

Strategic Dredging Disposal Sites



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EXECUTIVE SUMMARY

It is considered vital to develop a network of licensed dredging disposal sites throughout the Broads to guarantee the long term programme of dredging works.

A review of existing disposal opportunities including those brought about by the setback areas within the Broadland Flood Alleviation Project (BFAP) show an availability of some 501,000 m³, which provides around 37% of total volume required (1.35 M m³ from the Sediment Management Strategy January 2007).

A strategy to identify opportunities for strategic dredging disposal sites has been completed which takes into account not only current land use and environmental designations, but also current dredging techniques and constraints.

In total around 150 possible sites have been identified, of which 48 have been designated as primary disposal sites i.e. sites close to dredging area where side cast or side cast and short haul can be used. The number of sites allow a significant surplus to the quantities required but assume a proportion will be unavailable due to landowner, practicality or technical issues. However, this should still result in a need/capacity balance.

The fact that the majority are arable sites should also provide a simpler route for use for dredging disposal with fewer consents required and more exemptions possible.

1. INTRODUCTION

The Broads is a unique recreational and natural resource providing safe inland navigation over 125 miles of tidal waterways. It is used by approximately 12,000 recreational sailing and motor vessels, with up to 1000 vessel movements per day in some areas at peak times. Boats provide an excellent way to explore this internationally recognised wetland, with large areas of the waterways designated under the Birds and Habitats Directives for the ecology and wildlife it supports.

The Broads Authority (BA), as the navigation authority, has adopted a strategic catchment approach to managing sediment. This approach provides long-term combined benefits to water quality, ecosystems and navigation.

The Broads Authority's Sediment Management Strategy has identified the volumes of sediment that needs to be removed to reduce the backlog of sediment accumulated since at least the Seventies. This backlog of sediment has been identified by comprehensive assessment of the sediment within the rivers and broads, using information from a hydrographic survey, desk study of sediment inputs and sediment quality survey.

'The Sediment Management Strategy provides a new framework for local dredging operations to care for the navigation and improve the condition of the water bodies within the Broads and makes us think both where this sediment has come from and how we can work in partnership for the long term sustainable management of the Broads'
David Adler, Chairman, Sediment Management Strategy Steering Group.

The BA and its contractors carry out maintenance dredging on a routine basis with the main objective being to secure a reasonable depth for navigation. These ideal depths are identified through user-agreed Waterway Specifications. In some areas sediment management is undertaken to restore degraded or shallowing water bodies to "favourable condition" by removal of excess nutrients, and can also improve the water quality by reducing turbidity, as well as providing greater capacity for water storage.

Throughout the system the BA have a number of existing dredging disposal sites and this combined with the new sites becoming available through the flood defence works as part of the Broadland Flood Alleviation Project give a large number of sites in current use.

Why do we need a Strategic Dredging Disposal Sites Project?

Whilst the BA continues to seek opportunities for beneficial reuse of dredged material; within flood defence works, wetland creation, or agricultural benefit; it is also vital that it develops a strategic network of licensed disposal sites throughout the Broads system to provide long term security for the delivery of the dredging programme.

Indeed the Broads Plan 2004 (the statutory management plan for the Broads area as required by the 1989 Broads Act) provides awareness of the need to work at a catchment scale to address some of the challenges facing the Broads, and to develop consensus for the future.

Identifying Strategic Dredging Disposal Sites continues the work of the Sediment Management Strategy by working on a catchment scale thus building on the Fundamental Performance Review of Navigation, (undertaken in the late 1990's as a Defra requirement)

which recommended that ‘ the Authority continue working towards a Dredging Disposal Strategy’.

The aims of the project

Aim

To identify a long list of Strategic Dredging Disposal sites to provide sustainable long-term disposal of sediment within the Broads thus protecting both inland navigation and the internationally important wetlands.

Objectives

- Review existing data and identify current constraints to dredging disposal
- Identify new constraints
- Review current and future disposal methods
- Define technical criteria for selection of disposal site including haulage distances, proximity to water course, etc.
- Develop a methodology for identification of sites
- Review location and capacity of current sites plus new flood defence sites
- Identify new opportunities for dredging disposal sites

This work has been carried out as a desk study to review current constraints and identify opportunities for dredging disposal in a spatial format. This has been achieved utilising GIS mapping to identify a long list of possible sites for further site specific feasibility studies.

2. FACTORS TO CONSIDER FOR DREDGING DISPOSAL

The Broads area covers over 30,000 hectares of land of which some 21,000 hectares are used for agriculture. Some of these areas may be suitable for disposal of dredgings but in order to identify suitable sites it is first necessary to understand the constraints that might prevent a site being used. These we have considered to be our Primary Environmental Considerations.

Primary Environmental Considerations

The Broads is one of Europe's finest wetlands, supporting a wide range of habitats and species and as such has significant areas of land designated under European and UK legislation.

For the purposes of this study we have therefore identified areas which are not likely to be appropriate as a strategic dredging disposal site and these can be considered our primary constraints.

Wildlife and Environmental Conservation Designations

Special Protection Areas (SPAs) are strictly protected sites classified in accordance with Article 4 of the EC Directive on the conservation of wild birds (79/409/EEC), also known as the Birds Directive, which came into force in April 1979. They are classified for rare and vulnerable birds, listed in Annex I to the Birds Directive, and for regularly occurring migratory species.

Special Areas of Conservation (SACs) are strictly protected sites designated under the EC Habitats Directive. Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended). The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds). Of the Annex I habitat types, 78 are believed to occur in the UK. Of the Annex II species, 43 are native to, and normally resident in, the UK.

Ramsar sites are wetlands of international importance designated under the Ramsar Convention.

Sites of Scientific Interest (SSSI). Under the Wildlife and Countryside Act 1981 (amended 1985) the government has a duty to notify as a SSSI any land which in its opinion is of special interest by reason of any of its flora, fauna, geological or physiographical features. In England, SSSI's are designated by Natural England. A SSSI is not necessarily owned by a conservation organisation or by the Government - in fact, they can be owned by anybody. The designation is primarily to identify those areas worthy of preservation. A SSSI is given certain protection against damaging operations, and any such operations must in theory be authorised by the designating body.

National Nature Reserves (NNR's). Natural England have been empowered to declare NNRs in England, the Reserves being a selection of the very best parts of England's Sites of Special Scientific Interest. It is this underlying designation which gives NNRs their strong legal protection. The majority also have European nature conservation designations.

Designation	Interest Feature
The Broads SAC	
<i>Annex 1 Habitats of European importance</i>	Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i>
	Calcareous fens with <i>Cladium mariscus</i> and species of the <i>Carex davallianae</i>
	Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation
	Transition mires and quaking bogs
	Hard oligo-mesotrophic waters with benthic vegetation of <i>Chara</i> spp.
	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (<i>Molinion caeruleae</i>)
<i>Species</i>	Desmoulin's whorl snail (<i>Vertigo moulinsiana</i>)
	Otter (<i>Lutra lutra</i>)
Broadland SPA	
<i>Annex 1 species of European importance</i>	Marsh harrier (<i>Circus aeruginosus</i>)
	Bittern (<i>Botaurus stellaris</i>)
	Hen harrier (<i>Circus cyaneus</i>)
	Ruff (<i>Philomachus pugnax</i>)
	Whooper swan (<i>Cygnus cygnus</i>)
	Bewick swan (<i>Cygnus columbianus bewickii</i>)
<i>Migratory species of European importance</i>	Pink footed goose (<i>Anser brachyrhynchusera</i>)
	Gadwall (<i>Anas strepera</i>)
	Shoveler (<i>Anas clypeata</i>)
	Eurasian wigeon (<i>Anas penelope</i>)
<i>Other birds present in nationally important numbers</i>	Refer to site citation
<i>Other wetland breeding birds of interest</i>	Refer to site citation
Broadland Ramsar	
<i>Criteria 2: supporting vulnerable, endangered, or critically endangered species or threatened ecological communities</i>	The site supports a number of rare species and habitats within the biogeographical zone context, including the following Habitats Directive Annex I features as outlined above
<i>Criteria 6: regularly supports 1% of the individuals in a population of one species or subspecies of waterbird</i>	Pink footed goose (<i>Anser brachyrhynchusera</i>)
	Greylag goose (<i>Anser anser anser</i>)
	Eurasian wigeon (<i>Anas penelope</i>)
	Gadwall (<i>Anas strepera</i>)
	Shoveler (<i>Anas clypeata</i>)
	Bewick swan (<i>Cygnus columbianus bewickii</i>)

Table 1: International designations and interest features

Town and Country Planning Conservation Areas

Section 69 of the Civic Amenities Act 1967 gives local councils the power to designate as Conservation Areas, "areas of special architectural or historic interest, the character or appearance of which it is desirable to preserve or enhance".

Designation gives control over the demolition of buildings and provides the basis for policies designed to preserve or enhance all the aspects of character or appearance that define an area's special interest.

Other Primary Environmental Considerations

There are also a number of areas which although not legally enforceable constraints do merit inclusion as a primary constraint due to their conservation value.

County Wildlife Sites

These are non-statutory designations for sites of county significance for wildlife. Positive management of County Wildlife Sites is encouraged and development affecting them is controlled by Local Plan policies.

Environmentally Sensitive Area (ESA). This is a type of designation for an agricultural area which needs special protection because of its landscape, wildlife or historical value. The scheme was introduced in 1987. Originally it was administered by Ministry of Agriculture, Fisheries and Food, then the Rural Development Service for the United Kingdom Governments Department for Environment, Food and Rural Affairs, and currently Natural England following successive re-organisation of the departments. In 2005 the scheme was superseded by Environmental Stewardship and closed to new entrants. Existing agreements remain active until they expire, meaning the designation will remain active until 2014.

Within the ESA scheme land is designated under 6 categories:-

Tier 1 - Permanent grassland. Maintenance of permanent grassland by traditional grassland management regime including restrictions on stocking rates, the use of inorganic fertilisers and herbicides.

Tier 2 - Extensive grassland. As above but also maintenance of extensive grassland by managing water levels between April and October

Tier 3 - Wet grassland. As above but enhancement of wet grassland by controlling water levels and agricultural activities

Fen tier. Maintenance of fen by traditional management techniques.

Tier 4A - Arable reversion to permanent grassland

Tier 4B - Grassland margins (to reduce run off from arable land)

Of these Tier 3 and Fen tier has been categorised as Primary Constraints because of their environmental value. Land in remaining categories will have to be judged on a site by site basis at a later stage in the selection process.

Secondary Environmental Considerations

Further areas of environmental importance have also been included as secondary environmental constraints including areas of woodland BAP, peat fen, reedbed and heathland.

3. TECHNICAL CRITERIA

In order to assess the practicality of a site it is necessary to understand the technical criteria affecting the dredging operation. This will include the type of equipment and methods used for dredging and transportation and their limitations. These primarily affect the cost of the dredging operation.

It is also important to understand the type and quality of the dredged material and the constraints for its disposal. This includes the current waste management regulations for disposal to land.

Dredging Techniques.

Grab Dredging. The dredging technique currently employed by BA is the traditional method that has been used for many years on the rivers and broads. Unwanted sediment that has settled on the river bed is removed by a clamshell attachment on a water-borne crane. Sediment collected is then either side cast onto adjacent land or more typically placed into a wherry for transport to a disposal site where it is unloaded in a reversal of the loading process. This process physically removes quantities of sediment in discrete amounts from the river and relies on the skill of the operator to evenly dredge the river bed.

The method is straightforward and easy to control although placement at a distance from the river bank is restrained by the reach of the crane or excavator used to move the dredgings. Locating suitable disposal sites close enough to the river bank for off-loading is the biggest draw-back with this technique.

Mud-pumping or suction dredging. This technique involves a pump drawing up a water/sediment mix from the river bed and pumping it through a pipe to discharge into settlement lagoons. Water is drained off, leaving behind re-settled sediment. Mud pumping has been successfully carried out by the BA on a number of Broads including Barton Broad and Mautby Broad. After drying, this sediment can be handled for disposal elsewhere. Mud pumping distances vary greatly depending on the viscosity of the dredged material but can be up to 2 kilometres.

An alternative to settlement lagoons is the immediate drying of the sediment in a machine. This results in a series of graded materials, each having the moisture content of natural soils, making for easier handling. These materials may have a limited re-sale value, subject to transport costs. Again, there is a considerable quantity of water to dispose of. Discussions are underway with several manufacturers regarding potential use of this type of equipment in the Broads.

Water-injection Dredging. In 2007, the BA trialled water-injection dredging. This method involves jets of high-pressure water being injected into the sediment to break up and suspend it in the water column. Tidal and fluvial flows would then transport the sediment downstream and out to sea, where it would disperse. The method is only suitable in locations with high flows and near to an outlet to the sea. This method does not produce any dredgings for disposal.

Haulage Distance.

The distances from the point of abstraction to the point of disposal constitutes the haulage distance. When utilising the traditional grab method and placement in wherries for transportation to the disposal site, typically the longer the haulage distance the more costly the operation, both economically and environmentally.

This is because the haulage distance affects the cycle time of the dredging project, and at some stage depending on the speed of loading/unloading or the number of wherries employed there is likely to be some standing time whilst one waits for the other. The longer the haulage distance the more unpredictable this becomes as other external factors take effect. Typical realistic river haulage distances need to be kept well within the management units and a haulage distance to site no greater than 5 kilometres would be a worst case.

There may be other inland disposal sites which require the dredging to be off-loaded adjacent to the river and then transported by dumpers inland. Practically, the maximum haulage distance will be around 500 m. The presence of farm tracks which can be used as a haul road will allow greater distances to be covered.

Environmental Quality Standards

The Sediment Characterisation Survey completed in 2004 gives a general picture of the quality of Broads sediment, although further analysis is required for assessing any effects of spreading or site specific issues, (see Figure 1 below).

A total of 66 sediment samples were taken at approximately 2km intervals throughout the Broads. The survey showed the majority (88%) of samples taken were suitable for agricultural disposal, with less than 10% having zinc or copper concentrations above thresholds that could adversely effect growth of some plants at the disposal site (Figure 2), although exceedance of the thresholds was not large using ICRCL (Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing ICRCL 1990) trigger concentrations.

The remaining 3% of samples had high levels of Polycyclic Aromatic Hydrocarbons (PAHs), which are generally produced during combustion of substances such as diesel fuel, or from historic industrial processes. This survey provides overall data for the Broads and was not designed to pick up known hot spots of contaminants. It is well known that the majority of the sediment in the Yare from Norwich to upstream of Cantley is lightly contaminated with Mercury and Copper discharged from the Whitlingham sewage treatment works, Norwich from 1964 to 1973.

An Environment Agency policy provides a clear framework for decision making relating to the treatment of dredgings spoil in the Yare and concludes that the bulk of material needs to be disposed of to licensed landfill with site specific risk assessment for all other disposal routes. For other contaminated hotspots, such as boatyards and urban areas, a risk-based, cost benefit, approach is required to assess the impact of removal and disposal or retention within the aquatic system.

In the future, material may need to be re-sampled and analysed in order to accurately characterise it as inert, non-hazardous or hazardous wastes. In addition, due to expected changes in the legislation, the A, B, C classification may change in the future.

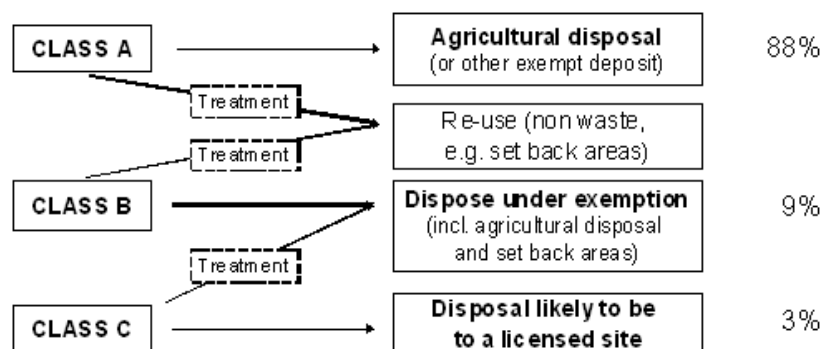


Figure 1 - Percentages of Broads sediment within sediment quality classes. and likely disposal routes for these classes

River Bed Texture by Percent & Associated Nitrogen, Phosphorus & Organic Matter Content for the Norfolk Broads Area.

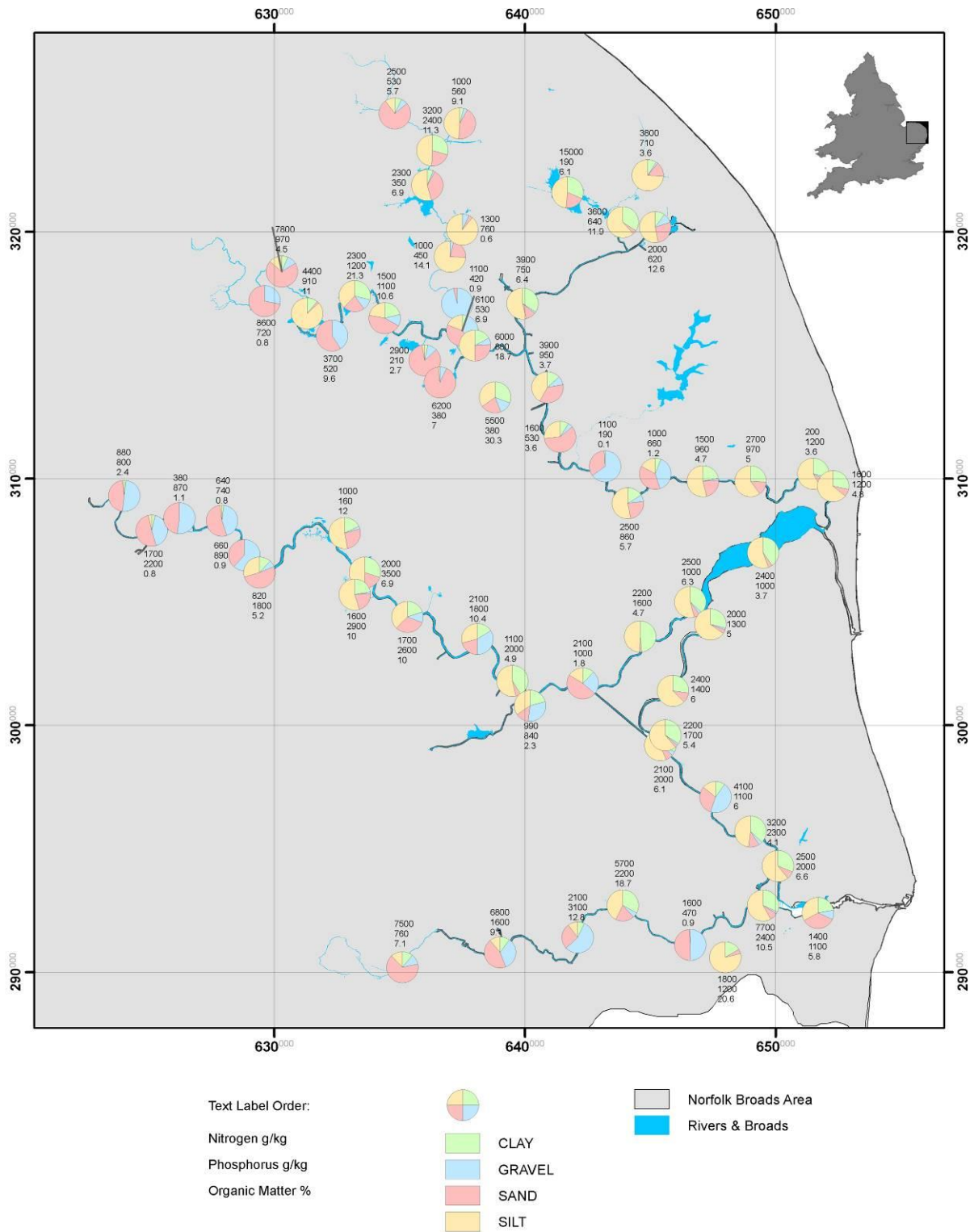


Figure 2. Grading of Bed material and content of nitrogen and phosphorus and organics matter, showing sample locations, number and distribution from Sediment Characterisation Survey undertaken in 2004.

Volume For Disposal

An estimate of the volumes of sediment requiring removal from the navigable area within each management unit has been calculated by comparing the hydrographic surveys with the waterways specification. This forms the basis of the Sediment Management Strategy 2007, and has been annually updated in each subsequent Action Plan.

UK Regulations for the Beneficial Use of Dredged Material

Sediment re-use conferring agricultural benefit. Dredging spoil can be re-used under a Paragraph 7 exemption of the Environmental Permitting (England and Wales) Regulations 2007 (EPR 2007) for agricultural improvement. This can include activities that involve the physical, chemical or nutrient enhancement of soil to support crop growth. The exemption currently applies to a maximum of 50ha of land with an annual limit of 5000 tonnes per ha of dredging spoil.

For dredged sediment to be permitted for use for agricultural benefit, several pieces of legislation are required to be complied with. These include rules covered by Nitrate Vulnerable Zones, Sludge (Used in Agriculture) Regulations 1989 and Groundwater Source Protection Zones. The Environment Agency regulates waste spreading to land through Environmental Permitting. It is therefore important to ascertain whether the disposal site falls within one of these zones as this may preclude its use.

Improvements to agricultural quality of land through spreading dredged sediments follows the “The Code of Good Agricultural Practice for the Protection of Soil” (MAFF 1998), and is deemed acceptable if its use does not result in the accumulation of certain deleterious elements in the soil (as outlined in the Sludge Regulations and determined through sediment analysis). An example of this would be the high sodium (salt) content within sediment in the Upper Thurne Broads which although not covered by any regulatory mechanisms would require further careful investigation of the potential sodium application rate to prevent impacts on the grass sward.

Bankside disposal. Under a Paragraph 25 (1) exemption of the EPR 2007, bankside disposal of non hazardous waste (on the existing floodbank or folding) is exempt up to a maximum rate of dredging spoil, currently 20 tonnes per running metre of the bank per day (under review), deposited progressively as the work proceeds along the same stretch of river and bank.

Sludge on Land. Under a Paragraph 6 (1) exemption of the EPR 2007, treatment with sludge of land which is not agricultural land within the meaning of the Sludge (Used in Agriculture) Regulations 1989 if it results in ecological improvement, or benefit to agriculture for non-food crops. Application must not cause the concentration in the soil of any of the elements listed in column 1 of the soil table set out in Schedule 2 to the 1989 Regulations to exceed the limit specified in column 2 of that table. No more than 250 tonnes of sludge per hectare is used on the land in any period of 12 months.

Applications of dredging spoil to agricultural land follows the best practice guidance outlined in the Code of Good Agricultural Practice for the Protection of Soil (MAFF 1998) when considering the application of heavy metals. The maximum permissible rates of application for a range of metals is given, with the annual values averaged over a maximum of 10 years if making single applications.

The maximum depth of dredging which could be disposed onto any given area will greatly depend on this analysis but for the purposes of this report we have assumed a depth of

10cm of dry dredgings. This will give a wet dredging volume approximately 1.5 times the dry dredging volume (a volume reduction of 1/3rd being standard for grab dredged sediment).

Soil quality of receiving land. In order to demonstrate the agricultural benefit of spreading dredged sediment the soil quality of the receiving fields will require sampling and testing. This will be for a standard suite of chemical and physical tests which enable the quality of the soil to be established prior to spreading. The BA has the sampling equipment and a contract with an analytical laboratory so samples can be collected when convenient.

Salt content of receiving soils following dredging applications There is some potential for high levels of salt in the sediment to cause harm to the grass sward, or impact future crop growth. Whilst the Broads Authority have demonstrated minimal impacts of this during trials on the Upper Thurne, this will need further consideration particularly for disposal to land in the lower reaches and the Upper Hickling areas.

Licensed Tip. The alternative to exemption is to gain a waste management licence and environmental permit for a river side disposal area like Postwick.

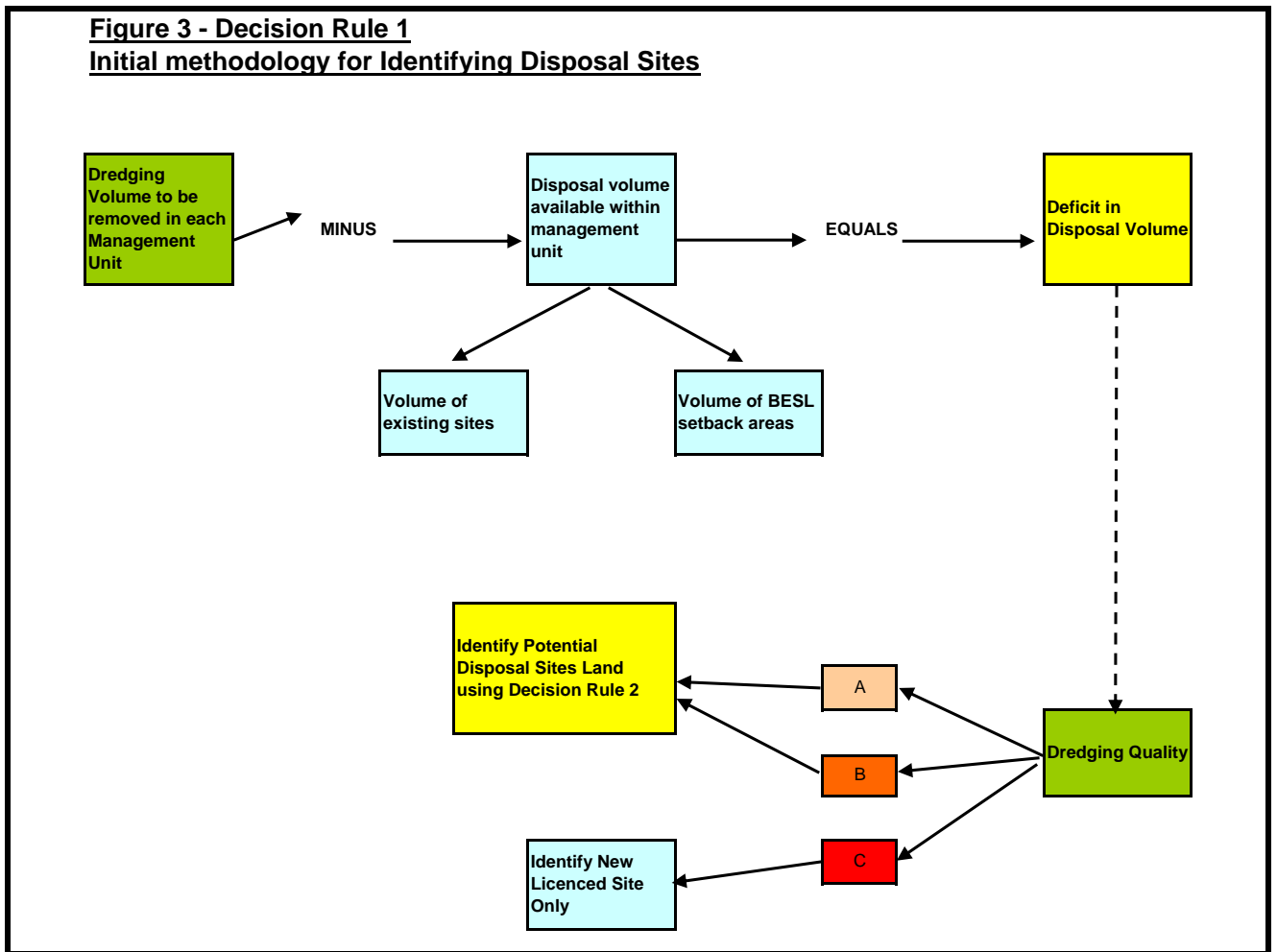
Note. There is currently an exemption review underway and details shown in the text above may be subject to change.

4. IDENTIFICATION OF SITES

Methodology

As part of the original Sediment Management Strategy volumes of sediment to be removed were identified for each management unit in the Broads. Before looking for disposal sites it is necessary to firstly understand the deficit in amount of dredging disposal volume available on existing sites including the BESL setback areas.

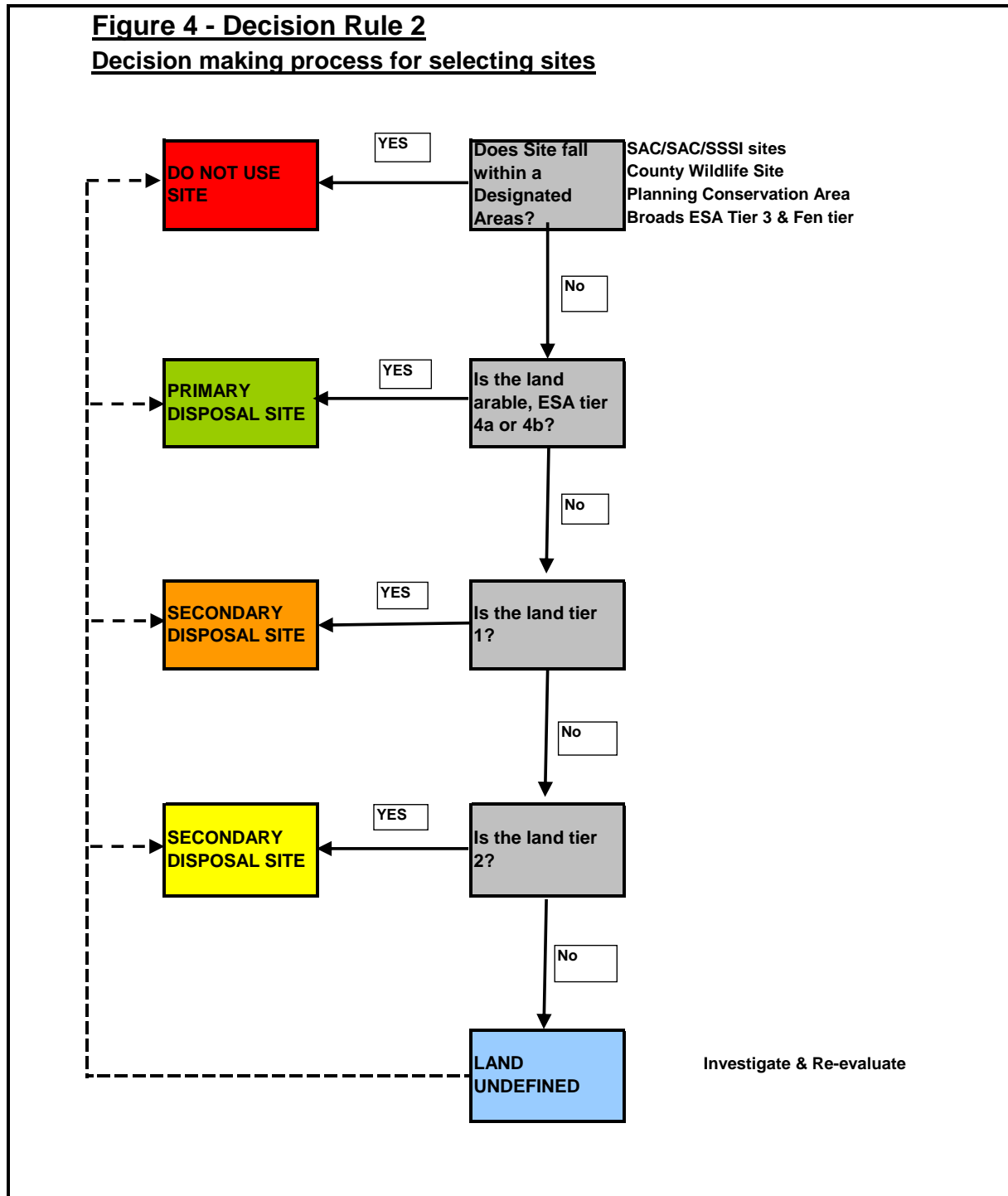
It is also important to understand the quality of the dredgings to be removed and where it can be disposed. The simple flow chart below shows the methodology used. Full details are included in Appendix B.



The identification of possible future sites has been undertaken as a desk based study utilising the GIS tool to overlay the constraints and opportunities. A list of the main GIS layers is shown in Appendix C.

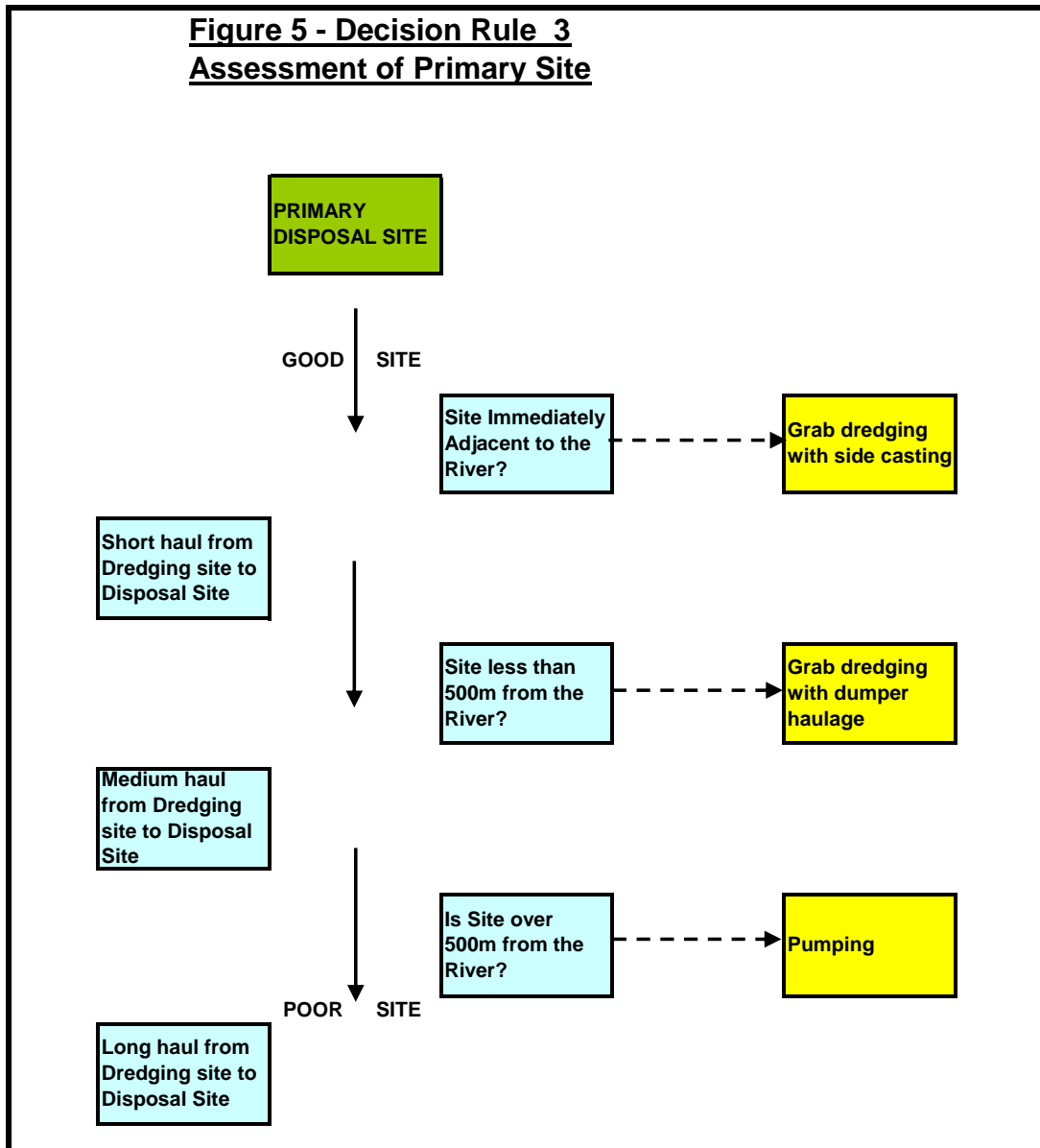
The GIS tool was used initially to produce a Base map of the Broads Executive area i.e. rivers and water bodies, chainage lines, etc. onto which the Primary Environmental designations were added, ie. SPA, SAC, SSSI designations.

Below these layers sat the main technical criteria, land type, which is be used to identify the most appropriate disposal site. A simple decision rule, shown below, was applied to highlight on screen the Primary, Secondary and Tertiary disposal areas.



By viewing the primary disposal areas on screen it has then been possible to identify those areas which sit alongside the river and thus make ideal candidates for a strategic disposal area. BA’s existing plant can be used to off-load these dredgings. Where these do not exist in a particular management unit, areas have been identified further away where material can be off-loaded and double handled into dumpers.

Finally, where neither of these options are available, pumping will be the only option. Coupled with these criteria, lie the haulage distance between the dredging site and the disposal site. Again, the further away the site is the less favourable it becomes.

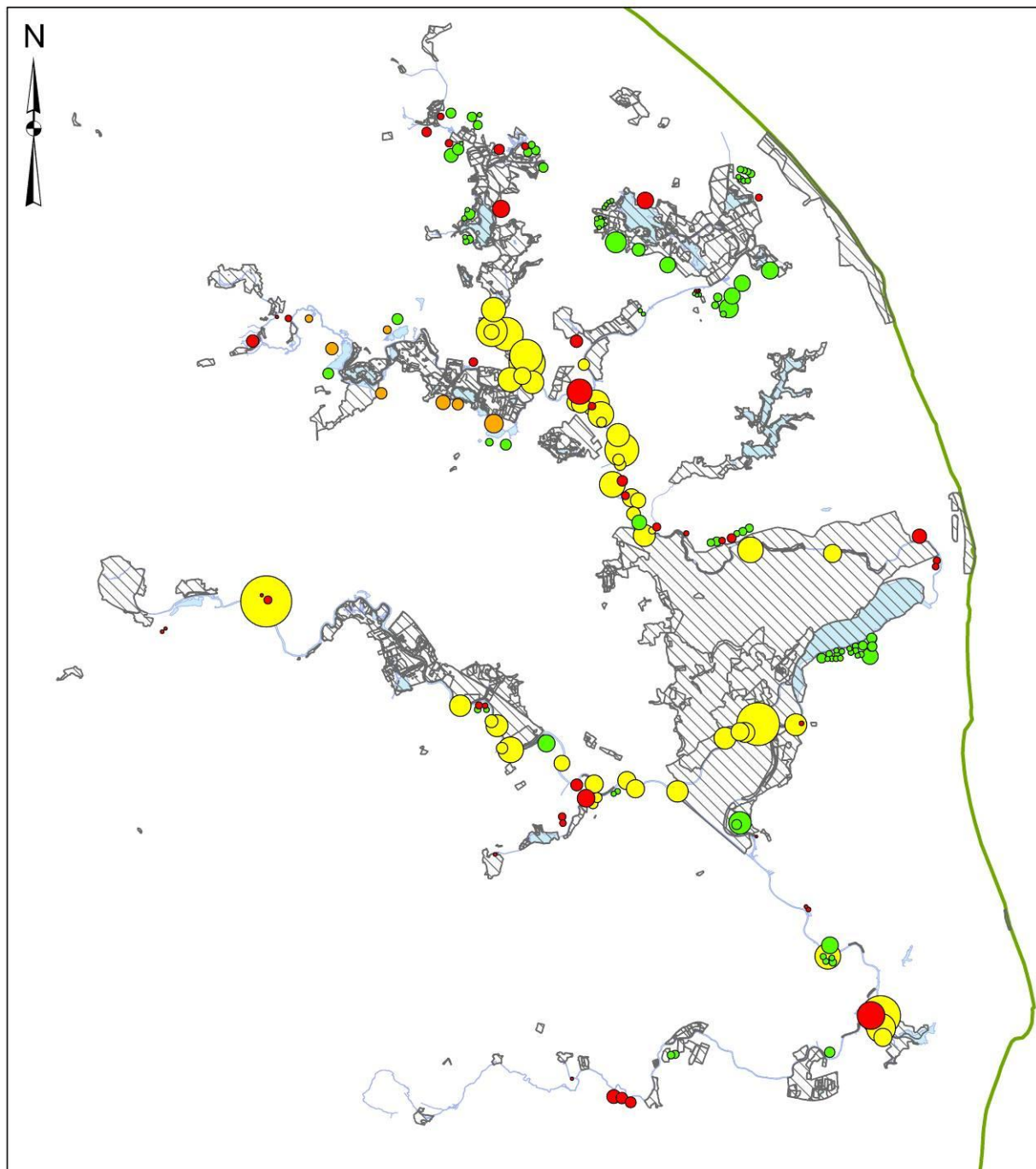


With the information available on the GIS system, it has then been possible to identify using best judgement, the sites which best match this criteria and rank them accordingly. This exercise was carried out as a joint BA/BESL desk based study.

5. PREFERENTIAL DISPOSAL SITES

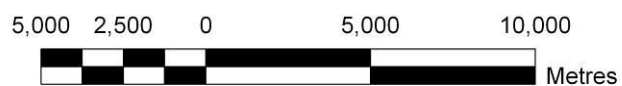
In total around 150 possible sites have been identified, all of which are currently available, and of which 48 have been designated as primary disposal sites i.e. sites close to dredging area where side cast or side cast and short haul can be used.

Distribution of Disposal Options



Legend

- | | | |
|----------------------------------|---------------|--------------------------------------|
| Existing and BFAP Disposal Areas | VOLUME | Primary Environmental Considerations |
| ● | ○ 1,000 | ▨ |
| ○ | ○ 2,500 | ▬ Rivers and Waterbodies |
| ● Prime 1 | ○ 5,000 | — Coast |
| ● Prime 2 | ○ 10,000 | |
| ● Prime 3 | | |



A full summary of the Strategic Dredging Disposal Sites identified as part of the GIS/desk based assessment is shown in detail in Appendix D. Each area is given a label based on its management unit, compartment number and a unique reference number. The approximate capacity that each field can take is based on the calculation discussed in section 3. An estimate for the total volume of dredging disposal capacity which each management unit has available is also given in this table.

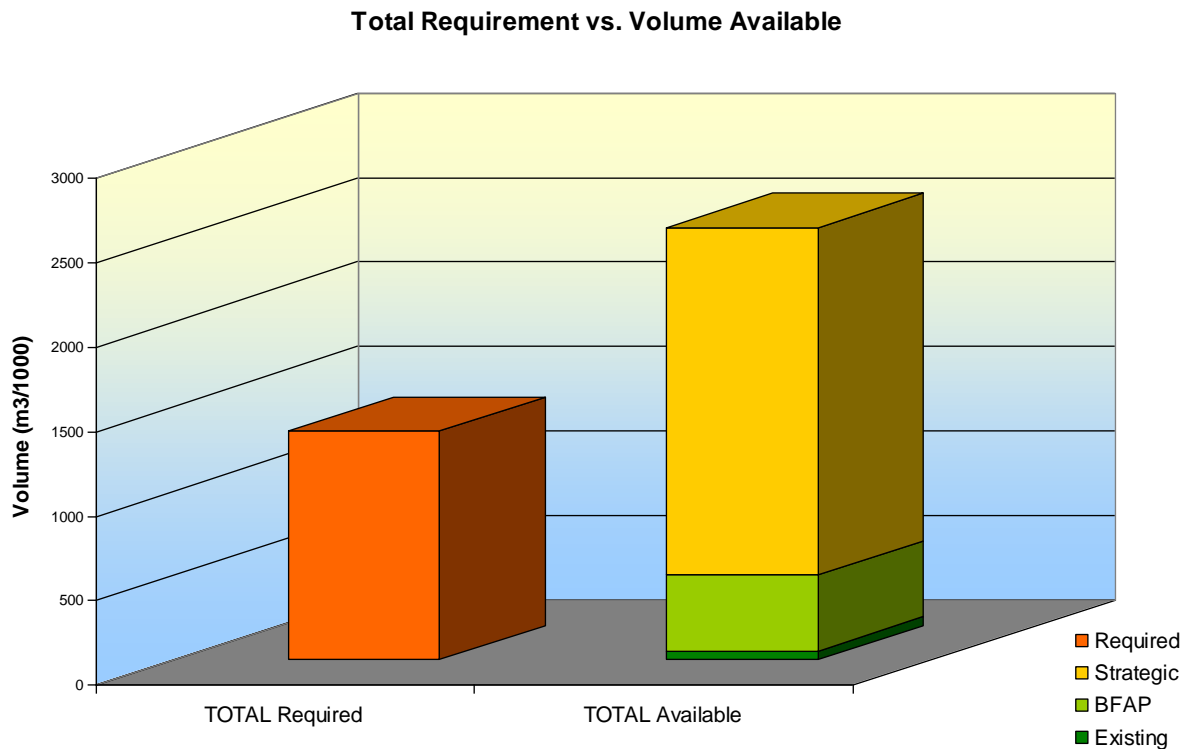


Table 2 overleaf gives an analysis of the requirement against areas available for disposal.

Detailed plans for each management unit have been produced which show the individual sites. Due to issues with confidentiality these plans do not form part of this report. However, set out below is more detail on each individual management units highlighting where any deficiencies lie.

Table 2 - Analysis of Requirement against Areas Available for Disposal

All

Management Unit	Dredging Volume Required From SMS	Volume Required	Volume available in Existing Disposal Areas	Volume Available in BESL setback Areas	Volume Identified in Strategic Disposal Areas	Total Volume Available (all options)	Surplus/Deficit per sub-unit	Overall Management Unit surplus/deficit
Southern Rivers		280,167						
Y2 (Rivers Class C)	33,224	33,224	0	0	15696	15696	-17528	-17528
Y3 (Broad Class C)	28,716		0	0	0	0	0	0
Y3 (Rivers Class C)	12,366	41,072	40,000	0	0	40000	-1072	
Y3 (Rivers)	42,699	42,699	0	47,750	140383	188133	145434	144362
C2 (Rivers Only)	8,991	8,991	2,246	18,000	14594	34840		
W1 (Upper Waveney)	1,146	1,146	0	0	1635	1635	489	489
W2 (Upper Waveney)	17,498	17,498	0	0	97951	97951	80453	80453
W3 (Rivers)	3,529		0	10,000	110344		116815	
W3 (Broad)	18,038	21,567	5,000	38,000	113638	276982	138600	255415
W4 (Breydon)	82,797		0	0	186773		103976	
W4 (Cut)	18,883		7,000	0	0		-11883	
W4 (Lower Yare)	9,384		0	112,000	0		102616	
W4 (Lower Waveney)	2,906	113,970	0	7,500	93296	406569	97890	189983
Northern Rivers		2,426,291						
A2 (Rivers)	31,468		0	0	163894		132426	
A2 (Broad)	153,944	185,412	0	81,250	83934	329077	11240	143665
B2 (Rivers)	15,308		0	0	30667		15359	
B2 (Broad)	1,497	16,805	0	0	8268	38935	6771	22130
B3 (Rivers)	78,360		0	99,000	139220		158660	
B3 (Broad)	361,042	439,402	0	0	211551	449770	-149491	10368
B4 (Rivers only)	24,076		0	29,750	106694		112368	
B4 (Breydon)		24,076	0	0	42677	179121	42677	155045
T2 (Rivers + Dykes)	14,562		0	5,750	32706		23894	
T2 (Hickling Broads & Dykes)	344,030		0	0	208496		-135534	
T2 (Heigham Sound + Candle Dyke)	12,230		0	0	196057		183827	
T2 (Horsey Mere & Waxham Cut)	36,545	407,367	0	0	54217	497225	17672	89858
TOTAL	1,353,229	1,353,229	54,246	449,000	2052689	2555935		

Management Unit A2

The disposal opportunities for this management unit are split into two distinct areas above and below Barton Broad.

Above Barton Broad and due to the extent of the wildlife designations through this section of the Upper Ant, there are no setback areas or other sites which offer the chance for the favoured option of river edge side casting. Despite this there are 23 other sites identified within this management units with an estimated capacity of over 250,000 m³.

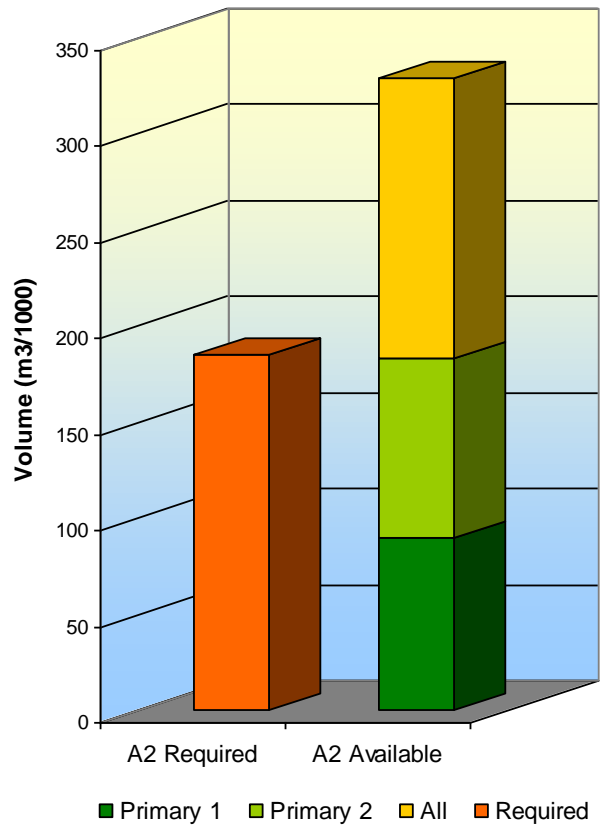
Looking specifically at Barton Broad which has the potential to require the biggest volume of dredgings for disposal, there are three major areas locally which offer disposal potential comprising 7 individual fields. These only provide around half the disposal volume required and it will require haulage of over 2 kilometers to access other upstream sites.

There are numerous opportunities for dredging disposal sites along the remainder of the Upper Ant including options for Sutton Broad, Tylers Cut and the North Walsham and Dilham Canal, (approximately 160,000 m³ identified). From these 6 sites offer the option to side cast and haul the material although clearance and dredging of existing boat dykes may be required to facilitate this operation.

Downstream of Barton Broad, the setback areas (approximately 80,000 m³ capacity) offer the most likely solution to the deficit in disposal volume for Barton Broad although haulage distances to sites below Ludham Bridge may be prohibitive. These sites may better used to address dredging disposal in the Lower Ant itself.

It may also be prudent to investigate disposal solutions within Barton Broad itself as discussed in more detail in section 6 following.

A2 : Requirement vs. Volume Available



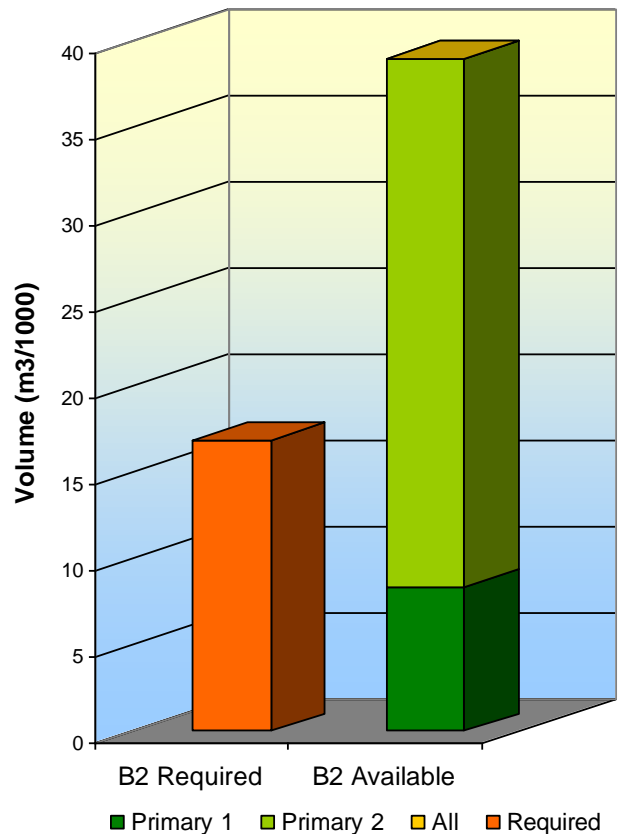
Management Unit B2

This management unit covers the River Bure from Horstead to Wroxham Bridge including Bridge Broad.

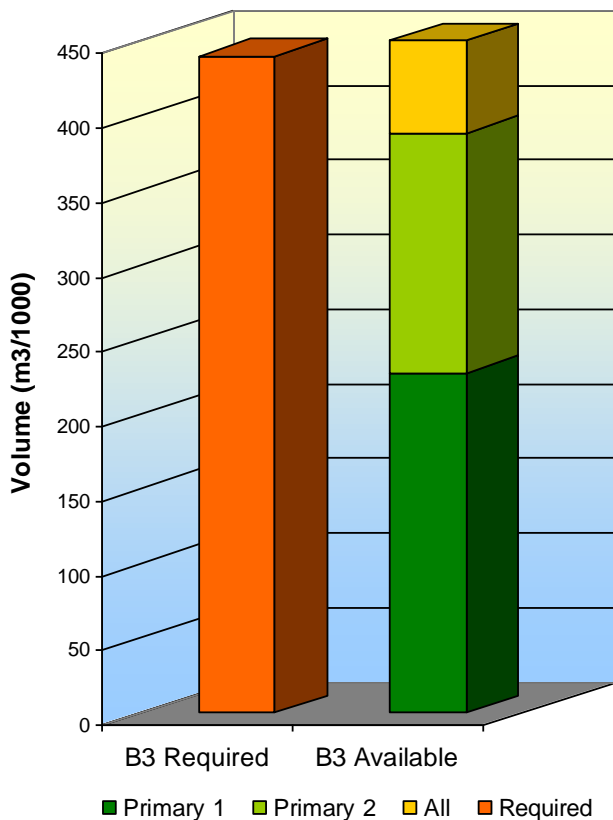
There are three sites totalling 31,000 m³ capacity which have been identified for use for the dredgings from the river. Two are directly adjacent to the river allowing side casting while the third will require either haulage or pumping.

Bridge Broad requires around 1500 m³ to be removed and local land has a dyke capacity for around 8,000 m³. The dredging will need to be pumped or a small boat dyke will need reinstating to allow closer access for haulage.

B2 : Requirement vs. Volume Available



B3 : Requirement vs. Volume Available



Management Unit B3

This management unit covers sites along the River Bure from Wroxham Bridge to Acle Bridge and can again be split into two areas at St Benets.

Above St. Benets the majority of the disposal sites will be required for dredgings from the Broads. Strategic sites have therefore been identified as close as possible to these Broads although all of these sites will most likely require pumping the dredgings in land.

Wroxham. Around 25,000 m³ of dredging capacity is required for Wroxham Broad and two adjacent areas could be used both requiring pumping. One area would be the primary site having an estimated capacity of 21,000 m³, which exceeds the dredging requirement by 90%.

Salhouse Broad. Capacity required 12,000 m³. Area adjacent approximately 19,000

m3 although, again this would have to be pumped.

Hoveton Little Broad. Capacity required 90,000 m3. Area adjacent approximately 28,000 m3. There is a significant shortfall for this Broad and no obvious local solution.

Ranworth Broad. Capacity required 6,000 m3. Area adjacent approximately 49,000 m3.

Cockshoot Dyke /Broad. Capacity required 260 m3. No disposal area required although Ranworth disposal sites could be used if needed.

South Walsham Broad has a requirement for removal of over 110,000 m3 of dredgings. Three areas around the Broad are identified although the estimated capacity is only around 75,000 so additional options would be required.

Malthouse Broad is currently being dredged but shows a requirement for 41,000 capacity. Whilst the land between the South Walsham and Malthouse could be used for disposal, this would increase the short fall at South Walsham. Spare capacity at the Ranworth disposal sites could be utilised with short haulage or pumping or a site near St Benedicts Church.

Downstream of St Benets there are 14 setback and 3 strategic sites offering around 100,000 m3 and 35,000 m3 of capacity for dredging disposal respectively. This offers additional space for disposal from the closer Broads (South Walsham and Malthouse) as well as catering for dredging extracted from the river itself.

All these sites offer the facility to side cast the dredgings straight onto the land.

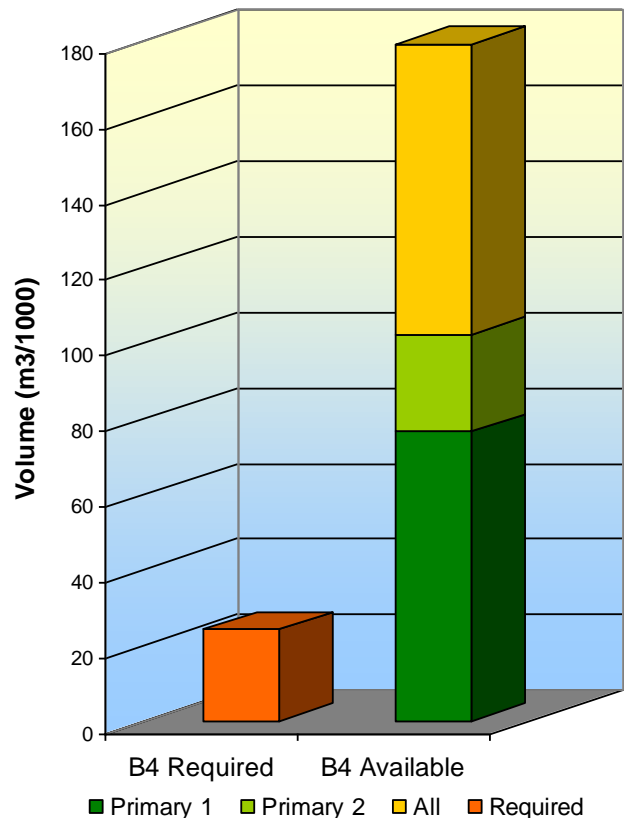
Management Unit B4

This management unit covers sites along the River Bure from Acle Bridge to Great Yarmouth. Whilst there is only a small quantity calculated for removal along the Lower Bure (24,000 m3) and this is adequately covered by setback areas (29,750 m3), 13 strategic areas have been identified which offer future options as the return period in the lower reaches is high.

The most down stream sites also offer the potential opportunity for dredging disposal for Breydon Water.

This is currently managed by the Port Authority but under the Broads Bill will move to Broads Authority jurisdiction.

B4 : Requirement vs. Volume Available



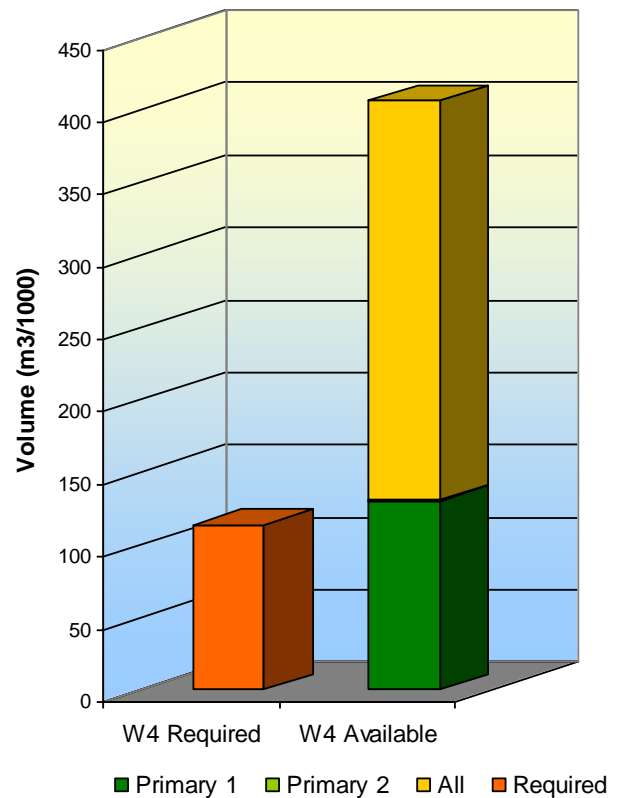
Management Unit W4

This management unit covers sites along the Lower Yare and Waveney from Breydon Bridge to Haddiscoe Cut confluence and Haddiscoe Cut itself. The main source of dredgings will be from the Breydon Water main channel (estimated at 83,000 m³) with the river itself only just under 3000 m³.

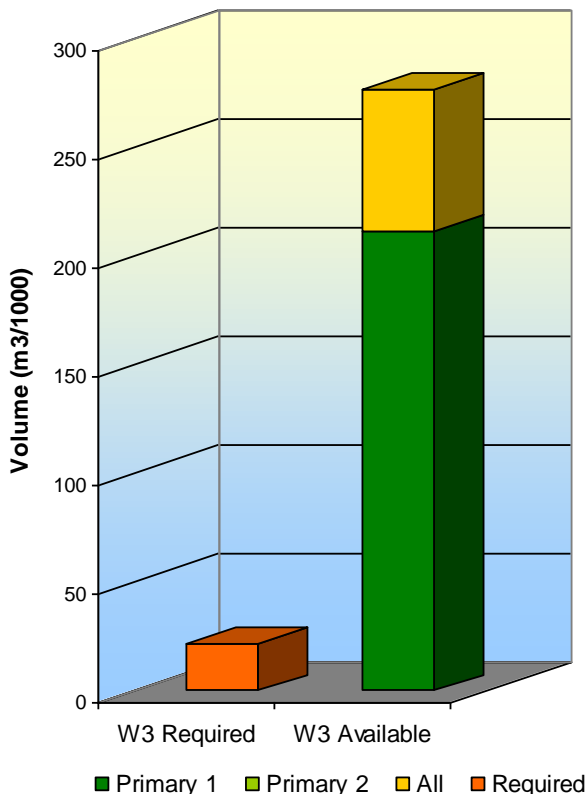
The mud flats around the edge of Breydon make it difficult to dispose of dredging to land with the only point of access likely to be at the pumping station situated at the end of Sandy Lane track, Burgh Castle. Whilst side casting would be impractical, pumping allow access onto the arable fields on Gapton and Burgh Castle marshes with a capacity of over 180,000 m³.

There are existing sites, new setback and strategic disposal site options along the Lower Waveney offering in excess of 100,000 m³ capacity albeit the larger sites would require pumping, which could be used for the river and Haddiscoe Cut dredgings.

W4 : Requirement vs. Volume Available



W3 : Requirement vs. Volume Available



Along the Lower Yare there are no obvious strategic dredging disposal sites mainly due to the large area which has been designated. However, there are sufficient disposal opportunities within the BFAP setback area to prevent this being an issue for a number of years.

Management Unit W3

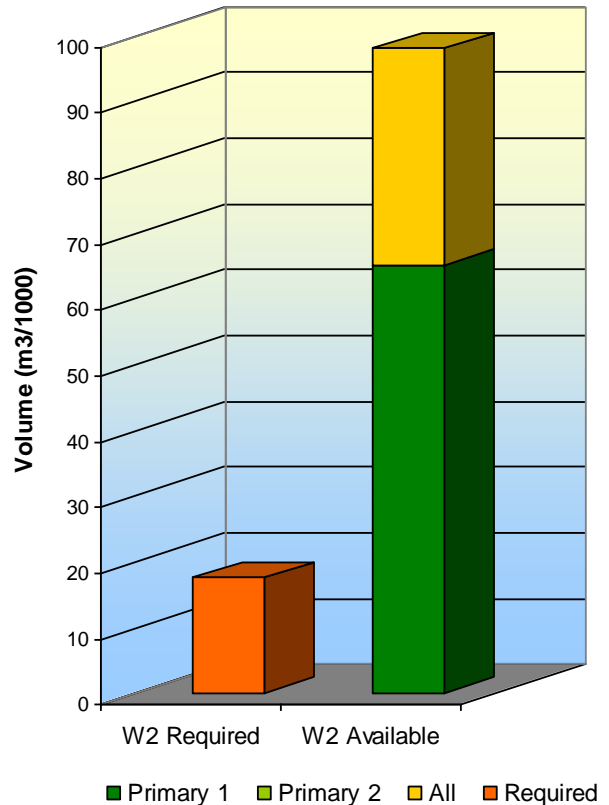
This management unit covers sites along the Lower and Mid Waveney from Haddiscoe Cut to the Waveney River Centre including Oulton Broad. With both the Strategic sites and the BFAP setback areas there is sufficient capacity identified for both the river system and the Broad. The main site identified to serve the Broad into the future (W3/28/001) also offers the ability to side casting from existing piling, although there is some risk to achieving agreement in this location.

Management Unit W2

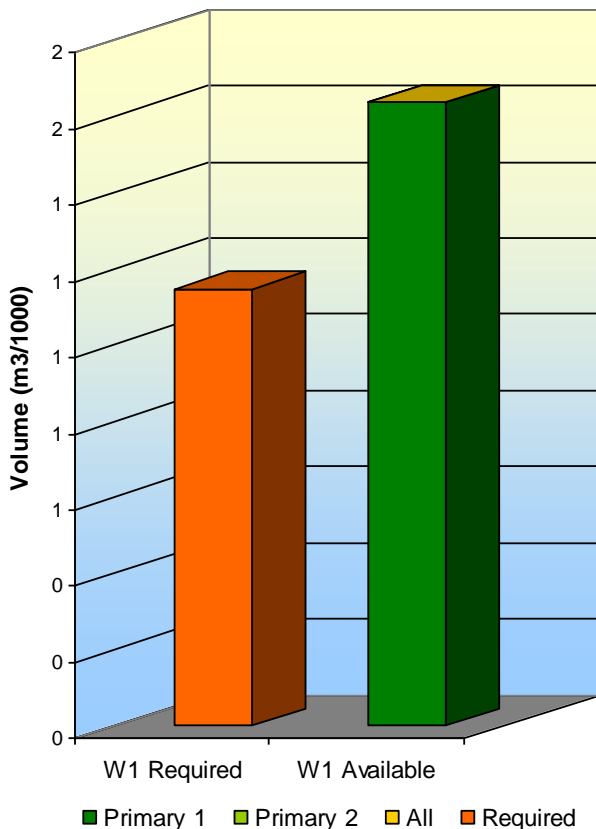
There are currently no existing disposal sites or no BFAP setback areas within the Upper Waveney management unit W2. This extends from the Waveney River Centre to but not including Geldeston Dyke.

The estimated disposal capacity required from the river is around 17,000 m³ and the strategic areas identified provide a capacity around 100,000 m³.

W2 Upper Waveney : Requirement vs. Volume Available



W1 Upper Waveney : Requirement vs. Volume Available



Management Unit W1

There is only a short section of navigable river in management unit W1. This includes the Upper Waveney from just above and including Geldeston Dyke to the footbridge at the Locks Inn.

Broads Authority own a small disposal site at the confluence of Geldeston Dyke and the Waveney (W1/25a/001) which currently has sufficient capacity to cater for dredging from the dyke itself. Additional river dredging would have to utilise sites in management unit W2.

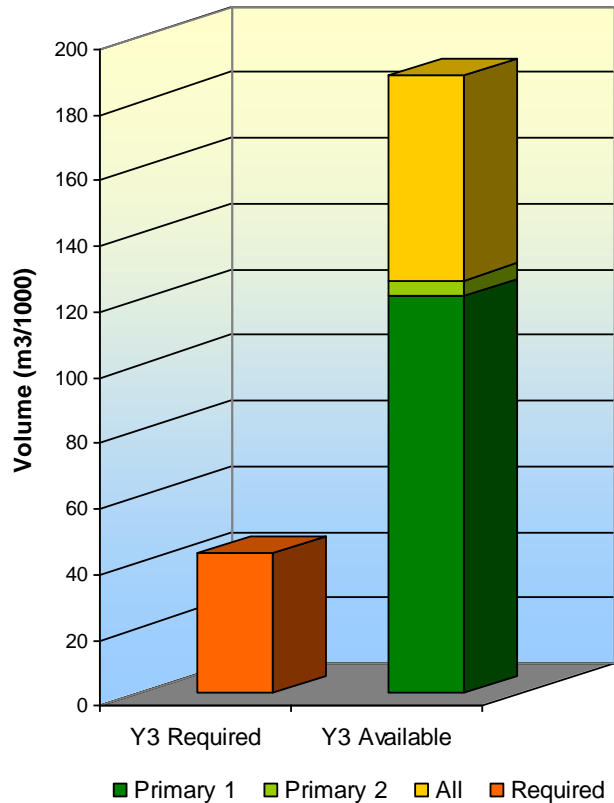
Management Unit Y3

Management Unit Y3 stretches from Reedham swing bridge to Brundall but is truly split in half at Hassingham Fleet Dyke where upstream any mercury contaminated dredgings need to go to a licensed disposal site. The unit also includes both Rockland and Bargate Broads and their associated dyke network.

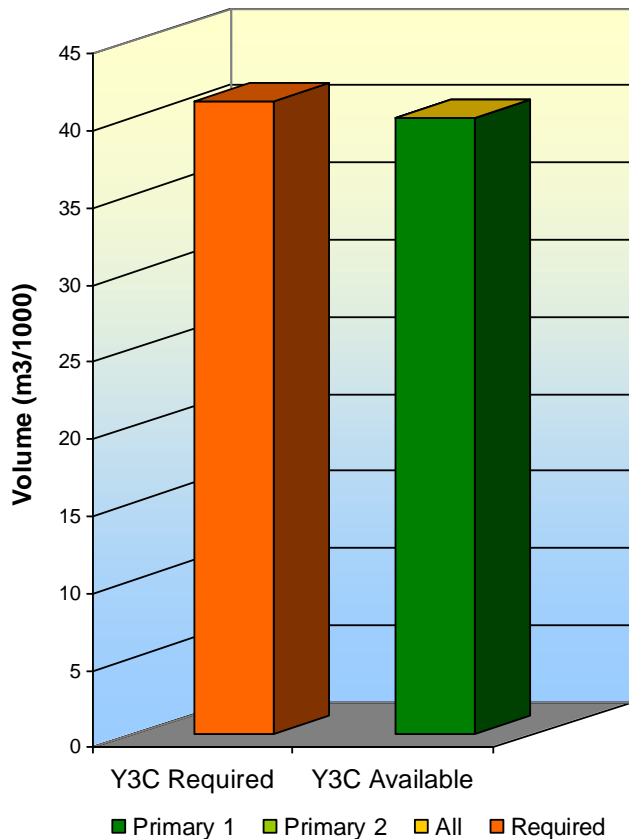
There are no shortage of options for this section of the Yare both in terms of BFAP setback areas and Strategic disposal sites. In total there is just under 85,000 m³ required with over 225,000 m³ identified.

There is currently insufficient capacity at Postwick to cover the potential Class A dredgings in the Yare and the main difficulty will be securing a future site within the area if required, subject to contamination levels.

Y3 Rivers : Requirement vs. Volume Available



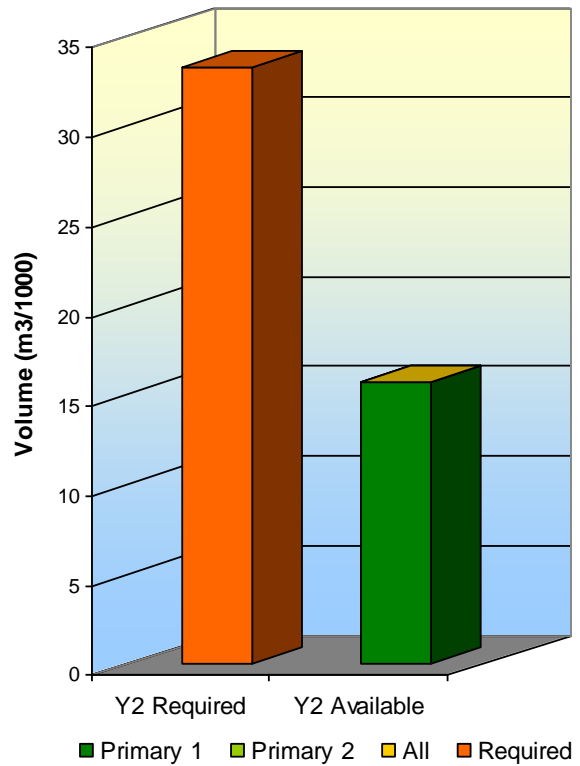
Y3 Class C : Requirement vs. Volume Available



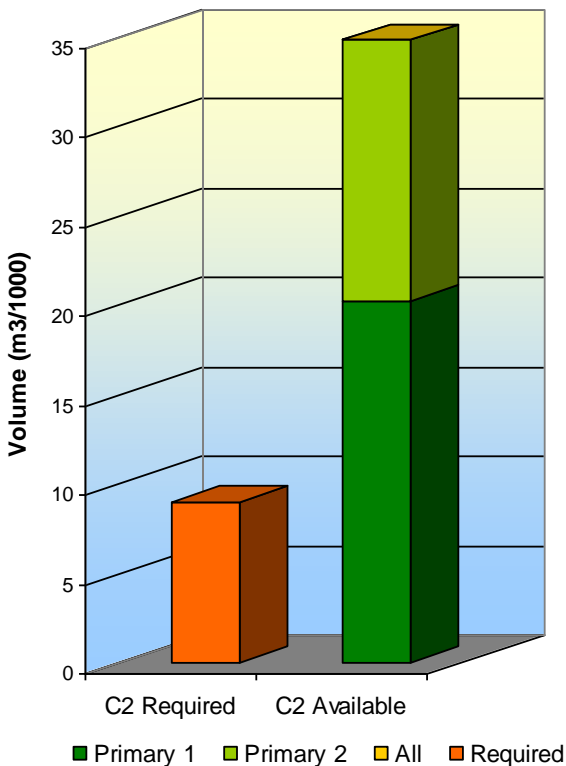
Management Unit Y2

The remainder of the navigable Yare (from Brundall to Trowse Mill) and Lower Wensum (from Yare confluence to Newmills) are covered by Management Unit Y2 with a dredging requirement of 33,000 m³. The best location for a future disposal would be to extend the existing licensed site at Postwick on either side. This would provide sufficient storage for the foreseeable future.

Y2 Class C : Requirement vs. Volume Available



C2 Rivers : Requirement vs. Volume Available



Management Unit C2

This management unit covers the River Chet from its confluence with the Yare to the limit of navigation at Loddon with a dredging requirement of 9,000 m³. With BFAP setback areas (18,000 m³) and strategic sites identified (17,000 m³), capacity for dredging disposal is adequately covered.

Management Unit T2

This management unit covers the River Thurne from the Bure confluence to Waxham New Cut including the major Hickling Broad network. It is the Broads themselves that offer the biggest challenge to disposal with just under 400,000 m³ of dredging capacity required.

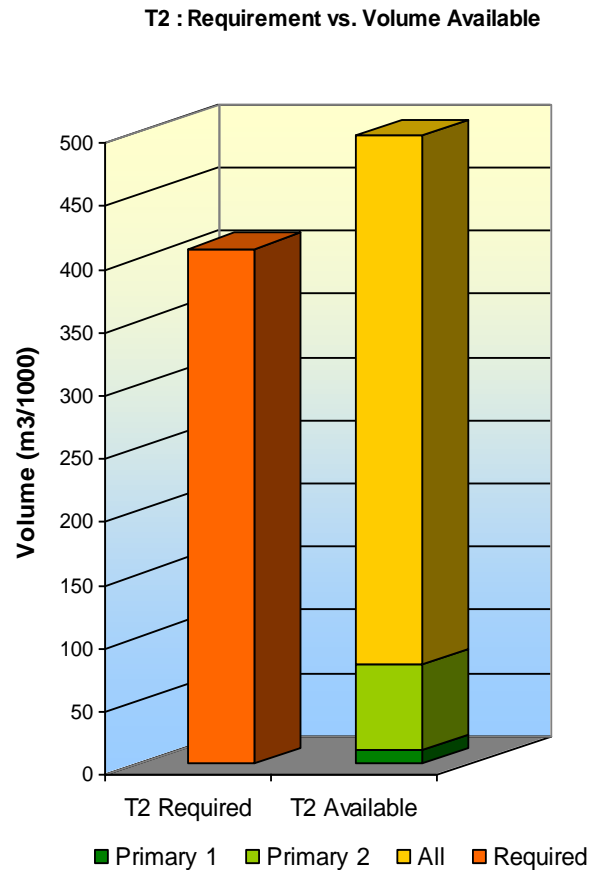
Looking at each individually:-
 Hickling Broad and Channels. There is over 340,000 m³ of dredging identified for removal. 16 sites have been identified with all but one, requiring pumping, offering the potential for around 200,000 m³ of dredging. Whilst this suggests a considerable deficit it is likely that once water level within the calculations have been adjusted then the estimated volume will reduce.

Heigham Sound, Duck Broad, Candle and Meadow Dyke. Requires a capacity of 12,230 m³. Area's identified offer the facility for over 200,000 m³ which could also pick up the short fall in Hickling if required.

Horseley Mere and Waxham Cut. Requires a capacity of 36,000 m³. Areas identified provide around 55,000 m³.

River Thurne including Womack Water, Martham Dyke, Thurne Dyke, etc. Requires just under 15,000 m³ and the combination of BFAP setback areas and strategic sites gives around 40,000 m³.

It should be noted that further work is required to refine spreading rates where salinity may be an issue, and thus could result in changes to the total volume capacity.



Summary of Preferential Disposal Sites

The Sediment Management Strategy January 2007 suggests a dredging requirement of over 1.3 million cubic meters. Taking account of existing sites and sites available through the setback areas within the BFAP (approximately 0.5 M m³), there was a short fall of over 800,000 m³. However, the sites identified as part of this Strategy have now provided a significant surplus which assuming a proportion are subsequently not available through landowner, practical or technical issues should still result in a need/capacity balance.

Nearly all of the preferential sites identified are on arable land. This should also provide a simpler route to usage for dredging disposal with fewer consents required and more possible exemptions.

6. OTHER REUSE AND DISPOSAL OPTIONS

Whilst identification of suitable agricultural land for disposal of dredgings has been the main aim of this project there are other options which should be mentioned which will require further assessment.

Re-use of historic sites

The re-use of dredgings from historic sites like Jenson's Island and Barton should be investigated further. The use of the dredging from Jenson's island is one of two options being assessed as part of the flood defence works at Compartment 28. This would allow either habitat restoration or further use of the degraded site to store dredged material subject to permissions

Disposal off-shore

The Port Authority currently hold a license to dump dredgings at sea. As previously mentioned the Broads Authority could utilise the Port in the future to maintain the channel in Breydon and dispose to sea should the transfer be concluded.

Salt Marsh Creation in Breydon Water

The impact of climate change and rising sea levels will accelerate the recession of salt marsh around Breydon Water turning them into shallow mud flats.

The BFAP has been successful at reinstating saltmarsh both at Berney Arms and at the tip of Haddiscoe Island using gabion baskets as front line protection. It is felt that with consultation with Natural England, it should be possible to re-establish salt marsh using the dredgings from Breydon channel and reverse the current trend.



Compartment 35 – Haddiscoe Island. Gabions installed awaiting dredgings behind.

Restoration of eroded reed bed

Analysis of records of Heigham Sound¹ show that between 1946 and 1977, there has been an increase in open water of some 7 hectares. Conversely, reed swamp has reduced by a similar magnitude. With agreement with the wildlife organisations it should be possible to install suitable erosion protection either to form islands or to fill in bays or inlet.

Indeed, the islands or inlets could be created simply by using a silt screens. These incorporate a floating flexible top section which extends vertically down to the bed where it is anchored with a ballast chain. Dredging can then be pumped in behind the curtain without affecting water quality downstream.

Alternatively, proprietary island creation bags 'benthos bags' are available. These are currently manufactured in small sizes (holding approximately 200 ton of compact dewatered silt) but the prospect of creating large units of a similar nature could be investigated.

¹ The Land Use, Ecology and Conservation of Broadland by Martin George pages 186 -187

7. CONCLUSIONS AND RECOMMENDATIONS

The project has identified that there are a significant number of potential sites throughout the Broads system which could form Strategic Dredging Disposal Sites.

These sites in general do not impact on either designated or ESA land and are typically arable fields where the application of dredgings could offer some benefits.

The next stage is to move towards more site specific analysis of each primary site. This should follow the typical sequence below:-

Prioritise Sites. Prioritise locations in accordance with the Sediment Management Strategy

Site Visit. This should be undertaken to establish if indeed the site is practical to use. This will confirm that data used in the assessment is still up to date, i.e. some arable reversion may have taken place since the ESA records were produced. It will also check that there are no 'show stoppers' which were not apparent from a desk study.

Appoint Land Agent. The transfer of agricultural land is a specialist field and it is important to understand the market and protocols when dealing with landowners. The need for a good land agent to maintain transparency and avoid any conflicts of interest is highly recommended. It also may be prudent to use land agents which are familiar with a specific area and understand the local issues.

Landowners. The first point of contact before any further work is undertaken should be with the landowner. Before any time or money is wasted it is vital to find out whether the landowner is interested in the use of his land for dredging disposal. Prior to meeting them, the Broads Authority should produce a short consultation leaflet which lays out clearly what they are trying to achieve and how they intend to achieve this. It should highlight not only the positive aspects of dredging disposal to land, i.e. soil improvement but also explain the disruption this may cause and the likely timescale for the operation.

It is important to present the landowner with details of the financial arrangement whether the Broads Authority is proposing to purchase the land (for a long term site) or pay compensation for use of the land for short term disposal.

This information is vital if the landowner is expected to make a commitment to proceed with further investigation.

Once an agreement has been reached with the landowner to progress, then further work can continue:

Site Specific Surveys. These will include analysis of existing soil type; baseline ecology surveys, i.e. water vole, dragon fly, dyke surveys, etc.; topographic surveys, i.e. to establish field sizes for compensation, access routes, etc; photographic records.

Planning Permissions/Consents. This should only be required for long term licensed disposal sites and is unlikely to be necessary where the dredging form part of a soil improvement scheme. However, more detailed discussions will need to be undertaken on a site by site basis.

References

The Land Use, Ecology and Conservation of Broadland by Martin George

The Sediment Management Strategy January 2007

APPENDIX A Outline of Brief

BROADS AUTHORITY Strategic Dredging Disposal Sites

Activity
Phase 1 Identification of Long List
Development of GIS based mapping tool
Review existing sediment management documentation for current constraints
Identify new constraints including environmental issues
Identify GIS layers of constraints
Develop a set of technical criteria to assess site suitability
Review current & future methods of disposal
Review and agree haulage distances
Review and agree proximity of site to watercourse
Analysis of legislative policies; planning, waste, minerals
Add layer to GIS
Disposal Site Identification
Review location and capacities of existing sites
Identify flood defence sites (setback areas)
Identify new land based sites against constraints
Add details to GIS
Consultation with partner organisation
Review landowners with land agent
Liaison with BA
Liaison with NE, NWT, SWT, etc.
Reporting
Prepare report

APPENDIX B GIS Layers

GIS DATA SETS

Item	Theme Name	Format	Source	Description
	Base Data			
24	Project Area Map	Raster Map Data	Ordnance Survey	Issued by Environment Agency
25	Rivers and Waterbodies	Polygon Shapefile	Broads Authority	Contains Volumes for Removal Informed by Appendix 2
26	allroutes	Route File	BESL	
23	BA Executive Area	Polygon Shapefile	Broads Authority	
9	Centre line	Route File	BESL	Definition of river chainage
10	Project Area	Polygon Shapefile	BESL	UEA Flood Compartments
	Management Units			
	Primary Environmental Constraints			
16	SAC Broads	Polygon Shapefile	Broads Authority	Part of Constraints Group
17	SPA Broads	Polygon Shapefile	Broads Authority	Part of Constraints Group
18	SSSI Broads	Polygon Shapefile	Broads Authority	Part of Constraints Group
11	Alluvial Forest SAC	Polygon Shapefile	Broads Authority	Part of Constraints Group
12	SSSI Woodland	Polygon Shapefile	Broads Authority	Part of Constraints Group
20	County Wildlife Site	Polygon Shapefile	Norfolk County Council	Part of Constraints Group
21	Planning Conservation Area	Polygon Shapefile	Broads Authority	Part of Constraints Group
22	Broads ESA Tiers 2003	Polygon Shapefile	Natural England	Part of Constraints Group
	Tier 3			
	Fen Tier			
	Secondary Environmental Constraints			
13	Woodlands LBAP	Polygon Shapefile	Broads Authority	Part of Constraints Group
14	Peat Fen	Polygon Shapefile	Broads Authority	Part of Constraints Group
15	Reedbed	Polygon Shapefile	Broads Authority	Part of Constraints Group
19	Heathland	Polygon Shapefile	Broads Authority	Part of Constraints Group
	Technical Criteria			
1	Sediment Characterisation	Point Shapefile	Broads Authority	
2	Volumes for Removal	Route Event	Broadland Environment	Linear Reference informed by Appendix 2 on Centre Line.shp
3	Specification Compliance	Polyline Shapefile	Broads Authority	Suitability of silt for disposal
	Haulage Distance			
	Distance of Site from river			
4	Landparcels	Polygon Shapefile	Broadland Environment	Plan of field margins linked to Dataset of landownership
8	Arable Areas	Polygon Shapefile	Broads Authority	
22	Broads ESA Tiers 2003	Polygon Shapefile	Natural England	Part of Constraints Group
	Tier 1			
	Tier 2			
	Tier 4a			
	Tier 4b			
	Identification of Sites			
	Existing BA sites			
	Existing Setback Areas			
5	Disposal Sites Point	Point Shapefile	Broads Authority	Part of Disposal Sites Group
6	Disposal Sites Rivers	Polyline Shapefile	Broads Authority	Part of Disposal Sites Group
7	Disposal Sites Broads	Polygon Shapefile	Broads Authority	Part of Disposal Sites Group

APPENDIX C EXISTING AND BFAP DISPOSAL SITES

APPENDIX D

STRATEGIC DREDGING DISPOSAL SITES

STRATEGIC DISPOSAL SITES

Summary of Site Details

AREA	PERIMETER	Unit_ID	Comp_ID	Chrono	Unique_ID	Method of Disposal	Prime Site	Approx Capacity of Wet Dredging for Area	Total	Site		
										1 - Sidecast 2 - SC + Haul 3 - Pump	Preference 1.best to 2. worst	Volume @ 10 cm with shrinkage factor of 1.3
110914	1589	A2	38	1	A2/38/001	2	1	16,637				
47571	865	A2	UD01	1	A2/UD01/001	2	1	7,196				
50530	923	A2	UD01	2	A2/UD01/002	2	3	7,580				
34477	1100	A2	UD01	3	A2/UD01/003	2	1	5,172				
121283	2043	A2	UD01	4	A2/UD01/004	3	3	18,192				
88039	1234	A2	UD01	5	A2/UD01/005	3	3	13,206				
22412	606	A2	UD01	6	A2/UD01/006	3	3	3,362				
82092	1155	A2	UD01	7	A2/UD01/007	3	3	12,314				
60264	1317	A2	UD02	1	A2/UD02/001	3	3	9,040				
34932	752	A2	UD02	2	A2/UD02/002	3	3	5,240				
20982	614	A2	UD02	3	A2/UD02/003	3	3	3,147				
22025	605	A2	UD02	4	A2/UD02/004	3	3	3,304				
28108	724	A2	UD02	5	A2/UD02/005	3	3	4,216				
102845	1744	A2	UD02	6	A2/UD02/006	3	3	15,427				
90130	1511	A2	UD02	7	A2/UD02/007	2	1	13,520				
52718	1127	A2	UD02	8	A2/UD02/008	2	1	7,908				
15044	523	A2	UD02	9	A2/UD02/009	3	3	2,257				
60000		A2	UD02	10	A2/UD02/010	3	3	9,000				
90000		A2	UD02	11	A2/UD02/011	3	3	13,500				
290403	3002	A2	UD03	1	A2/UD03/001	2	1	43,560				
71855	1074	A2	UD03	2	A2/UD03/002	3	3	10,778				
68877	1067	A2	UD03	3	A2/UD03/003	3	3	10,332				
86682	1829	A2	UD03	4	A2/UD03/004	3	3	13,002			247,827	
9654	402	B2	UD05	1	B2/UD05/001	1	1	1,448				
45681	877	B2	UD05	2	B2/UD05/002	1	1	6,852				
55120	1091	B2	UD08	1	B2/UD08/001	3	2	8,268				
149109	2089	B2	UD08	2	B2/UD08/002	2	1	22,366			38935	
56736	1023	B3	01	1	B3/01/001	1	1	8,510				
622538	3859	B3	05	1	B3/05/001	1	1	93,381				
66581	1388	B3	09	1	B3/09/001	1	1	9,987				
109178	1334	B3	09	2	B3/09/002	1	1	16,377				
65919	1086	B3	UD06	1	B3/UD06/001	3	2	9,888				
119994	1616	B3	UD06	2	B3/UD06/002	3	3	17,999				
73099	1154	B3	UD07	1	B3/UD07/001	2	1	10,965				
116744	1572	B3	UD09	1	B3/UD09/001	3	3	17,512				
131437	1605	B3	UD09	2	B3/UD09/002	3	2	19,716				
145161	2157	B3	UD09	3	B3/UD09/003	3	2	21,774				
196834	1863	B3	UD10	1	B3/UD10/001	3	2	29,525				
129066	1619	B3	UD10	2	B3/UD10/002	3	2	19,360				
332000	3019	B3	UD10	3	B3/UD10/003	3	2	49,800				
54890	894	B3	UD10	4	B3/UD10/004	3	3	8,233				
118293	1683	B3	UD10	5	B3/UD10/005	3	3	17,744			350770	
212429	2247	B4	09	3	B4/09/003	2	3	31,864				
50864	531	B4	09	4	B4/09/004	2	1	7,630				
192919	2577	B4	10	1	B4/10/001	1	1	28,938				
26565	653	B4	10	2	B4/10/002	1	1	3,985				
55542	1031	B4	10	3	B4/10/003	3	3	8,331				
80947	1169	B4	10	4	B4/10/004	3	3	12,142				
40633	912	B4	10	5	B4/10/005	2	1	6,095				
80147	1210	B4	10	6	B4/10/006	2	1	12,022				
36673	785	B4	10	7	B4/10/007	3	3	5,501				
62979	1020	B4	10	8	B4/10/008	3	3	9,447				
64515	1079	B4	10	9	B4/10/009	3	3	9,677				
40684	822	B4	11	1	B4/11/001	1	1	6,103				
50908	929	B4	11	2	B4/11/002	1	1	7,636			149371	
57712	1338	C2	21	1	C2/21/001	2	1	8,657				
39580	825	C2	21	2	C2/21/002	2	1	5,937				
14975	627	C2	22	1	C2/22/001	1	1	2,246			16840	
143903	1730	T2	06	2	T2/06/001	2	1	21,585				
431917	3098	T2	06	1	T2/06/001	3	3	64,788				
159299	1705	T2	06	2	T2/06/002	3	3	23,895				
247888	1956	T2	06	3	T2/06/003	3	3	37,183				
18500	549	T2	06	4	T2/06/004	3	3	2,775				
18195	571	T2	06	5	T2/06/005	3	3	2,729				
109670	1597	T2	06	6	T2/06/006	3	3	16,450				
4345	269	T2	06	7	T2/06/007	3	3	652				
12550	484	T2	06	8	T2/06/008	3	3	1,882				
23643	950	T2	06	9	T2/06/009	3	3	3,546				
16133	822	T2	06	10	T2/06/010	3	3	2,420				
10593	434	T2	06	11	T2/06/011	3	3	1,589				
20867	601	T2	06	12	T2/06/012	3	3	3,130				
17083	555	T2	06	13	T2/06/013	3	3	2,563				
16880	518	T2	06	14	T2/06/014	3	3	2,532				
18011	549	T2	06	15	T2/06/015	3	3	2,702				
264401	2697	T2	06A	1	T2/06A/001	2	1	39,660				
52695	983	T2	06A	2	T2/06A/002	3	3	7,904				
32987	731	T2	06A	3	T2/06A/003	3	3	4,948				
33420	887	T2	06A	4	T2/06A/004	3	3	5,013				
39523	883	T2	06A	5	T2/06A/005	3	3	5,928				
24864	781	T2	06A	6	T2/06A/006	3	3	3,730				
44902	993	T2	06A	7	T2/06A/007	3	3	6,735				
39804	854	T2	06A	8	T2/06A/008	3	3	5,971				
43645	926	T2	06A	9	T2/06A/009	3	3	6,547				
49605	1014	T2	06A	10	T2/06A/010	2	1	7,441				
260799	2573	T2	07	1	T2/07/001	3	3	39,120				

STRATEGIC DISPOSAL SITES
Summary of Site Details

AREA	PERIMETER	Unit_ID	Comp_ID	Chrono	Unique_ID	Method of Disposal	Prime Site	Approx Capacity of Wet Dredging for Area	Total
						1 - Side cast 2 - SC + Haul 3 - Pump	Site Preference 1.best to 2. worst	Volume @ 10 cm with shrinkage factor of 1/3	
68857	1119	T2	07	2	T2/07/002	3	3	10,329	
50773	1000	T2	07	3	T2/07/003	3	3	7,616	
357997	3632	T2	07	4	T2/07/004	3	3	53,699	
37409	873	T2	07	5	T2/07/005	3	3	5,611	
249184	4086	T2	07	6	T2/07/006	3	3	37,378	
282027	2775	T2	07	7	T2/07/007	3	3	42,304	
11063	445	T2	07	8	T2/07/008	1	1	1,659	
8248	394	T2	07	9	T2/07/009	1	1	1,237	
7742	399	T2	07	10	T2/07/010	1	1	1,161	
17288	730	T2	07	11	T2/07/011	2	3	2,593	
17286	534	T2	07	12	T2/07/012	2	3	2,593	
12508	496	T2	07	13	T2/07/013	2	3	1876	491475
10902	618	W1	25A	1	W1/25A/001	1	1	1,635	1635
104345	1311	W2	23	1	W2/23/001	2	3	15,652	
191116	1895	W2	25B	1	W2/25B/001	1	1	28,667	
130208	1743	W2	25B	2	W2/25B/002	1	1	19,531	
111514	1580	W2	25B	3	W2/25B/003	1	1	16,727	
56048	1193	W2	26	1	W2/26/001	2	3	8,407	
59775	1084	W2	26	2	W2/26/002	2	3	8,966	97951
35989	1028	W3	22	1	W3/22/001	3	3	5,398	
30696	746	W3	22	2	W3/22/002	3	3	4,604	
55478	1040	W3	22	3	W3/22/003	3	3	8,322	
37652	825	W3	22	4	W3/22/004	3	3	5,648	
757589	4075	W3	28	1	W3/28/001	1	1	113,638	
276902	2140	W3	31	1	W3/31/001	3	3	41,535	
12835	530	W3	32	1	W3/32/001	1	1	41,535	
22008	619	W3	32	2	W3/32/002	1	1	3,301	223932
497551	4917	W4	33	1	W4/33/001	3	3	74,633	
92982	1685	W4	33	2	W4/33/002	3	3	13,947	
7800	380	W4	33	3	W4/33/003	2	1	1,170	
23640	661	W4	34	1	W4/34/001	1	1	3,546	
95354	1589	W4	36	1	W4/36/001	3	3	14,303	
97493	1370	W4	36	2	W4/36/002	3	3	14,624	
23828	693	W4	36	3	W4/36/003	3	3	3,574	
32408	785	W4	36	4	W4/36/004	3	3	4,861	
29409	720	W4	36	5	W4/36/005	3	3	4,411	
45086	930	W4	36	6	W4/36/006	3	3	6,763	
34317	785	W4	36	7	W4/36/007	3	3	5,148	
86835	1200	W4	36	8	W4/36/008	3	3	13,025	
96005	1580	W4	36	9	W4/36/009	3	3	14,401	
37585	935	W4	36	10	W4/36/010	3	3	5,638	
90877	1338	W4	36	11	W4/36/011	3	3	13,631	
250224	2331	W4	36	12	W4/36/012	3	3	37,534	
28634	738	W4	36	13	W4/36/013	3	3	4,295	
32201	728	W4	36	14	W4/36/014	3	3	4,830	
32155	727	W4	36	15	W4/36/015	3	3	4,823	
28429	687	W4	36	16	W4/36/016	3	3	4,264	
25542	685	W4	36	17	W4/36/017	3	3	3,831	
39210	824	W4	36	18	W4/36/018	3	3	5,881	
36199	804	W4	36	19	W4/36/019	3	3	5,430	
24944	706	W4	36	20	W4/36/020	3	3	3,742	
78417	1183	W4	36	21	W4/36/021	3	3	11,763	280,069
11590	426	Y2	UD14	1	Y2/UD14/001	1	1	1,738	
66950	1110	Y2	UD14	2	Y2/UD14/002	1	1	10,042	
14894	598	Y2	UD17	1	Y2/UD17/001	1	1	2,234	
11209	552	Y2	UD17	2	Y2/UD17/002	1	1	1,681	15,696
48435	982	Y3	19	1	Y3/19/001	1	1	7,265	
32102	790	Y3	19	2	Y3/19/002	2	1	4,815	
33185	783	Y3	19	3	Y3/19/003	2	3	4,978	
43098	950	Y3	19	4	Y3/19/004	2	3	6,465	
285361	2198	Y3	20	1	Y3/20/001	2	3	42,804	
141488	2236	Y3	21	1	Y3/21/001	1	1	21,223	
297617	2601	Y3	21	2	Y3/21/002	1	1	44,643	
29648	694	Y3	22	1	Y3/22/001	2	3	4,447	
24956	625	Y3	22	2	Y3/22/002	2	3	3,743	140383