

# The Sediment Management Framework app – an open access viewer of contaminant data to support national decision making

Claire Mason, Kirsty Clarke & Richard Heal



# Introduction

- National policy development
- Drivers for development of the Sediment Management framework app

Claire Mason – Principal Investigator for the Action Levels Review Project

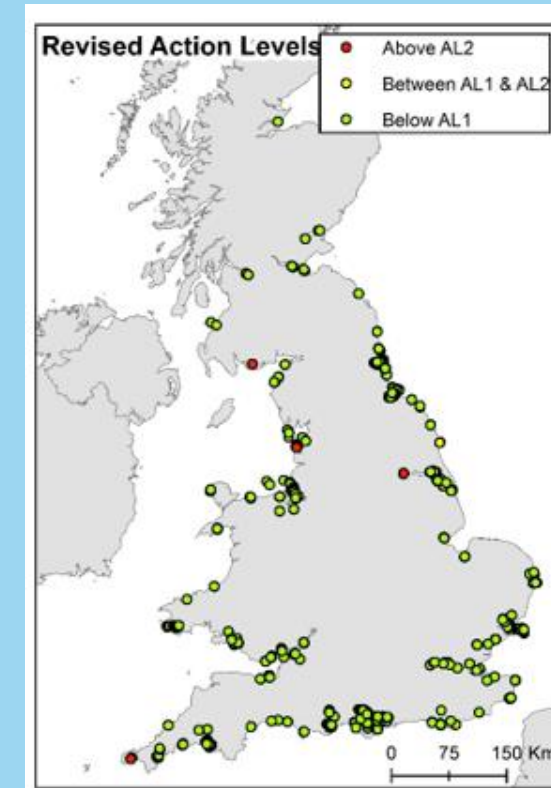
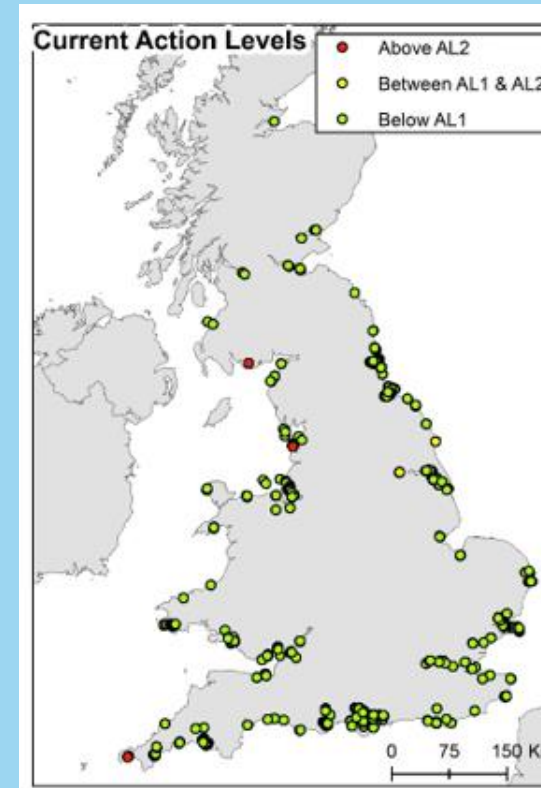


# Background

## Review of Action Levels used for assessing dredging and disposal marine licences - ME5226

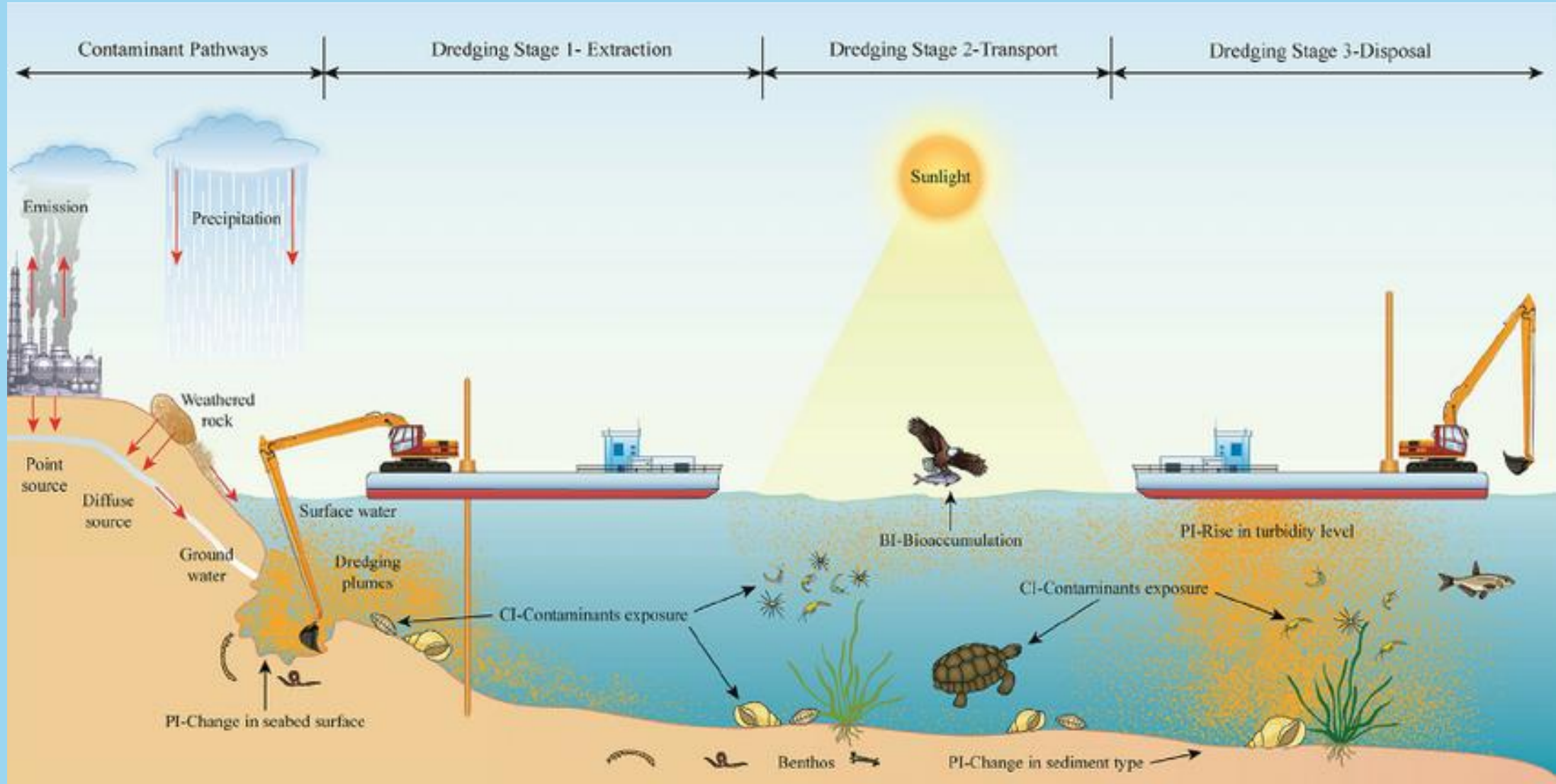
Claire Mason  
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Mason, C.; Vivian, C.; Griffith, A.; Warford, L.; Hynes, C.; Barber, J.; Sheahan, D.; Bersuder, P.; Bakir, A.; Lonsdale, J.-A. Reviewing the UK's Action Levels for the Management of Dredged Material. *Geosciences* 2022, 12, 3.  
<https://doi.org/10.3390/geosciences12010003>

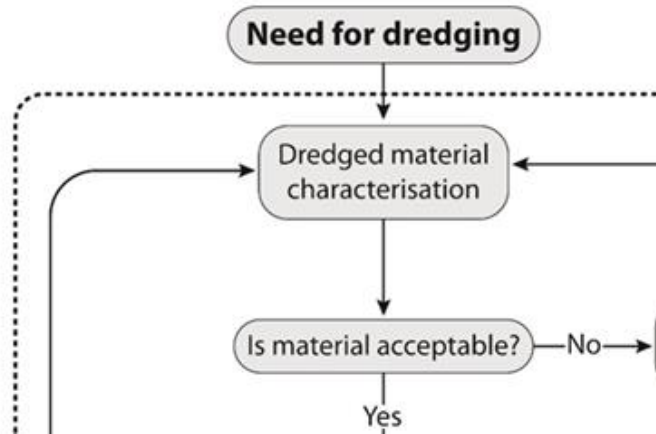
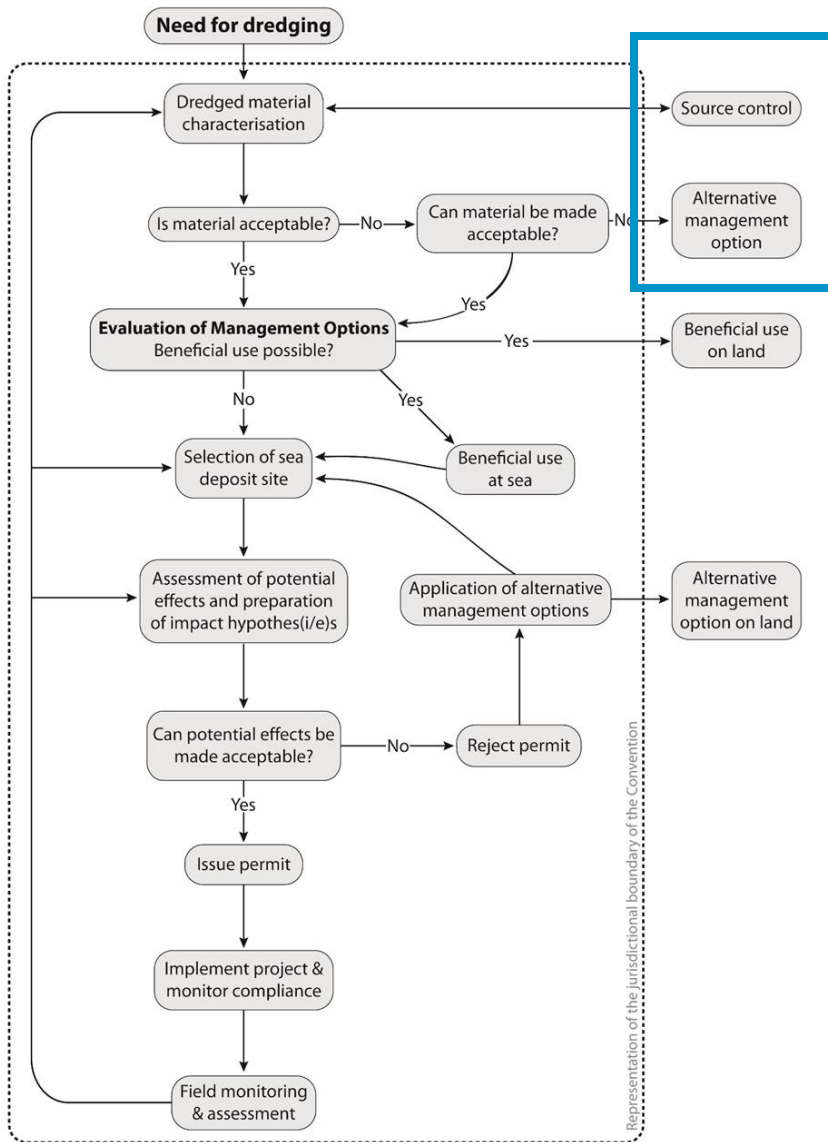


*Tributyltin TBT*

# Introduction



# OSPAR Guidelines for the Management of Dredged Material at Sea (Agreement 2014-06) – Updated 2024



## International Requirement

the UK is signatory to both the **London Convention/ London Protocol** and **Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR)**

These aim to prevent marine pollution from human activities like disposal of dredge material.

The UK reports annually to the OSPAR and London Convention/ London Protocol Secretariats

- volume of material disposed of to each designated disposal site
- the contaminant loading (based on the concentration of contaminants in samples and tonnages disposed).

These figures then feed into international assessments regarding the amount of contamination potentially being released into the marine environment based on the UK's national action levels.

Requirement to review action levels regularly

<b>ACTION LEVELS</b>		
<b>Contaminant / Compound</b>	<b>Action Level 1</b>	<b>Action Level 2</b>
	<b>mg/kg Dry Weight (ppm)</b>	
<b>As</b>	<b>20</b>	<b>100</b>
<b>Hg</b>	<b>0.3</b>	<b>3</b>
<b>Cd</b>	<b>0.4</b>	<b>5</b>
<b>Cr</b>	<b>40</b>	<b>400</b>
<b>Cu</b>	<b>40</b>	<b>400</b>
<b>Ni</b>	<b>20</b>	<b>200</b>
<b>Pb</b>	<b>50</b>	<b>500</b>
<b>Zn</b>	<b>130</b>	<b>800</b>
<b>Organotins; TBT DBT MBT</b>	<b>0.1</b>	<b>1</b>
<b>PCB's, sum of ICES 7</b>	<b>0.01</b>	<b>none</b>
<b>PCB's, sum of 25 congeners</b>	<b>0.02</b>	<b>0.2</b>
<b>*DDT</b>	<b>*0.001</b>	
<b>*Dieldrin</b>	<b>*0.005</b>	
	<b>*these levels were set in 1994</b>	

# Data

Dredge sample data collated from:

England (CEFAS holdings plus public register)

Scotland (sent from MSLOT)

Wales (Cefas holdings)

NI, IoM, Jersey, Guernsey, no compatible data

Substantive existing dataset from 1998 to 2015

Data added from 2015 to 2018

All data reviewed for accuracy (coordinates, wrong units etc)

All LOD entered as the detection limit

Total of 7026 records from 1998 to 2018

84 different determinands

Decision to restrict data to 2009-2018

to make sure any differences noted are relevant now

The ten year period covered at least 2 cycles for ongoing maintenance licences:

Trace metals ~2720 samples

Organotins ~2140 samples

Polycyclic Aromatic Hydrocarbons (PAHs) ~1852 samples

Polychlorinated biphenyls (PCBs) ~1000 samples

Organochlorine Pesticides (OCPs) ~ 450 samples

Polybrominated diphenyl ethers (PBDEs) ~141 samples



# Proposed Action Levels

Contaminant	Units (dry weight)	Current Action Level 1	Proposed Action Level 1	Current Action Level 2	Proposed Action Level 2
<b>Trace Metals:</b>					
Arsenic (As)	ppm	20	20	100	70
Cadmium (Cd)	ppm	0.4	0.4	5	4
Chromium (Cr)	ppm	40	50	400	370
Copper (Cu)	ppm	40	30	400	300
Mercury (Hg)	ppm	0.3	0.25	3	1.5
Nickel (Ni)	ppm	20	30	200	150
Lead (Pb)	ppm	50	50	500	400
Zinc (Zn)	ppm	130	130	800	600
Organotins: TBT, DBT	ppm	0.1	0.1	1	0.5

Following Action Levels Review, follow up work has included:

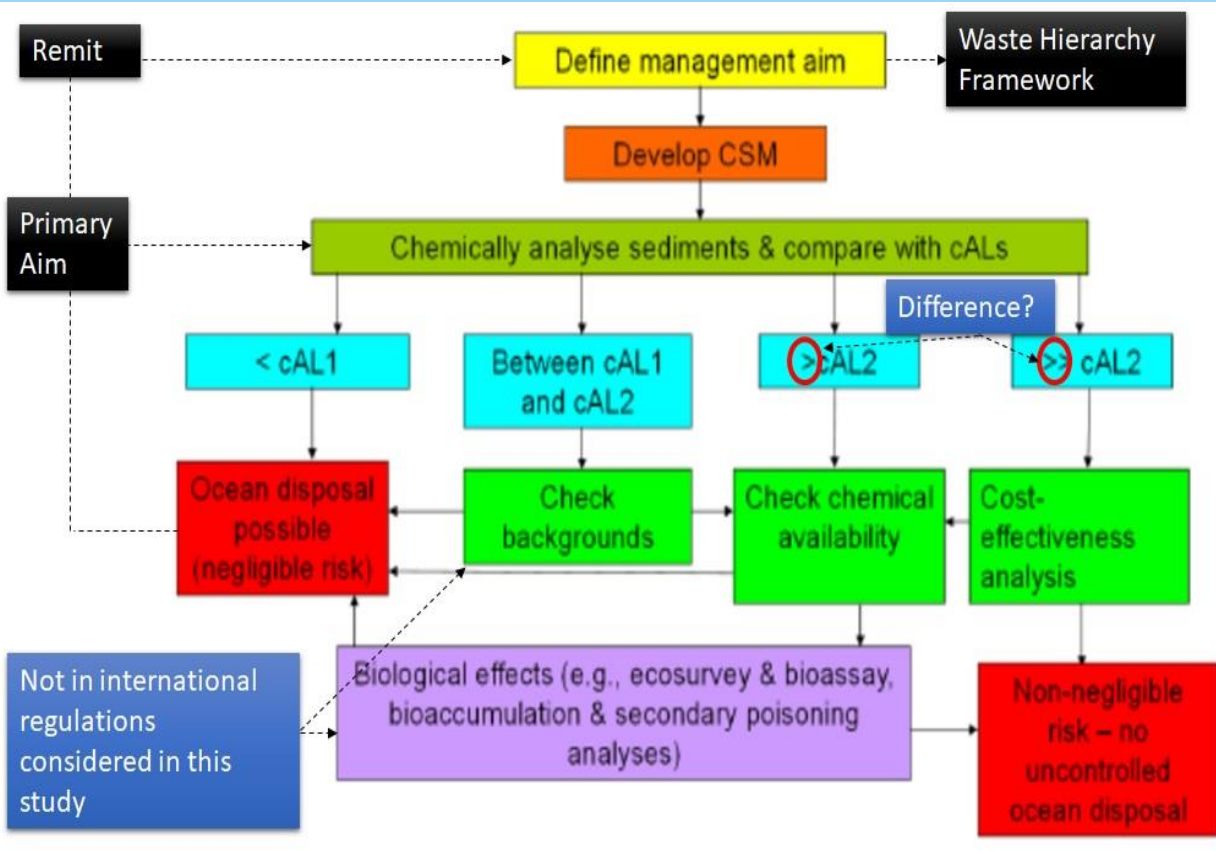
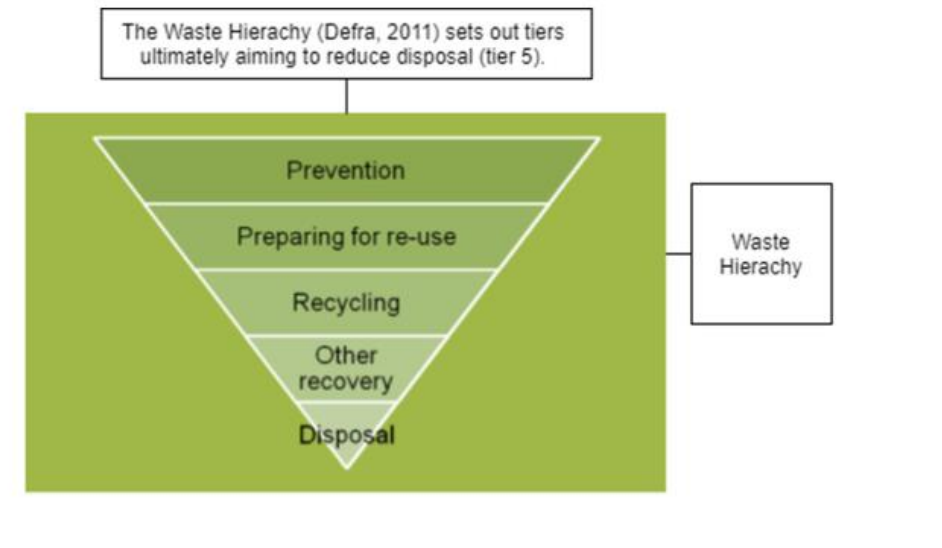
- Economic assessment
- **Development of a Framework tool**

Additional elements to consider:

- Integration of sediment and water assessments
- Use of ecotox testing
- Open-loop scrubbers
- Disposal site data collation
- Review options for dredge material

Contaminant	Units (dry weight)	Current Action Level 1	Proposed Action Level 1	Current Action Level 2	Proposed Action Level 2
<b>Polycyclic aromatic hydrocarbons (PAHs):</b>					
PAHs_THC	ppm	(100)	-	-	-
PAHs_LMW	ppb	-	552	-	3160
PAHs_HMW	ppb	-	1700	-	9600
<b>Polychlorinated biphenyls (PCBs):</b>					
Σ25_PCBs	ppb	20	20	200	180
ΣICES7_PCBs	ppb	10	10	-	90
PCB28	ppb	-	0.6	-	1.7
PCB52	ppb	-	0.9	-	2.7
PCB101	ppb	-	1	-	3
PCB118	ppb	-	0.2	-	0.6
PCB138	ppb	-	2.6	-	7.9
PCB153	ppb	-	13	-	40
PCB180	ppb	-	4	-	12
<b>Organochlorines (OCs):</b>					
DDT	ppb	1	1	-	-
Dieldrin	ppb	5	5	-	-
<b>Poly/brominated diphenyl ethers (PBDEs):</b>					
BDE28	ppb	-	38	-	110
BDE47	ppb	-	33	-	97.5
BDE66	ppb	-	33	-	97.5
BDE85	ppb	-	0.3	-	1
BDE99	ppb	-	0.3	-	1
BDE100	ppb	-	0.3	-	1
BDE153	ppb	-	367	-	1100
BDE154	ppb	-	367	-	1100
BDE183	ppb	-	4666	-	14000
BDE209	ppb	-	16	-	47.5

# Action Level Review workshop 2020: Framework stakeholder discussion



Currently, only one part of a bigger question- is it clean?

When is the material acceptable?

Recommendations for the further development of a hypothetical tiered dredged material assessment framework for the UK (based on **Apitz et al. (2005)** and **MMO (2015)**)  
 CSM = conceptual site model .

Aims to give an indication of what is currently missing and considered for inclusion for a new framework.

Black text boxes and dashed lines are additions to the original framework. Dark blue boxes are questions to consider for the new framework.

# Rationale for Sediment Management Framework application

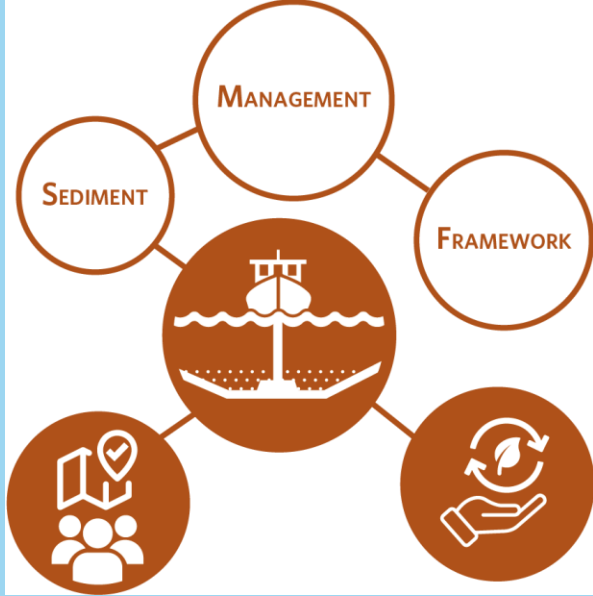
## Overarching aims

- All stakeholders can see the same
- Improve understanding of weight of evidence approach
- Increase sustainable use of dredged material
- Improve linkage between water quality and sediment assessments

## What is not designed to do

- Replace assessment process

# Stakeholder engagement – feedback from December 2021 workshop



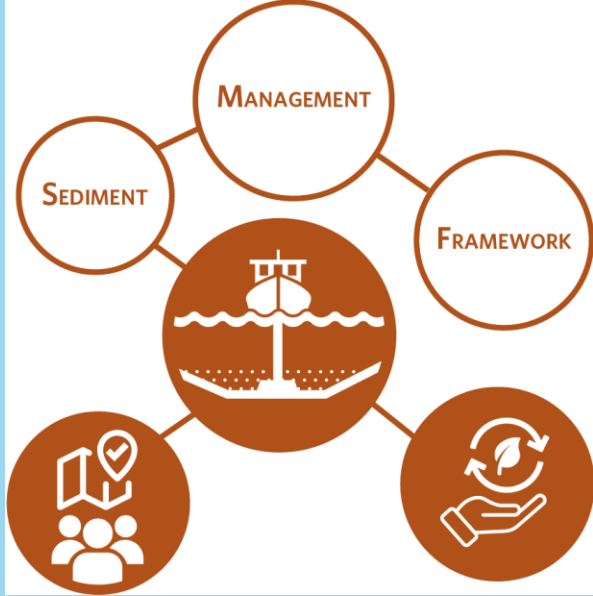
## Immediate ideas/issues to address:

1. Update the time slider to ensure that it is working/updating properly and allows users to change the scale easily for a single determinand.
2. Ensure the base map is visible when zoomed in at local scale
3. Make closed disposal sites selectable with default being that they are not selected.
4. Change the box-whisker plot to a histogram for PSA.
5. Address the data visualisation bugs outlined to check for any issues and sort out a temporary fix to the notation for the AIs where there is only AL1.

## Next steps:

1. Data upload for results as they are submitted for each application (including QA checks).
2. Data export of selected results table.
3. Addition of a header that shows titles for current view (to include parameter, AL type, date range, etc).
4. Long term maintenance plan

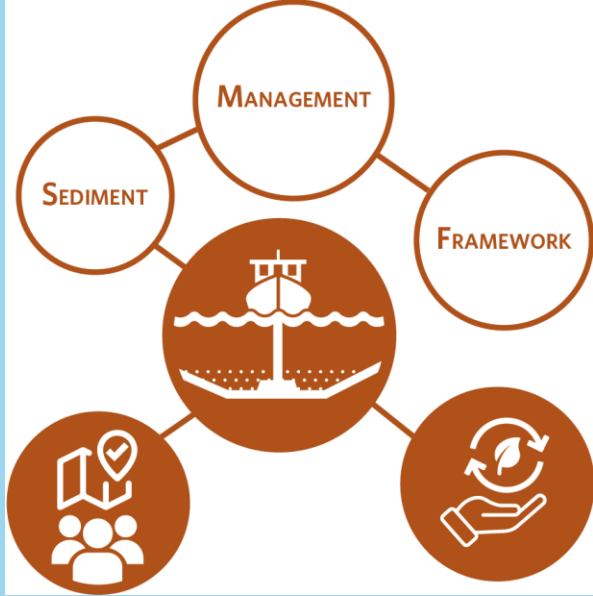
# Stakeholder engagement – feedback from December 2021 workshop



Further potential development including building of new apps where not sensible to include in the Sediment Framework Application that could be developed:

1. Addition of 3D view to visualise depth as well as surface concentrations.
2. Provision of draw polygon feature to set map window.
3. Additional PSA utility (linking with other data sources such as OneBenthic) for detailed PSA results. This would also mean better PS distribution statistics could be presented for example in line with Gradistat (Blott and Pye, 2001).
4. Addition of other parameters, such as organic carbon (which can be used to normalise concentrations), bacteriological risk presented by sediment to bathing and shellfish waters which are WFD protected, contaminants of emerging concern (CECs), plastics, PFOS/PFAS.
5. Licence status. The licence application that the sample data relates is included in the database, but not the timeline that this relates too specifically. This could be added and be selectable so only current licences can be seen for example.
6. An interpretation tool to allow trend analysis of the data could be developed. This would most likely be a different application. This could allow use of an indicator to show rise/fall of concentrations over time.
7. Additional map layers, such as dredge area boundaries, water bodies, nature conservation areas including MPAs, other activities (windfarms, etc) could be added.
8. Disposal site licensing conditions could be added.
9. Water quality background information to help aid understanding of where this may be more of an issue for dredging.
10. Development to allow applicants to share anecdotal experience from previous dredging campaigns and summarise any changes observed.

# Stakeholder engagement – feedback from December 2021 workshop



There are some suggestions for development that are not possible or intended with the current application, based partly on the current database and/or data structure.

For example,

- source of samples including laboratory details and quality assurance – this is sensitive information and is not included in the current database/ dataset. All data present has been quality assessed and all laboratories for England and Wales complete a MMO validation process with confidence limits defined. Recognise that the date given is the sample collection date. The sample analytical date is not currently collected in the database.
- Note there is no plan for external data to be uploaded to the database, and it will only be available locally until formally submitted and QA completed.
- Note the application is for information and evidence only, not to replace any of the current processes in place.

# Waste Hierarchy

The Waste Hierarchy (Defra, 2011) sets out tiers ultimately aiming to reduce disposal (tier 5).



Possible methods that are not considered to generate waste include:  
 - Plough dredging  
 - Water injection dredging (WID)

**Tier 1: Reduce / prevention**  
 Do nothing or reduce as far as possible. For example, use techniques that are not considered to produce a waste

OSPAR categories of Beneficial use  
 - Environmental enhancement\* (includes habitat restoration)  
 - Engineering Uses\* (includes construction and land reclamation),  
 - Agricultural and other products

**Tier 2: Reuse**  
 Using dredged material in a manner that will benefit society and the natural environment  
 Disposal within the sediment cell (which may include many of the current disposal sites (see disposal site categories) is considered as sustainable placement under Tier 2

**Tier 3: Recycle**  
 Creating a new substance or product

**Disposal at sea**  
 Applies to all disposal below MHWS (i.e., also includes beneficial uses such as restoring marshes). Disposal in this sense is related to the category for which the disposal site has been authorised (according to the categories provided by OSPAR). However true 'disposal' is defined as placement of sediment outside of the local sediment cell **and** where it is not considered to benefit society and natural environment.

**Tier 4: Other recovery**  
 Generally not considered applicable to dredge material

**Tier 5: Disposal**

Landfill — Disposal to land

# Next steps

- OneBenthic for sediment grain size - [https://rconnect.cefas.co.uk/onebenthic\\_portal/](https://rconnect.cefas.co.uk/onebenthic_portal/)



- Sediment Reuse – supporting Dredge Sediment Resource Data Platform – being developed by ABPmer for the UK Beneficial Working Group (BUWG).

<https://experience.arcgis.com/experience/dd2c3b9285144e1f943f5aa28a794021?dlg=Viewer>



## Dredge Sediment Resource Data Platform

*"Making connections between the supply of dredged sediment and locations where this material could be used beneficially"*

- One Contaminant – building on the Sediment Management Framework application – seabed contaminants data



**Sustainable and Strategic Management of Dredged Material**

Claire Mason  
Jemma Lonsdale  
Will Manning

Action Level Review and Sediment Quality Sustainable Marine Management Habitat Restoration and Beneficial Use

**Background**

- In order to maintain safe navigation, on average, ~27.3 M wet tonnes of dredged material (DM) is disposed of across the UK each year (2009 to 2019), ~70% of which is disposed of offshore.
- Classified as a waste, Action Levels (ALs) are used to assess contaminant loading of DM and determine acceptability for disposal at sea.
- Rather than a 'waste', DM should be viewed as a resource, forming an essential component of sedimentary processes.
- Where suitable, beneficial uses such as habitat restoration are considered the most favoured management options (Figure 1), with offshore disposal a last resort. However, only ~0.5% of DM currently supports habitat restoration.

**Partners**

**Providing the Tools**

- Following a Cefas review, new ALs have been proposed to Defra that provide greater environmental protection and transparency in the decision making process.
- To support strategic management and co-ordination of habitat restoration opportunities, Cefas are developing an online framework to help match sources (dredging activity) and sinks/stores (habitat restoration).
- Working with partners, Cefas are producing a handbook providing conceptual, practical and regulatory advice on how to use DM to support the restoration of estuarine and coastal habitats.

Figure 1. A vegetated shingle ridge and saltmarsh, Horsey Island, Essex. Created using dredged material. Provides flood defence benefits, protects designated habitats and supported the most successful little tern breeding colony in Essex in 2020 (RSPB, pers. comms.).

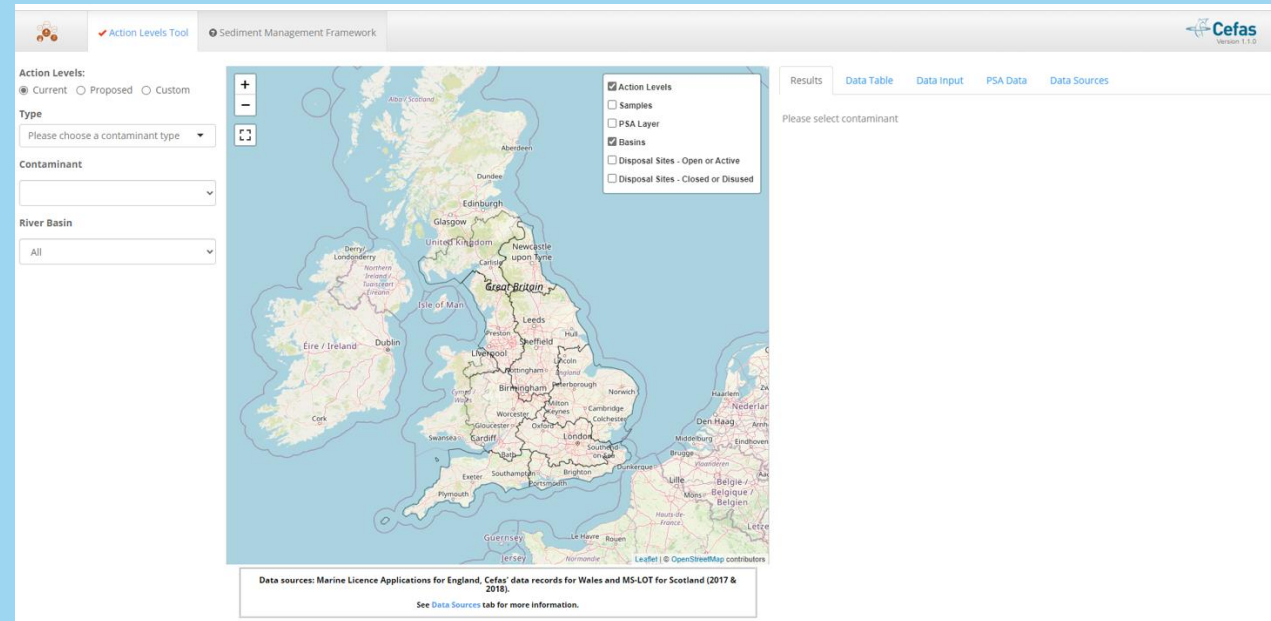
For more posters: @CefasGovUK



## Marine Chemistry Working Group

[https://ices-library.figshare.com/articles/report/Marine\\_Chemistry\\_Working\\_Group\\_MCWG\\_outcomes\\_from\\_2021\\_meeting\\_/19317827?file=34313558](https://ices-library.figshare.com/articles/report/Marine_Chemistry_Working_Group_MCWG_outcomes_from_2021_meeting_/19317827?file=34313558)

# Next a look at how the SMF has been developed



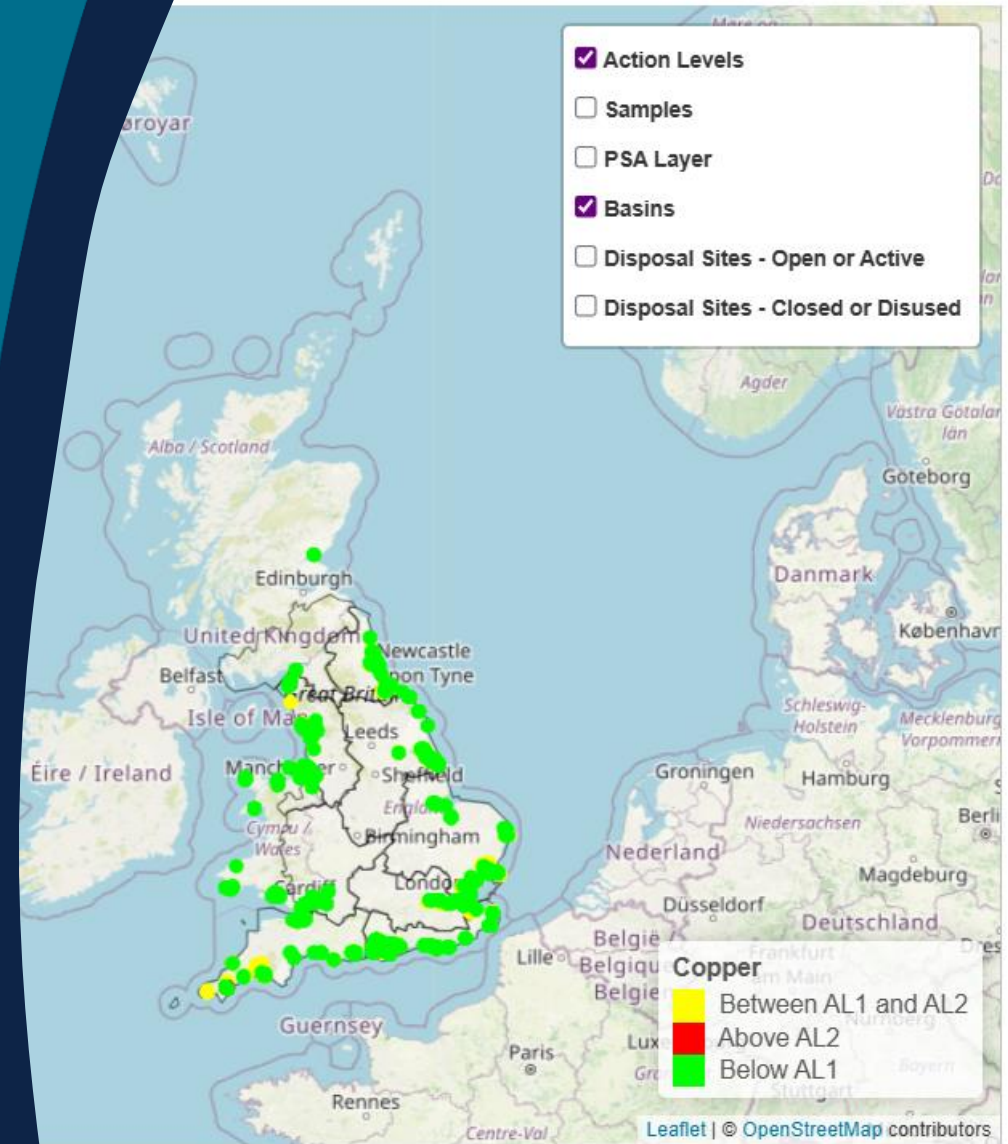
More details on the app, its operation, and potential case studies can be found in:

Mason et al (2025) Developing a national online decision support system framework for dredging and disposal: Working with Stakeholders, lessons learned and achievements. To be submitted to the special edition "SedNet2025: Healthy Sediments" of the *Journal of Soils and Sediments*.

# Behind the scenes of the Sediment Management Framework app

- Databases & coding

Richard Heal – Developer & Database administrator



Licence Applications for England, Cefas' data records for Wales and MS-LOT for Scotland (2017 & 2018).

See [Data Sources](#) tab for more information.

# Sediment Management Framework (SMF) app

Development of the app needed to consider:

- 👁️ Display of the framework documentation that is easy to view and navigate
- 📊 Visual display of contaminant data spatially and temporally
- 📈 Dynamic display of summary statistics for the contaminant data
- ✂️ Ability to use recommended and custom action levels to classify contaminant data
- ⬇️ Facility to download selected contaminant data for further analysis



# Behind the scenes - a multiplatform approach



Read-only



Data housed in a bespoke,  
Postgres relational  
database

App hosted as an R Shiny  
app on Posit with read only  
access to database

Multiple instances of the  
app can be served on PC,  
tablet or other mobile  
device (not optimised for  
small screen)



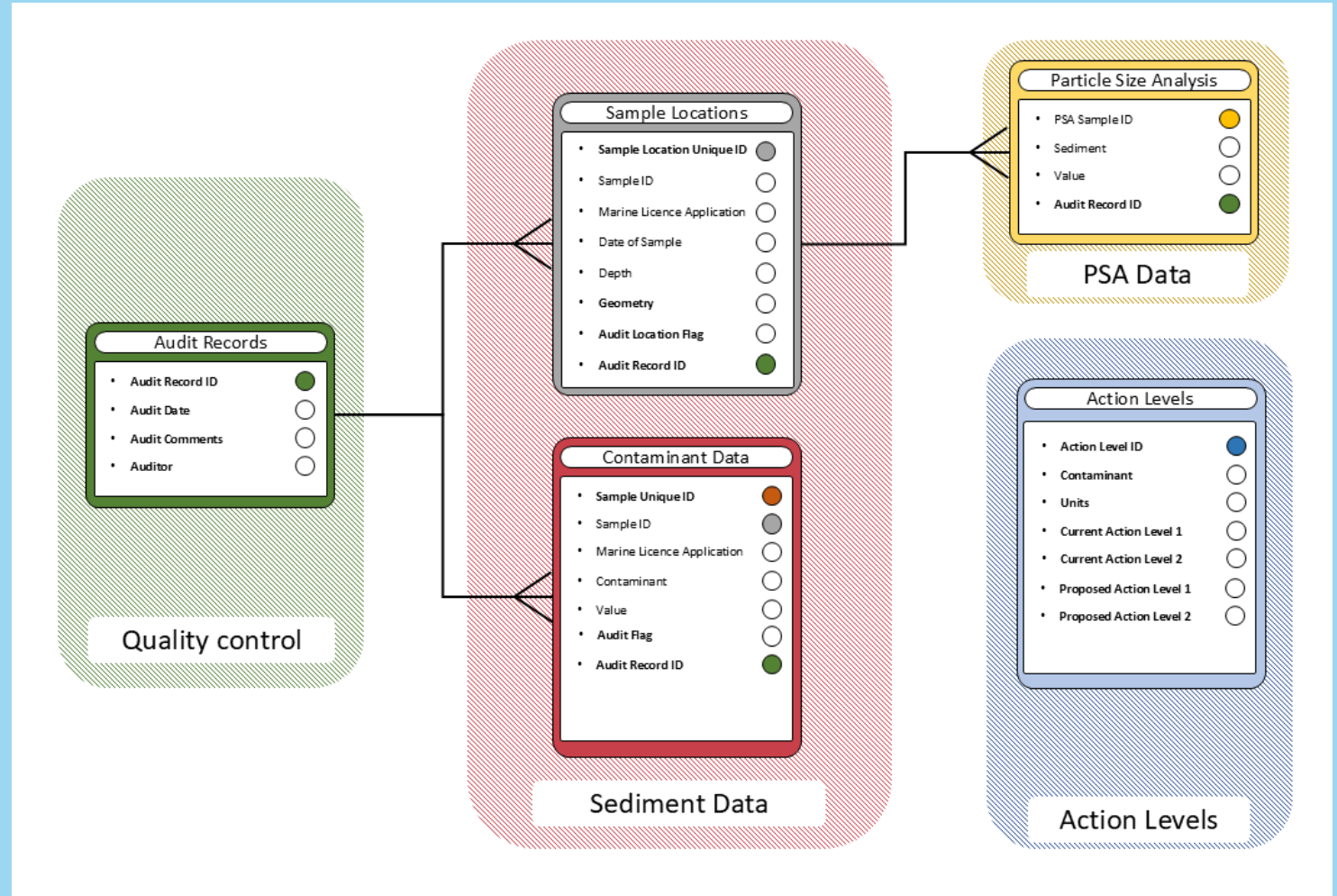
# Development of a web-based app

- App development written in R as an R Shiny application
  - Application accesses the wealth of R libraries for data curation, analysis and display
  - An open-source approach was adopted for code and access
- The sediment management framework is accessed through the app as webpages
  - Documentation converted to html files allowing ease of update
- Application is hosted via Posit



# Database structure

- Basic structure
  - Contaminant data linked to sample location
  - PSA data also available
  - Table of action levels for each contaminant
- Audit information available (even for failed samples)



# Navigation of the Sediment Management Framework

Links are provided for more information

Progress through the framework is indicated

Navigation menus & buttons

Key references cited

Overview

Why manage dredge material?

- Introduction
- London Protocol
- Oslo-Paris Convention
- Annual reporting to OSPAR
- Water Regulations
- HM Government 25 year plan
- Marine and Coastal Access Act
- Licensing authorities
- Action Levels

Defining the Management Plan

Determine sample plan including chemical analysis requirements

Collect and analyse dredge material samples

Dredge Use Application

## Why manage dredged materials?

### Introduction

There are a number of pieces of legislation that aim to manage the marine environment, in terms of reducing pollution release, to also protect and where possible improve the states of our oceans and to monitor and enforce any protection or restriction measures.

Of relevance to dredge and disposal operations is the potential for chemical pollution that can be released during the operations which could have negative effects on biological life (e.g. [Oehlmann et al., 1998](#); [Afshan et al., 2014](#); [Jepson et al., 2016](#)). Seabed sediment can be a sink for contamination, and when it is dredged and disposed, can release these contaminants into the marine environment. By testing the sediment for chemical contamination before it is disturbed and assessing the risk of the contamination on marine life, the Regulators can ensure the decisions are made on the best available evidence.

Those legislative instruments relevant to the UK's dredge operations are provided below.

In this section you can view the information regarding:

1. London Convention/London Protocol
2. Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR)
3. Annual Reporting to OSPAR and London Convention/ London Protocol Secretariats.
4. The Water Framework Directive.
5. HM Government 25 year plan.
6. The Marine and Coastal Access Act 2009.
7. Licencing Authorities.
8. Action Levels.

#### References

Afshan, S., Ali, S., Ameen, U.S., Farid, M., Bhanwana, S.A., Haman, F. and Ahmad, R. (2014). Effect of different heavy metal pollution on fish. *Research Journal of Chemical and Environmental Sciences*, 2(1) pp.74-79.

Jepson, P.D., Deaville, R., Barber, J.L., Aguilar, A., Borrell, A., Murphy, S., Barry, J., Brownlow, A., Barnett, J., Berrow, S. and Cunningham, A.A. (2016). PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Scientific report*, 6, pp. 18573.

Oehlmann, J., Bauer, B., Minchin, D., Schulte-Oehlmann, U., Fioroni, P. and Markert, B. (1998). Imosex in *Nucella lapillus* and intersex in *Littorina littorea*: interspecific comparison of two TBT-induced effects and their geographical uniformity. In *Aspects of Littorinid Biology*, pp. 199-213. Springer, Dordrecht.

**DISCLAIMER:** This information is for guidance only and the user is directed to the Regulators and further case/site specific instructions via the links below.

## Dredge material management

Waste hierarchy

OSPAR dredge material assessment

Water framework directive

Define management plan including dredging requirements, and what possible options should be considered

Determine sample plan including chemical analytical requirements. Contact regulator (relevant marine licensing authority)

Regulator liaise with respective advisors to provide a sample plan for sediment quality, but also to include any sampling to address water quality concerns such as resuspension of sediment during dredging

Collect samples and complete required analyses. Use validated laboratory. Sample results template as defined by regulator

Update and complete dredge management plan (taking consideration to all options possible). Combination of options possible. Ouse evidence base to confirm how current results fit with historic data for example.

Submit licensing application to regulator

Regulators liaise with respective advisors and relevant government bodies to assess licensing application

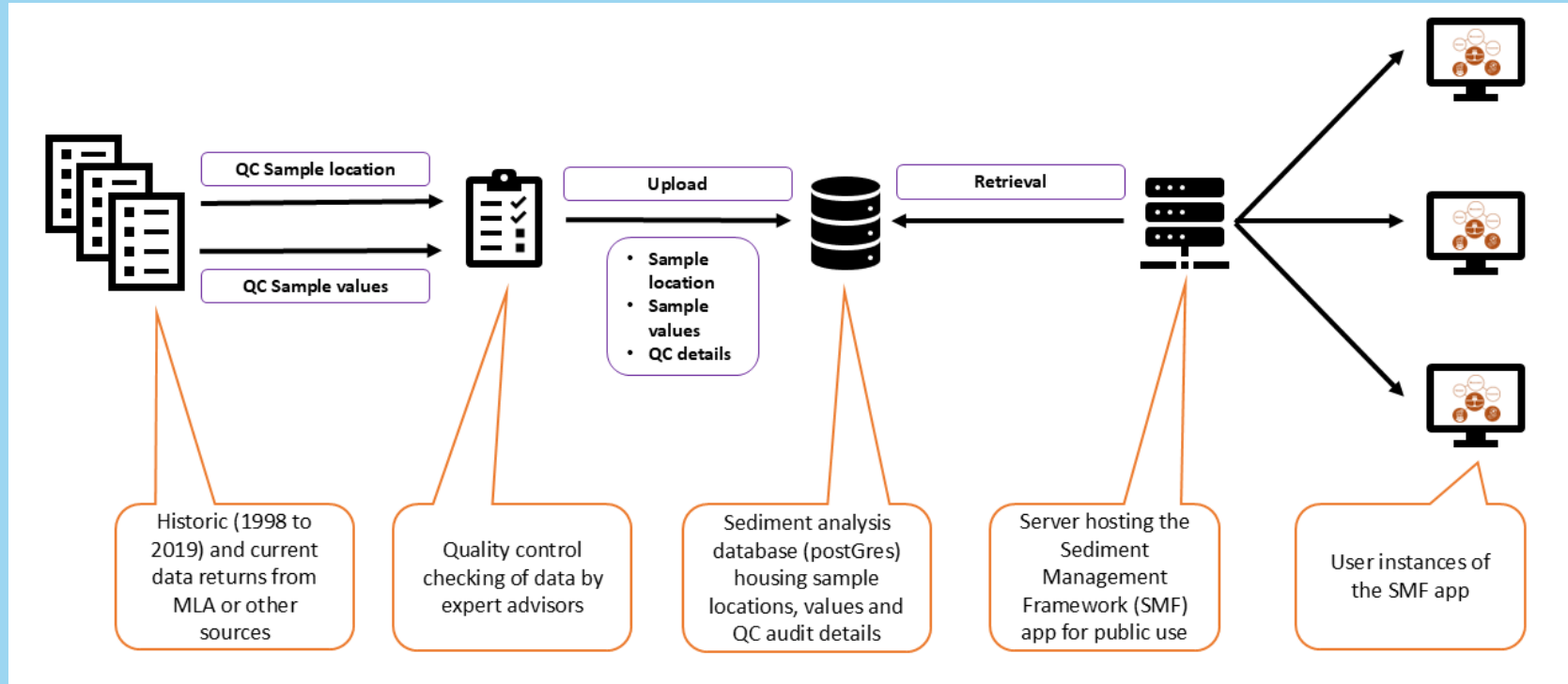
License awarded by regulator for dredge material plan

Complete dredging monitor and undertake management mitigation and adaptive management measures, if deemed necessary, based on monitoring results and in accordance with marine licence conditions (OSPAR, 2015)

Sample results are assessed on weight of evidence basis

- <AL1
- >AL1, <AL2
- >AL2

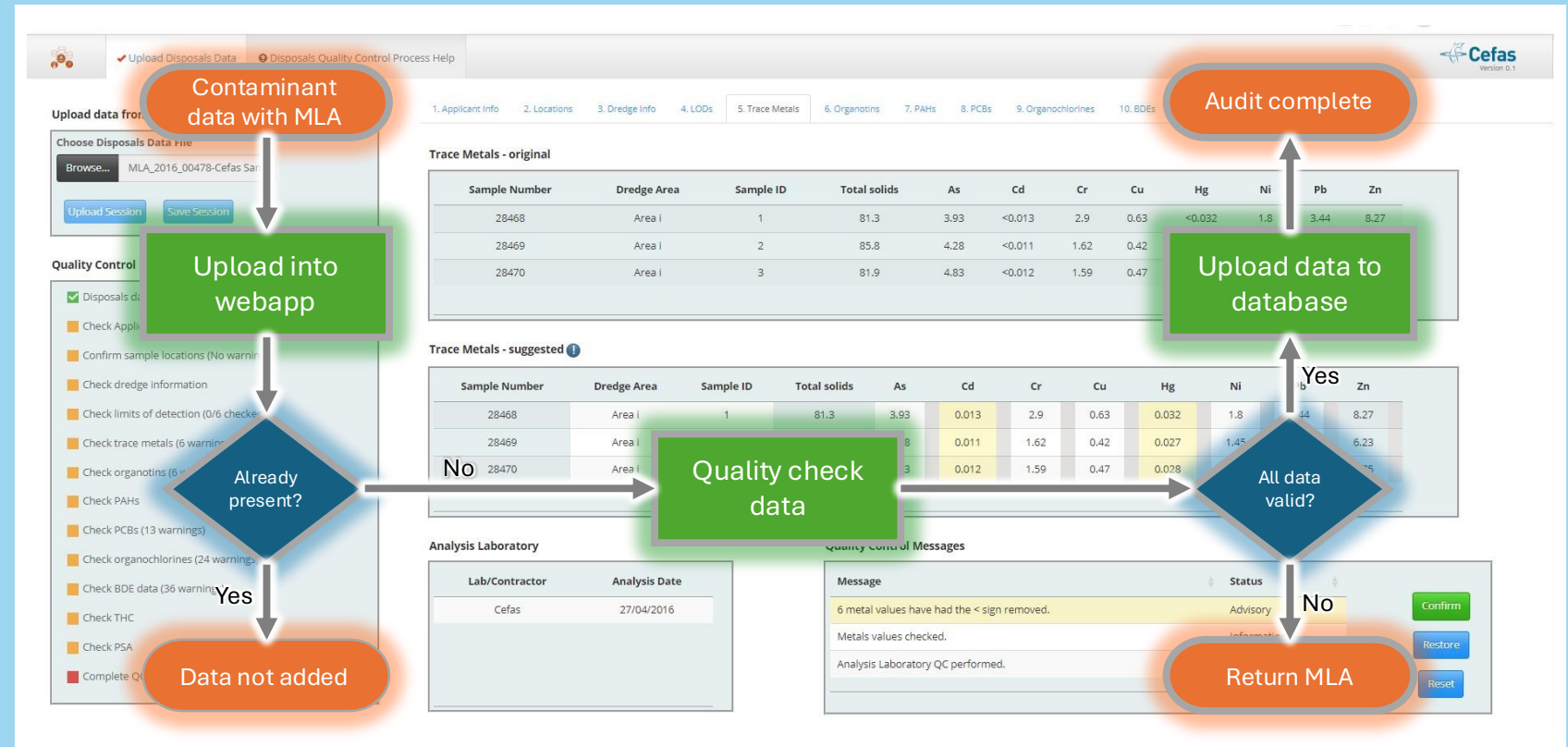
# Ensuring quality of the data



- Historical data was quality controlled by advisors prior to upload to the database
- Sister web-app developed to enable update of the app as new data is available
- QC process is audited and records maintained in the database alongside the data

# SMF Quality Control Data Upload app

- Key output from feedback sessions was the need for the latest, best available data



- App serves as a quality control guide for the advisors
  - Data is uploaded into the app from spreadsheet
  - App performs automated checks on the data
    - Checks coordinate location(s)
    - Checks for missing information
    - Checks contaminant values against the database

# Overview of the SMF App

User selection options

The screenshot displays the SMF App interface. On the left, the 'Action Levels Tool' sidebar includes filters for 'Action Levels' (Current, Proposed, Custom), 'Type' (Metals), 'Contaminant' (Arsenic (As)), 'River Basin' (All), and 'Samples in database' (Total: 6303, Selected: 6303, PSA results: 177). A 'Time series selection' section shows a time frame from 01/01/1998 to 31/12/2019. The central map shows the UK with green dots representing samples. A legend indicates 'Action Levels' (Samples, PSA Layer, Basins, Disposal Sites) and 'Arsenic' status (Between AL1 and AL2, Above AL2, Below AL1). A tooltip for sample ID 2003/01570 shows an 'Action Level Status: Between AL1 and AL2'. On the right, the 'Results' section features a histogram of 'Measurement (ppm)' and a donut chart for 'CURRENT AL' status. Below these are summary statistics for Arsenic (As) with Current AL1 at 20ppm and Current AL2 at 100ppm.

Contaminant	Current AL1	Current AL2
Arsenic (As)	20ppm	100ppm

AL Status	Count	Proportion
< AL1	4104	0.651
≥ AL1 & ≤ AL2	2154	0.342
> AL2	45	0.007

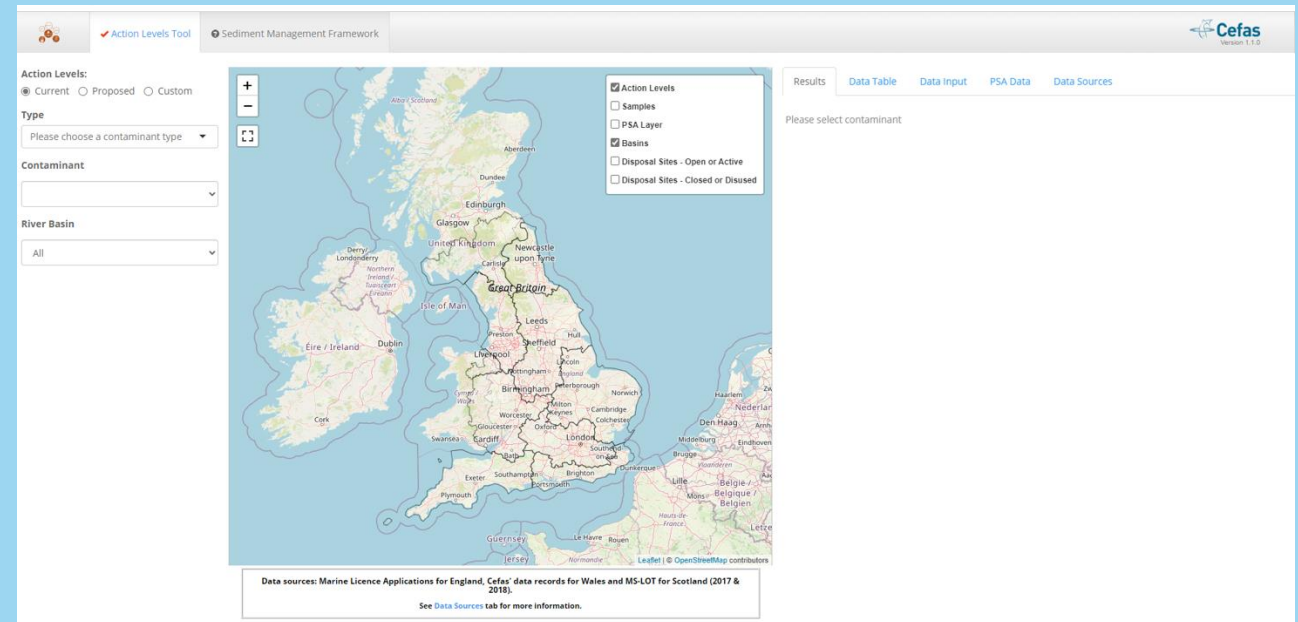
\*Note: "Between AL1 and AL2" is inclusive of the AL value.  
\*Note: "Above AL1" is inclusive of the AL value.

Dynamic map displaying results

Data table and summary statistics

# The SMF App

A demonstration of the app will follow...



To view the app please use the QR code displayed

More details on the app, its operation, and potential case studies can be found in:

Heal et al (2025) Sediment Management Framework app: an open access web-based viewer of sediment contaminant concentrations from dredge material measured from 1998 in coastal and marine waters of Great Britain. To be submitted to the special edition "SedNet2025: Healthy Sediments" of the *Journal of Soils and Sediments*.



# App Demo

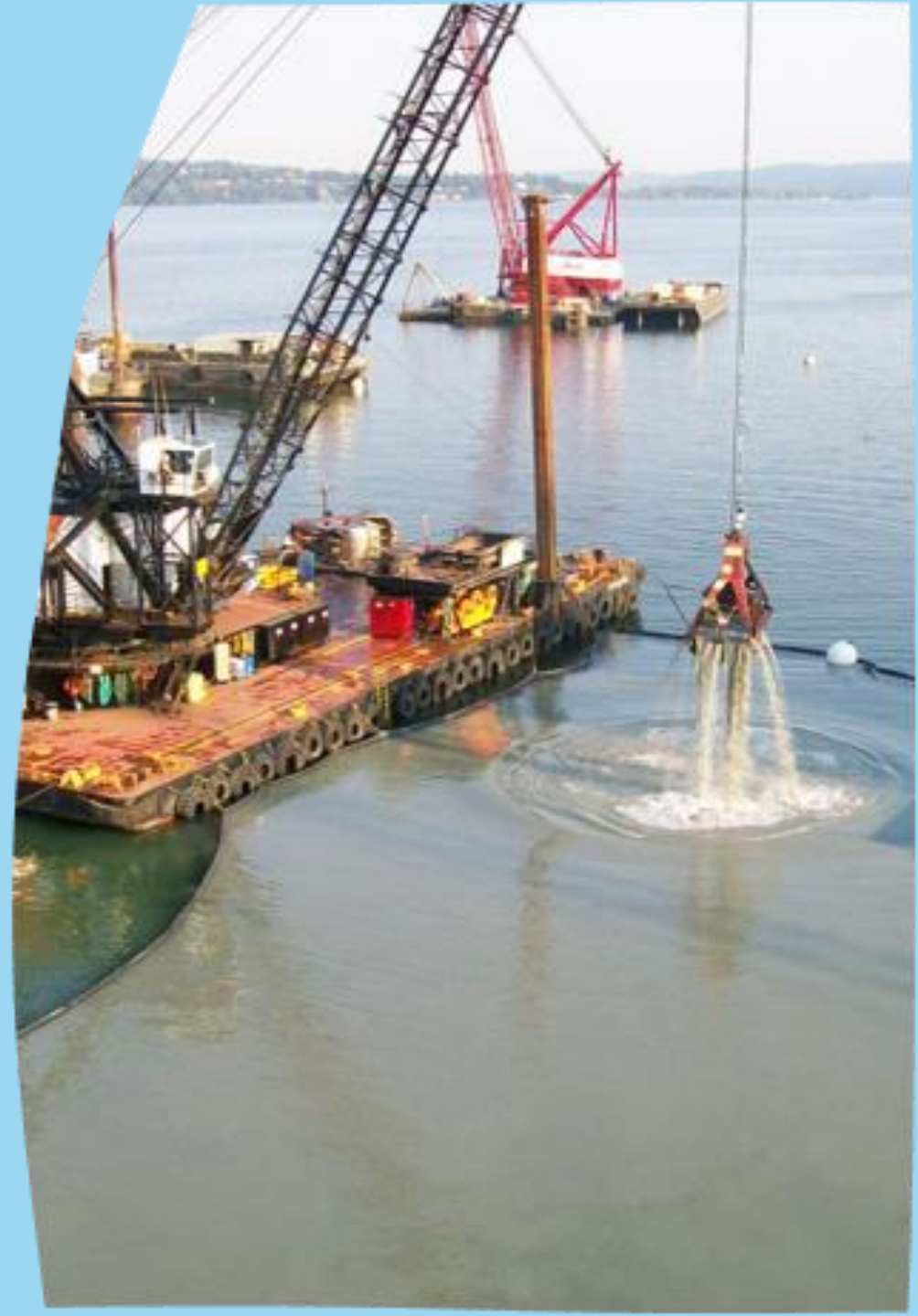


# Strengths

- **Accessibility:** Freely available; enables anyone to access sediment contaminant data, supports collaboration/sharing of data (SNCBs, consultants, researchers, students)
- **Comprehensive Data Integration:** large, quality-controlled dataset (1998-2019); semi-automation saves time resource, money
- **User-Friendly:** Spatial/temporal visualisation; easy filtering; intuitive traffic-light colour coding; rapid assessment

# Limitations

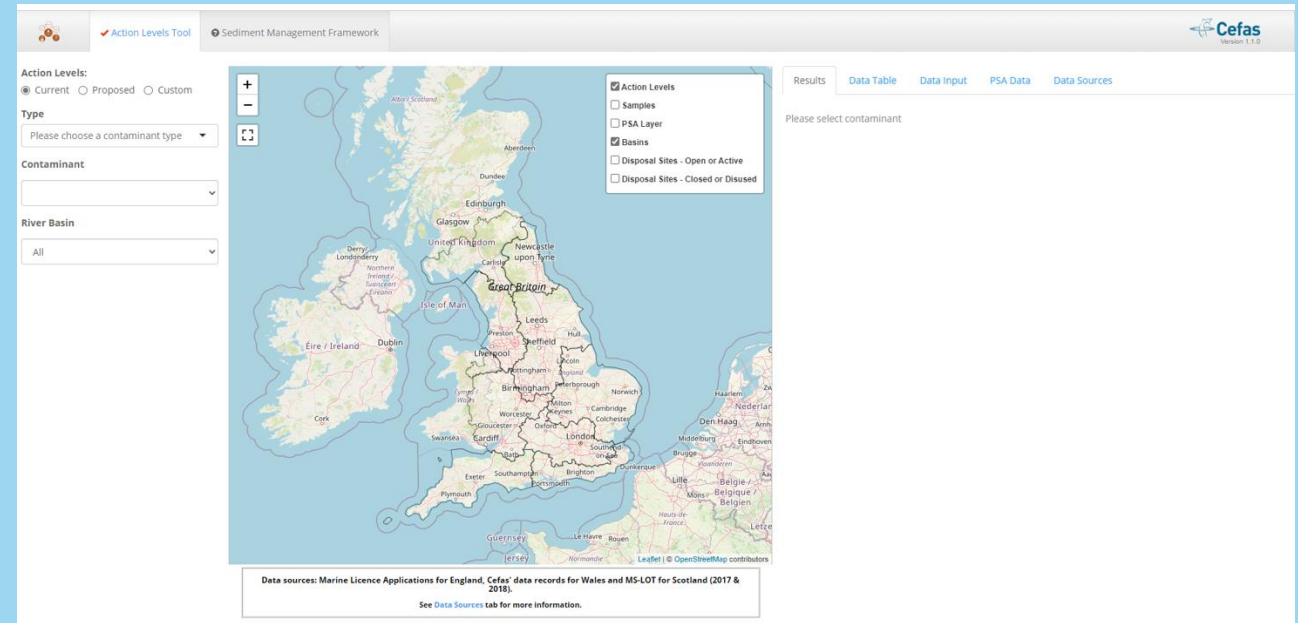
- **Data Currency:** No post-2019 data; manual updates required - plan to go 'live'; doesn't account for changes in analytical methods (extra parameter?)
- **Intermediate value:** yellow colour coding can be misleading— individual values should be checked; it's a scale; e.g., Zinc (133 vs 799)
- **Intended Use:** Not a decision-making tool; expert judgement and local knowledge still essential e.g., POLREPS



# Finally, please can we ask for some feedback about the SMF app:

Mentimeter:

<https://www.menti.com/alcva7jt4vgk>



Join at [menti.com/](https://www.menti.com/alcva7jt4vgk) use code 2439 4090

# Thank you for listening

If you have any further questions, please contact us using any of the following emails:

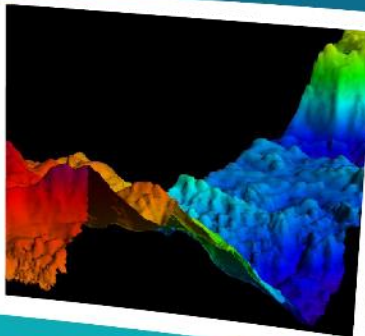
[Claire.mason@cefas.gov.uk](mailto:Claire.mason@cefas.gov.uk)

[Richard.heal@cefas.gov.uk](mailto:Richard.heal@cefas.gov.uk)

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