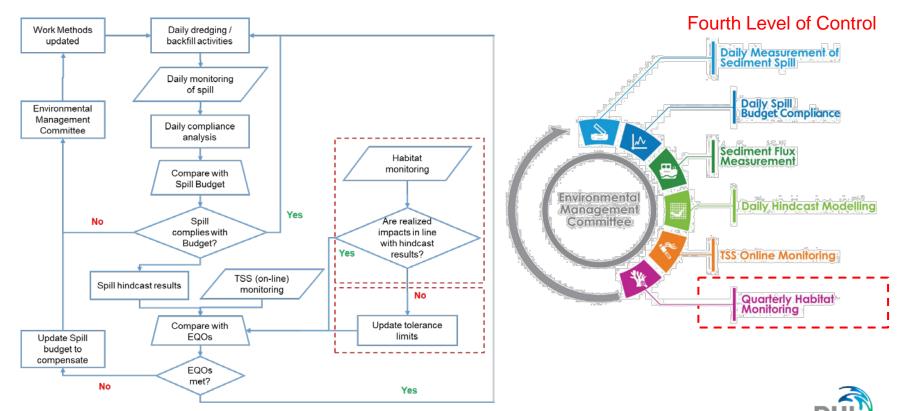
 this highlights potential impacts to any of the receptors before they occur, allowing proactive management measures



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 recommencement
- 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

For further information please contact:

Tom Foster – <u>tmf@dhigroup.com</u> Josh van Berkel – <u>jvb@dhigroup.com</u>

Alternative Practitioner:

Tan Cheng Ann - ChengAnn.Tan@advisian.com

