Greenwich Peninsula
Land Management Plan
on behalf of English Partnerships

Section B
Component Area Management Plan
2. Inter-tidal Terraces

April 2001

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JOB NUMBER: AC1790			DOCUMENT REF: AC1790/D2/219/4953-e.063			
Draft	Internal Review	GF	AMB	AMB		02/05/00
1	Draft to Client	GF	MW	GF/AMB	J Gibbins	12/05/00
2	Final	GF	AMB	MW		18/04/01
		Originated	Checked	Reviewed	Authorised	Date
Revision	Purpose Description	WS ATKINS CONSULTANTS LTD				

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EXECUTIVE SUMMARY

Some 119.6 hectares of the Greenwich Peninsula in East London have been subject to regeneration measures. The regenerated landscape includes notable areas of green space, which require management. Responsibility for land management for these areas lies with an organisation called the Greenwich Peninsula Trust.

A Land Management Plan has been prepared in relation to this land holding and is in two sections. Section A covers the land holding in general and provides detail on those elements which are best considered at the peninsula-wide scale. Section B comprises a series of five component area plans relating to identifiable management units within the overall holding.

The present document is the first 20 year component area management plan relating to the management of the inter-tidal terraces, which were created at the northern tip and along the eastern side of the peninsula as an innovative experiment in sustainable river edge flood defence. The terraces, in January 2001, supported habitats in their early stages of evolution. Already, however, they were even then already of Metropolitan Value to fish, and as a habitat, of Medium to High (and increasing) Local Value to plants, invertebrates and birds.

The key aims of management are: to develop and maintain healthy, diverse and attractive inter-tidal ecosystems on the terraces in the long-term; to ensure they are safe and educational; to ensure that their ecological development is recorded and to promote dissemination of monitoring data from this landmark scheme to assist in the guidance and development of other river flood schemes in London and elsewhere.

PART 1 – DESCRIPTION

1.1 GENERAL INFORMATION

Location

Two areas of inter-tidal terracing have been created on the Greenwich Peninsula. One is at Blackwall Point TQ390803 and the other along the Eastern River Wall (roughly centered on TQ 398796). These locations within the Greenwich Peninsula are shown in Figure 1.1.

Land Tenure

Details can be found in 'Section A of the Greenwich Peninsula Management Plan'.

Management Infrastructure

Details can be found in 'Section A of the Greenwich Peninsula Management Plan'.

Map Coverage

See Appendix 1 for list of as built plans that cover this area. Details of where these are located within the Management Library can be found in 'Section A of the Greenwich Peninsula Management Plan'.

Document and Photographic Library

See the relevant reference section in 'Section A of the Greenwich Peninsula Management Plan' for documents which relate to this area.

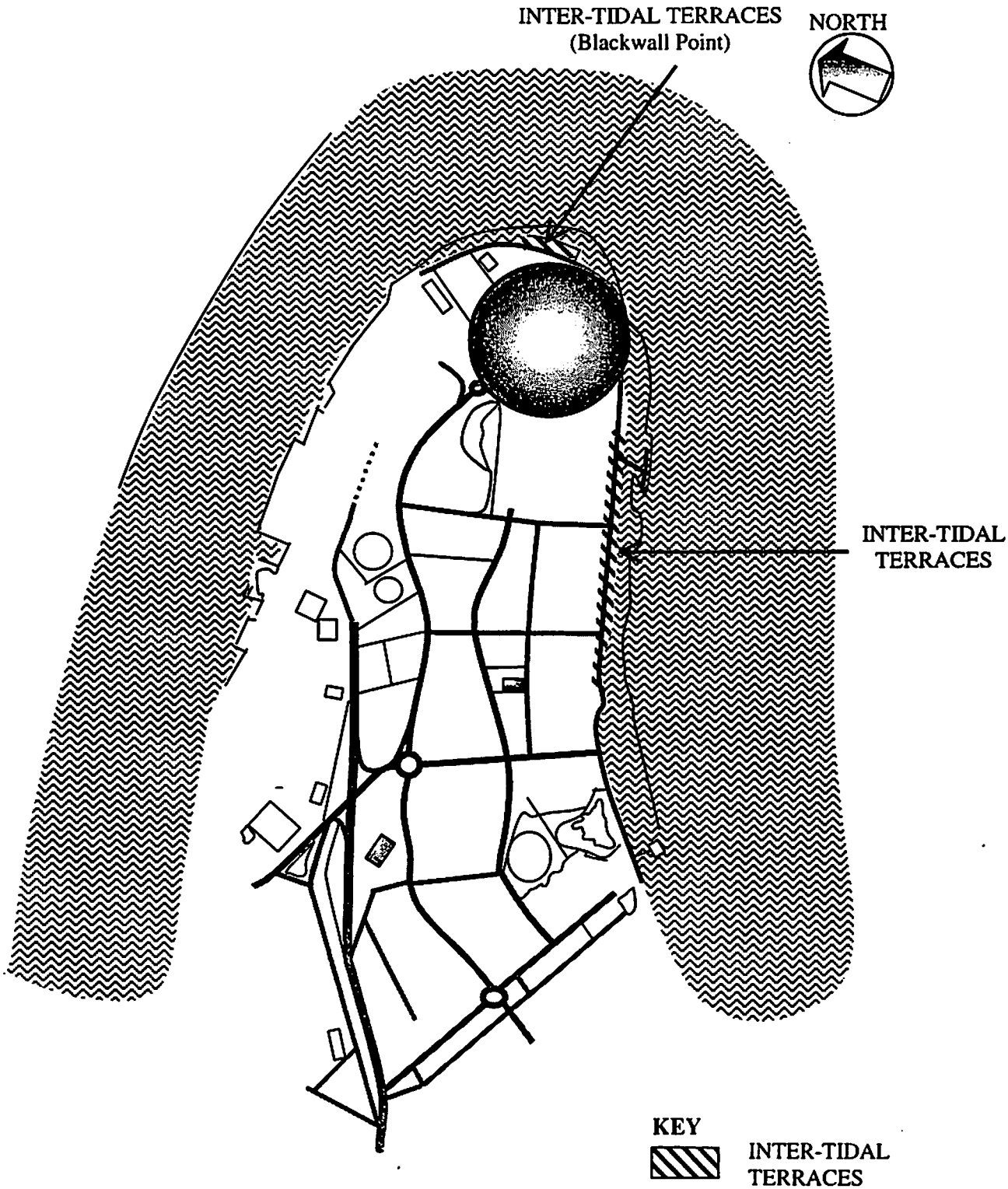
The library locations of further photographic, diagrammatic and other relevant archive information are as follows *(To be filled out as required).*

Management Compartments

There are two geographically separate main areas of terraces, at Blackwall Point and along the eastern side of the peninsula. As regards management, however, both may be considered together. Management compartments relate to the tidal levels at which the terraces occur. In broad terms there are three compartments for management purposes:

- compartment 1 - gravel terrace, below approximately 2.65 m AODN, although some saltmarsh may grow below 2.65m AODN;
- compartment 2 - saltmarsh terraces between approximately 2.65 and 3.75 m AODN;
- compartment 3 - reedbed terraces above around 3.7 m AODN, planted only with the Common Reed *Phragmites australis* (Blackwall Point only).

Figure 1.1 - Location of Intertidal Terraces within the Greenwich Peninsula



1.2 ENVIRONMENTAL INFORMATION

Physical

Climate

Details can be found in 'Section A of the Greenwich Peninsula Management Plan' for general climate data for the area.

Geology, Geomorphology, and Hydrology

Details can be found in 'Section A of the Greenwich Peninsula Management Plan' of the general geological, geomorphological and hydrological characteristics of the peninsula.

The terraces experience both wave action and current flows (see Bibliography Section 4.0 (Battle McCarthy 1997a, 1997b). Maximum wave heights have been estimated not to exceed 0.5m, and flow velocities over the main part of the terraces in the unvegetated state were predicted not to exceed 0.25m/s. It was predicted at the design stage that flows would be significantly lower than this through established vegetation. No actual data for the constructed terraces have been collected at the time of writing. The number of submergence events and hours of accumulated submergence time at different tidal levels are as follows:

Mean High Water Springs (+3.75m ODN): 226 submergences = 12.4 days per year
Mean High Water Neaps (+2.6m ODN): 530 submergences = 57.3 days per year

Along the Greenwich Peninsula, salinity of the river ranges between 1 and 7 parts per thousand (ppt). Brackish waters are generally classified as occurring in the range between 0.5 and 30 ppt, so salinity in the main river at Greenwich varies at the lower end of the brackish range. Salinity levels can fall further when the Thames Barrier is closed. Salinities are also lower in the winter than in the summer months due to rainfall. On the terraces themselves local evaporation may lead to much higher salt concentrations, but the average has been predicted to be around 4 to 5 ppt. Sediment concentrations are in the range 50-250 parts per million (ppm) exceptionally reaching 400 ppm. Dissolved oxygen levels in the main Thames vary from 70% to 80% saturation in the winter to around 50% in the summer. Levels of dissolved oxygen over the terraces are likely to be much higher and not limiting to flora and fauna.

Soils/Substrates

Research has suggested that the foreshore level adjacent to the Greenwich Peninsula oscillates around an approximate long-term equilibrium level (Bibliography Section 4.0 - Battle McCarthy 1997a, 1997b).

A variety of possible specifications for the growth medium (which was installed to a mean depth of 500 mm) were considered. Factors considered include: suitability to encourage rooting and strong growth of saltmarsh plants, resistance to erosion by wave action and storm events, and suitability as habitat for macroinvertebrates and fish / fish fry. The likelihood and probable extent of natural sediment deposition were also considered. The eventual specification for substrates in each of the three compartments was as Table 1.1.

Table 1.1 - Substrate Specification

Compartment	Composition	Sources of Materials
Compartment 1 Shingle Beach	• 150mm thick layer of natural rough angular cobbles 30-75mm diameter	Rossers Quarry, Daviot, Inverness
	• 300mm thick bottom layer as follows:	
	42% sand & gravel dredged balast 43% single size gravel	United Marine Aggregates Ltd, Outer Thames Estuary/English Channel/North Sea sources.
	10% natural rough angular cobbles 30-75mm dia	Rossers Quarry, Daviot, Inverness
	5% Topsoil	Ellerby Topsoils Ltd, Kent
Compartment 2 Saltmarsh	• 250m thick layer as follows:	
	50% silt 25% sand 0.06-2mm dia 25% coarse gravel 2-16mm dia	United Marine Aggregates Ltd Outer Thames Estuary/English Channel/North Sea sources.
	• 250mm thick bottom layer as follows:	
	50% topsoil 25% sand 0.06-2mm dia 25% coarse gravel 2-16mm dia	Ellerby Topsoils Ltd, Kent United Marine Aggregates Ltd, Outer Thames Estuary/English Channel/North Sea sources
Compartment 3 Reedbed	As Compartment 2	As Compartment 2

Several months after installation, despite the problem described below with matting, the substrates had sorted well to give a semi-natural beach appearance. Little erosion had occurred, and notable deposition of fine silts had deposited where terrace level fell below mean high water neap level.

Other installed features of the substrate included lines of boulders of material granite 300-500mm diameter sourced from Bartons Quarry, Leicestershire. These were located both parallel to and perpendicular to the direction of wave action. The majority of boulders were positioned in the northern section of the eastern river wall, which was the chosen location for planting trials. Subsequent to the recording of what could be readily deduced from the trials (despite the effects of the matting) proposals were made for re-aligning the boulders to create horizontal breakwaters only. (See Bibliography Section 4.0; Wells 1999).

The substrate in the saltmarsh and reedbed terraces were initially protected by loop matting of two specifications (one containing a polypropylene mesh). The mattings were approximately 2 cm thick, attached to the front and back gabions using standard gabion 'C' clips. The mattings may or may not have protected the substrates during storm events, but did lift several months after installation thereby damaging and uprooting planted material and

becoming unsightly. In autumn 1999, Environment Agency staff manually cleared the matting still visible above ground.

Human/Cultural

Archaeology and Past Land Use

Refer to the Peninsula-wide plan for an account of prehistoric and historic land use and the palaeobotany of the peninsula.

The lengths of the peninsula's 'coast' where terraces were created were formerly areas of wall decay and degradation. At Blackwall Point, the terraces are located in an area which used to flood on Highest Astronomical Tides as recently as the turn of the 20th century. (Bibliography Section 4.0 Ede / Battle McCarthy 1996).

Present and Predicted Land Use Categories

The terraces have been constructed primarily for purposes of nature conservation, fisheries (nursery, refuge and marginal feeding zone) and environmental education. There is no unauthorised access to the terraces and no navigational or mooring function. The terraces serve a major function in terms of visual amenity for pedestrians, the inhabitants of Central Village and visitors to the Dome.

Landscape Context

Details can be found in 'Section A of the Greenwich Peninsula Management Plan' for the site wide and surrounding context. On a peninsula-wide scale the ecological terraces are part of the Riverside Walk and Meridian Gardens sites.

Details of Recreational Uses

Passive visual amenity (including wildlife watching). Fishing and other activities are not permitted over the terraces areas.

Public/Organisational Interest and Involvement - Present and Predicted

Details can be found in 'Section A of the Greenwich Peninsula Management Plan'.

Educational/Research/Interpretational Uses and Facilities

Details can be found in 'Section A of the Greenwich Peninsula Management Plan'. An interpretational board has been placed by English Partnerships.

Biological and Ecological

Flora

The terraces did not exist before the project for regeneration was implemented. Nevertheless data existed in relation to the plants that had colonised parts of the river wall, and to the nearby foreshore; these data were collated. Surveys were undertaken of foreshore

invertebrates close to the sheet piling. Results are summarised in Part 2 of this plan (Evaluation). The northern section of terraces on the eastern river wall was initially subject to trial planting in June-July 1998. Common Reed, *Phragmites australis* Hemlock Water-dropwort *Oenanthe croccata,* Wild Angelica *Angelica sylvestris* and Sea Club-rush *Bolboschoenus maritimus*, were the only appropriate species which were commercially available and these were planted as a mixture of plugs, 9cm and 2 litre pot sizes. A small amount of Common Club-rush *Schoenoplectus lacustris* was also planted.

The main remaining areas of the terraces at the appropriate tidal height were planted in July and September 1998. Common Reed and Sea Club-rush were planted in large quantities along with varying quantities of English Scurvygrass *Cochlearia anglica*, Sea Aster *Aster tripolium*, Lesser Sea-spurrey *Spergularia marina*, Sea Arrowgrass *Triglochin maritimum*, Sea Milkwort *Glaux maritima*, Saltmarsh Rush *Juncus gerardii*, Sea Plantain *Plantago maritima*, and Common Glasswort *Salicornia europaea.* Of these species Common Glasswort was particularly experimental as its current distribution on the tidal Thames does not extend more than 1 km upstream of Cayford Ness. Only Common Reed and Sea Club rush were commercially available – the remaining species were obtained from a 'Donor site' at Erith and translocated. The lifting of the erosion protection matting notably compromised the survival of this planting. In April 1999 a provisional assessment suggested that Common Reed had survived quite well as had areas of Sea Club-rush. Plants of Sea Aster and Hemlock Water Dropwort appeared also to have survived and Common Scurvygrass had appeared to self seed or recolonise quite well. Some plants of the annual Celery-leaved Buttercup had also colonised.

In autumn 1999 the terraces were planted and replanted with a number of species - building on the lessons learned from the previous 12 months. The species comprised:

Sea Arrowgrass *Triglochin maritimum, Sea* Spurrey *Spergularia media,* Sea-purslane *Atriplex portulacoides,* Common Glasswort *Salicornia europaea,* Common Saltmarsh Grass *Puccinella maritima,* Sea Aster *Aster tripolium,* Spear-leaved Orache *Atriplex prostrata,* Sea Beet *Beta vulgaris spp. maritima,* English Scurvygrass *Cochlearia anglica,* Sea Milkwort *Glaux maritima,* Grey-Club rush *Schoenopleatus tabernaemontani,* Wild Angelica *Angelica sylvestris,* Sea Plantain *Plantago maritima.*

Details of locations of all plantings mentioned here may be found in the project drawings listed in Appendix 1. A number of the species planted are considered uncommon in London (see Table 1.2). Use of these species was an international, recorded, experiment to test the hypothesis of whether species were absent from many sections of the tidal Thames because of habitat loss, or because of varying species tolerance of the prevailing conditions (mainly salinity).

Table 1.2 - Plants Considered Uncommon in London have been Planted on the Greenwich Intertidal Terraces

Scientific Name	Common Name	Rare (in London – less than 5% tetrads Source: London Biodiversity Audit 2000	% 2 x 2 km tetrads in London Source: Burton 1983
Aster tripolium	Sea Aster	•	5
Atriplex sp.	Oraches		0
Beta vulgaris maritima	Sea Beet		7.75
Bolboschoenus maritimus	Sea Club-rush		5.5
Cochlearia anglica	English Scurvy-grass		1
Glaux maritima	Sea Milk-wort		1.25
Juncus gerardii	Saltmarsh Rush		1.25
Plantago maritima	Sea Plantain		0.75
Salicornia sp.	Glasswort		0
Schoenoplectus lacustris	Common Club-rush		4
Spergularia marina	Lesser Sea-spurrey		0.75
Spergularia media	Greater Sea-spurrey		0.75
Triglochin maritimum	Sea Arrowgrass		2

Fauna

Historic data on invertebrate fauna of and close to the river wall are contained in Bibliography Section 4.0 (University of Wales 1996; Unicomarine 1998; and Physalia 1998). Essentially, before construction, the fauna was of low inherent nature conservation value, but in places valuable as a food resource to fish and birds. Some data were available on the use of the wall near Blackwall Point as a roost site by waterfowl. At Blackwall Point an important roost (Borough to Metropolitan Importance) of 15 to 20 Grey Herons on the undisturbed sheet piling occurred, adjacent to valuable feeding grounds in the inter-tidal gravels and shingles extending out from the point.

An assessment of the invertebrate fauna of the inter-tidal terraces soon after construction was undertaken by Physalia Ltd on direct commission from the Environment Agency in November 1998. The incipient invertebrate fauna included extremely abundant meiofauna - especially nematodes and abundant small brackish water gastropod molluscs *Assiminea grayana* associated with algal growth. Below the larger rocks there were large concentrations of the estuarine isopod *Lekanesphaera rugicauda*. Various salt-tolerant insects were also present including springtails, chirnonomid midge larvae and tipulid fly larvae. It is significant that many species found in November 1998 were not particularly pollution tolerant, whereas nearly all species in the foreshore below the terraces are stress-tolerators.

Data from the Environment Agency suggest that fish and fish fry started using the terraces in large numbers almost immediately. The authors are unaware of any other data on any faunal group that may have been collected/compiled since terrace construction.

Communities

Recognised semi-natural communities on the river walls before terrace construction were almost non-existent. The inter-tidal invertebrate community was typical for a pollution-stressed benthic and oligo-mesohaline brackish system. Fish communities in the tidal Thames have improved steadily in species-richness and diversity over time since the nadir in the 1960s. In the last decade of the 20th Century the Thames became the cleanest metropolitan estuary in Europe boasting over 100 species of fish. (See Bibliography Section 6.0: Environmental Agency 1998a and b).

1.3 LANDSCAPE DESIGN STRATEGY

The terraces were constructed by cutting down the existing river wall and erecting a new flood defence (as a simple cantilever concrete wall) at a position some 7 to 10 m inland of the former defence. The construction of the new river wall in this way was undertaken as an environmentally enlightened alternative to 'raking', that is, the installation of a new sheet-piled wall with new wall ties a short distance in front of the existing wall. Raking is expensive, especially because of the wall ties which may extend some 10 m or more inland from the sheet piling.

The creation of the terraces necessitated the cutting into and removal of contaminated back-fill. Cross-sections of typical construction and details of how leaching-out of contaminants was prevented / reduced are provided in the library Drawing Reference Appendix 1. The height of the lowest terrace was determined largely by the predicted structural stability of the remaining part of the original wall. Partly because of this, and partly to create visual and ecological variety, terrace levels undulate in broad keeping with the height of the foreshore sediment (which has remained remarkably stable over recent decades). Intermediate terraces were created using steel-mesh gabion baskets.

Key design parameters were that:

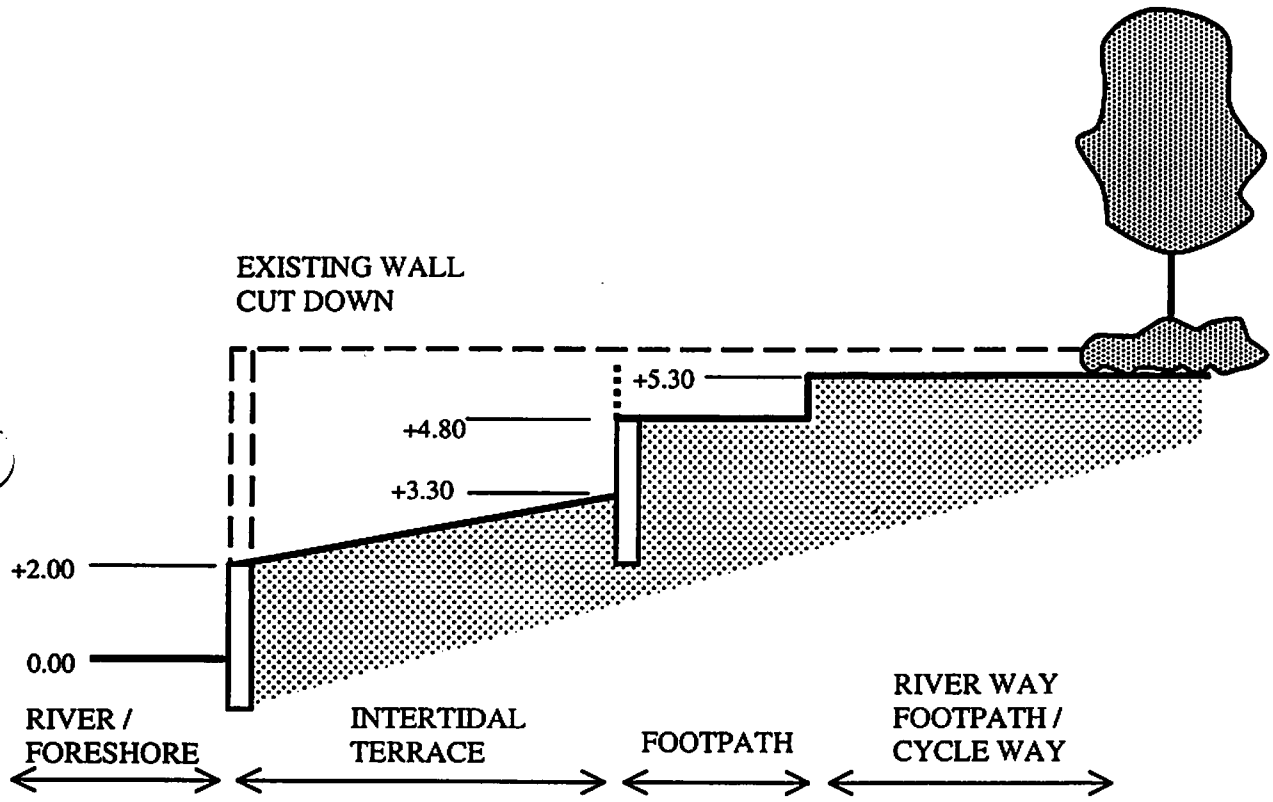
a) saltmarsh was likely to grow mainly between mean high water spring and mean high water neap tide marks; and

b) the maximum acceptable slope for stable saltmarsh would be 1:7.

An important point to reiterate here is that whilst the inter-tidal terraces are fundamentally a natural system, and natural colonisation is to be encouraged, there is also a design intention in several respects. Areas of the terrace are to be kept relatively clear of dense vegetation to encourage use by waterfowl, and it is also intended that attempts be made to reflect design lines e.g. along the river walkway in the developing vegetation by appropriate management. The aim is to achieve an impressive visual aesthetic whilst also ensuring continued ecological function.

A key visual aim is to break the monotonous and oppressive appearance of continuous sheet piling as viewed from the tideway. An associated aim is to bring the river closer to people, in reality and conceptually, hence improving the public perception of, care for, the tideway as a focal resource in the Capital.

Figure 1.2 - Stylised Cross Section through Intertidal Terrace



PART 2 – EVALUATION & OBJECTIVES

2.1 SITE EVALUATION

Nature Conservation and Biodiversity Evaluation of Site

Table 2.1 - Historic Nature Conservation Value

Feature	Description	
Plants and plant communities on river wall	Very few plant species and very few individuals. Documented in Bibliography Section 4.0 (WS Atkins 1997), and Section 6.0 (Ecoscope 1995b). Main plants were algal species tolerant of low water quality.	Low Local Value
Invertebrate communities on sheet piling	Largely devoid of invertebrates life due to lack of colonisation niches. No terrestrial invertebrate survey data collated.	Low Local Value
Invertebrates of adjacent foreshore	See Bibliography Section 4.0 (WS Atkins 1997; Unicomarine 1998; and University of Wales 1996). Abundant Ragworms and small shore crabs, with some shrimp-like species e.g. *Corophium palustre* and *Gammarus adachis.*	Variable: Low to High Local Value
Fish:		
Sheet piling		Negligible Local Value
Foreshore Immediately Adjacent to Wall	Negligible number of niches for foraging or shelter value in site-specific terms not assessed.	Metropolitan Value as part of overall Site of Metropolitan Importance foraged by many fish. Also part of spawning grounds for Sand Smelt.
Birds	Grey Heron roost near Blackwall Point	Metropolitan Value
Sheet piling	Teal roost site close to current Yacht club	High Local Value
	Other areas	Low Local Value
Foreshore Immediately Adjacent to Wall	Limited use but part of important waterfowl population	Medium Local Value

Flora: Spring 2000

The most recent data on the floristic composition of the terraces is based on the September 1999 planting plans. Natural plant colonisation is a feature that is intended be encouraged on the terraces. Because of this and because of interactions between flora and fauna, the flora

will change over time as the whole system matures perhaps to some semi-stable climax community.

Fauna: Spring 2000

Populations had without doubt changed since the 1998 Physalia survey, as much of the matting has been removed and considerable further planting had been undertaken, but it is likely that species dominant in 1998 were still present in abundance. The sections of terrace in the supra-littoral zone had probably started to be colonised by a variety of flies and spiders.

No data had been collated on the current value of the terraces to fish or birds.

Communities

No true semi-natural climax saltmarsh communities are present.

Table 2.2 - Nature Conservation Value – 2000

Element	Description	Evaluation
Habitat Complex	Inter-tidal habitat features between 0.5 m AODN and above mean high water springs, including shingle, saltmarsh and reedbed habitats.	Metropolitan Value as part of Site of Metropolitan Importance with potential for steady increase in biodiversity.
Saltmarsh flora	Planted and self-seeded saltmarsh community in very early stage of maturation.	Medium Local Value until the success of the planting/colonisation can be fully confirmed
Reeds in reedbeds	Common Reed *Phragmites communis* beds planted in July 1998. Damaged by subsequent publicity events and access by the public.	High Local Value at present until the success of the planting/colonisation can be fully confirmed
Invertebrates	Already colonised by a number of species (Bibliography Section 4.0: (Physalia 1998).	High Local Value
Birds	Unknown at present.	Probably High Local Value
Fish	Current high level of use of the terraces by fish and fish fry is documented by the Environment Agency (pers. comm.).	Metropolitan Value

Predicted Future Value

It is predicted that, with careful management, the terraces will develop Metropolitan or higher importance for all the taxa listed above. Fish-saltmarsh community associations typical of estuarine upper reaches in non-modified estuarine systems may develop in time.

Site Value in the Wider Perspective & Implications for Management

This issue is dealt with strategically in Section A of the Greenwich Peninsula Management Plan. With specific regard to the terraces, however, extra emphasis must be added. The inter-tidal terraces are the most experimental and innovative features within the Greenwich Peninsula landscape. They have been constructed as a potential exemplar of best practice for flood defence refurbishment in London and other metropolitan estuarine settings. Information on the techniques used and planting attempted has a politically very wide audience amongst scientists and landscape designers both nationally and internationally. Every opportunity should be taken, via monitoring to inform this audience of the project from costs to technological and ecological benefits.

Key Environmental Relationships with Implications for Management

The precise development of the terrace ecosystems is difficult to predict. Tidal immersion time, substrate type and salinity are the three factors likely to have the greatest influence on plant and animal community development on the terraces. The main plant growth is expected to occur above MHWN - although in some areas plants will grow at lower tidal levels.

The balance between accretion and erosion is difficult to predict. There seems at present to be net erosion of fine sediments above MHW and accretion below this - though only to a depth of some 10 to 25 cm. Whether this represents a stable equilibrium position remains to be seen. Interactions between occasional strong erosive forces (during storms) and plants/substrates may exert notable effects on invertebrate communities and hence the communities of foraging fish and birds. Sediment transport processes in the river as a whole may affect nutrient flow into the terraces, although the relative contribution of this at higher tidal levels will decrease relative to locally generated inputs from plant and animal decay in the maturing ecosystem.

As the plant communities mature it may be that higher animals could play a notable role in modifying vegetation. Various species of fauna may play significant roles in dispersal of plant propagules.

As regards salinity, the position of the surface water outfalls are already affecting species composition. Such differences are likely to increase in terms both of species composition and biomass. Where erosion pockets and pools develop at higher tidal levels, high salinities may occur, especially in summer due to evaporation. Such pools may become significant microhabitats for a variety of flora and fauna.

As sedimentation modifies the internal structure of gabions, so the invertebrate communities within the gabions will evolve. In the short to medium term at least, notable diversification would be expected.

2.2 MANAGEMENT POLICY

Refer to 'Section A of the Greenwich Peninsula Management Plan' for peninsula-wide policy.

AIM: To develop and maintain healthy appropriately diverse and attractive inter-tidal ecosystems on the inter-tidal terraces.

Table 2.3 – Ideal Management Objectives

NUMBER OF IDEAL OBJECTIVE	DESCRIPTION OF OBJECTIVE
IDEAL OBJECTIVE 1	TO DEVELOP AND MAINTAIN HEALTHY APPROPRIATELY DIVERSE AND ATTRACTIVE INTER-TIDAL ECOSYSTEMS ON THE INTER-TIDAL TERRACES.
IDEAL OBJECTIVE 2	TO ENSURE THAT THE TERRACES DO NOT BECOME ASSOCIATED WITH ANY HAZARDS TO HUMAN HEALTH OR SAFETY.
IDEAL OBJECTIVE 3	TO PROMOTE EDUCATIONAL OPPORTUNITIES FOR ACADEMIC STUDENTS AND THE INTERESTED PUBLIC.
IDEAL OBJECTIVE 4	TO MONITOR THE DEVELOPMENT OF THE TERRACE ECOSYSTEMS.
IDEAL OBJECTIVE 5	TO UTILISE THE DATA COLLATED FROM MONITORING TO DEVELOP NEW METHODS FOR THE CREATION OF INTER-TIDAL TERRACES AND OTHER ALTERNATIVE FORMS OF FLOOD DEFENCE AND TO DISSEMINATE THIS INFORMATION TO THOSE ORGANISATIONS INVOLVED IN THE CONSTRUCTION OF FLOOD DEFENCES.

Table 2.4 - Ideal Management Objectives and Prescriptions

Objective Number	Operational Objective	Outline Prescriptions
IDEAL OBJECTIVE 1:	TO DEVELOP AND MAINTAIN HEALTHY APPROPRIATELY DIVERSE AND ATTRACTIVE INTER-TIDAL ECOSYSTEMS ON THE INTER-TIDAL TERRACES.	
Operational Objective 1.1	Permit and encourage appropriate natural colonisation of saltmarsh compartment.	1.1.1 Ensure key maintenance staff/foreman able to identify plant species or are accompanied by botanists when performing major maintenance work. 1.1.2 Refer decisions to remove or modify areas of self-seeded vegetation to the Environment Agency. 1.1.3 (As per Operational Objective 1.2).
Operational Objective 1.2	Prevent excessive dominance by one species in the saltmarsh compartment, especially Common Reed.	1.2.1 Annually inspect extent of cover by dominant plants. 1.2.2 Annually in late summer, cut areas of Common Reed that have spread extensively and remove arisings (cut to ground level). Possibly cut before seed set. 1.2.3 Consider other methods of control as desired in liaison with the Environment Agency.
Operational Objective 1.3	Supplement by planting if required (Reedbed and saltmarsh compartments).	1.3.1 Assess area of damage or loss in liaison with the Environment Agency. 1.3.2 Procure replacement plants ensuring that they are of appropriate origin. 1.3.3 Replant areas damaged by occasional adverse events as required at the appropriate time of year.
Operational Objective 1.4	Experiment with creation of imposed patterns on the vegetation within the saltmarsh compartment.	1.4.1 Refer to original planting plans and experiment with maintenance of planted and self-seeded areas to reflect on-shore geometries. 1.4.2 Liaise with Environment Agency before undertaking vegetation management for aesthetic reasons.
Operational Objective 1.5	Promote areas for use by appropriate waterfowl (all compartments).	1.5.1 Clear small areas as embayments at the edge of reeded and rush-covered areas as feeding and pre-roost areas for moderate numbers of waterfowl. 1.5.2 Consider further seeding of same areas with Goosefoot (*Chenopodium*) to provide food for Teal.
Operational Objective 1.6	Remove litter from terraces on a daily basis (all compartments).	1.6.1 Inspect terraces daily for litter at low and high water for floating and stranded material. 1.6.2 Remove as much litter and stranded material as possible using pole-fixed grabs from walkway and pole-fixed nets at high water. 1.6.3 Access terraces on foot to remove rubbish and litter, only when not possible from adjacent walkway.

Objective Number	Operational Objective	Outline Prescriptions
Operational Objective 1.7	Repair substrate, if necessary, following storms, based on the original design specification.	1.7.1 Refer to original specification and results of monitoring to prescribe for composition of any replacement substrate. 1.7.2 Repair substrate by local regrading replacement and/or deployment of rocks and boulders as necessary in a manner that causes minimum damage to plant and animal communities present.
IDEAL OBJECTIVE 2:	TO ENSURE THAT THE TERRACES DO NOT BECOME ASSOCIATED WITH ANY HAZARDS TO HUMAN HEALTH OR SAFETY	
Operational Objective 2.1	Assess terrace features regularly in relation to safety concerns, removing any hazardous features that might become marooned.	2.1.1 Assess terraces daily for hazards (concurrent with litter monitoring). 2.1.2 Remove hazards liasing with the Environment Agency, Port of London Authority and others as required. 2.1.3 Make or commission necessary repairs to safety barrier along walkway and access ladders.
Operational Objective 2.2	Record, report and take necessary actions in relation to any major concentrations of bird life that might pose hazard to aircraft.	Detailed in the peninsula-wide management plan
IDEAL OBJECTIVE 3:	TO PROMOTE EDUCATIONAL OPPORTUNITIES FOR ACADEMIC STUDENTS AND THE INTERESTED PUBLIC	
Operational Objective 3.1	To maintain environmental information points.	3.1.1 Assess condition of information points on daily basis. 3.1.2 Commission immediate repairs as required.
Operational Objective 3.2	To organise warden -guided tours and events.	3.2.1 Promotion and events to be organised via wardens of the Ecology Park. 3.2.2 Run guided tours. 3.2.3 Levy fees for tours and events.

Objective Number	Operational Objective	Outline Prescriptions
IDEAL OBJECTIVE 4:	TO MONITOR THE DEVELOPMENT OF THE TERRACE ECOSYSTEMS	
Operational Objective 4.1	Monitor plant species, communities and plant health.	4.1.1 Commission and/or compile data from others on the monitoring of the composition of plant communities annually in June and December using photography and inspection by a qualified botanist utilising standardised techniques. Plant community composition to be determined using surface searches, standard point and squared quadrats. Size of quadrats to be determined using cumulative species plots. Minimise damage to terrace ecosystems during work. 4.1.2 Commission and/or compile data from others on the plant health annually in June using indicators such as internode length, leaf areas, number of spikes per stem and number of flowering structures or fruiting bodies. Minimise damage to terrace ecosystems during work.
Operational Objective 4.2	Sample invertebrate populations annually for two years, biannually for eight years and thence once every five years.	4.2.1 Commission and/or compile data from others on the invertebrates using visual inspection and picking or scraping core sampling (125 cm^2 to a depth of 12 cm), all to be undertaken as necessary to obtain indications of species composition in each habitat. Specify and co-ordinate preservation and storage of the samples and the undertaking of laboratory identification and analysis. 4.2.2 Commission and/or compile data from others on the sampling of invertebrates associated with vegetation using sweep netting and vacuum sampling. Ensure minimal damage to terrace vegetation and substrate during sampling. Specify and co-ordinate preservation and storage of samples and the undertaking of laboratory identification and analysis.
Operational Objective 4.3	Monitor populations of fish and fish fry utilising the terraces, in association with the Environment Agency.	4.3.1 Commission and/or compile data from others on the monitoring of use of terrace areas by fish concurrent with main tideway sampling by the Environment Agency. Survey to be undertaken once per year between May and September.
Operational Objective 4.4	Bird monitoring (see Peninsula-wide plan).	See peninsula-wide plan.

Objective Number	Operational Objective	Outline Prescriptions
IDEAL OBJECTIVE 5:	TO UTILISE THE DATA COLLATED FROM MONITORING TO DEVELOP NEW METHODS FOR THE CREATION OF INTER- TIDAL TERRACES AND OTHER ALTERNATIVE FORMS OF FLOOD DEFENCE AND TO DISSEMINATE THIS INFORMATION TO THOSE ORGANISATIONS INVOLVED IN THE CONSTRUCTION OF FLOOD DEFENCES.	
Operational Objective 5.1	Apply appropriate statistical analysis to assess the data in terms of the effectiveness of the infill used, and the number and diversity of species annually using the terraces.	5.1.1 Collate data. 5.1.2 Undertake appropriate statistical analysis. 5.1.3 Produce graphics
Operational Objective 5.2	Store the data in a publicly presentable form that is easy to disseminate and make amendments.	5.2.1 Input data into database. 5.2.2 Backup of database to be kept in separate location.
Operational Objective 5.3	Produce an annual report summarising the data, and making conclusions as the effectiveness of the terraces as a habitat and method of flood defence, making suggestions for improvements to be made in the future and in hindsight.	5.3.1 Scope report in liaison with the Environment Agency. 5.3.2 Produce draft report for comment. 5.3.3 Finalise report following comments.
Operational Objective 5.4	Add this information to the peninsula web site with recommendations for organisations wishing to use alternative methods of flood defence.	5.4.1 Input terrace monitoring data to Ecology Park web site. 5.4.2 Produce occasional papers regarding development of terraces.

Factors Influencing the Achievement of Ideal Management Objectives

Owners/Occupiers Objectives

Refer to 'Section A of the Greenwich Peninsula Management Plan' for Peninsula-wide evaluation.

Internal Natural Factors

As discussed in the section on 'Environmental Relationships' various natural trends will affect the appearance of the terraces. These will include the balance between sediment erosion and accretion, the spread and potential domination by the more vigorous species such as Common Reed and Sea Aster, and damage by waterfowl (grazing, flattening, nutrient addition etc). In order to maintain ecosystem diversity at this high-estuarine site, it may be necessary to control the spread of the more vigorous species. This might be done in a way that improves the general aesthetic appeal of the terraces (see Landscape Aims). Health of saltmarsh plant and invertebrate communities are also interlinked. Plants provide refuge and food for the invertebrates, and the invertebrates in turn may ameliorate the substrate for the plants. Some saltmarsh invertebrates can affect vegetation health and appearance through excessive herbivory, or the spread of disease.

Internal Man-induced Factors

Human activity within the boundary of the terrace management compartments should be limited to land management staff. The most frequent visits will be made by those collecting litter on a daily basis. For such a regular activity as removal of litter and rubbish, methods will need to be developed which cause minimal damage to the substrate and plant/animal life. Reach poles and grabs operated from the adjacent riverside walkway may be one possible technique.

The risk of disturbance to bird life during management and maintenance operations needs to be carefully considered, gauged and minimised through modification of methods and timing based on monitoring and experience.

There is the possibility of occasional damage by accidentally or intentionally beached vessels and from damage by floating debris discarded by people into the river. Such factors may necessitate active intervention by way of removal of the items in question, which may necessitate some reinstatement of sediments and plants thereafter.

External Factors

The following exogenous influences are likely to affect the development of the terrace ecosystems in various ways and at various times:

- Climatic factors e.g. increasingly warmer drier summers;
- River and airborne dispersal onto the site of potentially invasive species;
- Wave action both ambient and storm events;

- Changes in populations, habitats or habits of bird life outside the site, increasing their chances of utilising the site;
- Vandalism by occasional visitors;
- River borne pollution, e.g. oil spillages, sewage discharge etc.; and
- Aerial pollution.

PART 3 – ACTION PLAN

Introduction

In this section all project groups are brought together as logical task lists organised by season and year. From this table it is possible to begin to estimate the manpower requirements and costs of management.

To be completed in association with Facilities Management Company.

PART 3 – PROJECT RECORD AND REVIEW

Introduction

In this section, monthly maintenance reports and reviews are to be filed.

APPENDIX 1

Map Coverage

1. MAP COVERAGE

Name of Plan	WS Atkins Reference / Management Library Reference
Construction Engineering Plans	tba
Substrates and levels: Blackwall Point	AC 1787/C/1168 Rev A
Substrates and levels: Eastern River Wall	AC 1787/C/1155 Rev B AC 1787/C/1166 Rev A AC 1787/C/1167 Rev A
Trials planting Plan: Blackwall Point	AC1787/PLD/8705 Rev 0 (6 of 6)
Trials planting Plan: Eastern River Wall	AC1787/PLD/8700 Rev 0 (1 of 6) AC1787/PLD/8701 Rev A (2 of 6) AC1787/PLD/8703 Rev A (4 of 6) AC1787/PLD/8704 Rev A (5 of 6)
Final Planting Plan: Blackwall Point September 1999	AC1787/PLD/8705 Rev B 6 of 6
Final Planting Plan: Eastern River Wall September 1999	AC1787/PLD/8700, 8701, 8702, 8703, 8704,