INSPECTORS REPORT
WASTE LICENCE REGISTER NUMBER 164-1

APPLICANT: Dunloe Ewart PLC

FACILITY: **<u>Former</u> Hammond Lane Metal Company\Molloy & Sherry Site. Site Contained by the following street frontages: Sir John Rogerson's Quay to the North; Britain Quay to the East; Green Street East to the South; and Benson Street to the west.**

Recommendation: That a licence be granted subject to Conditions.

(1) Introduction

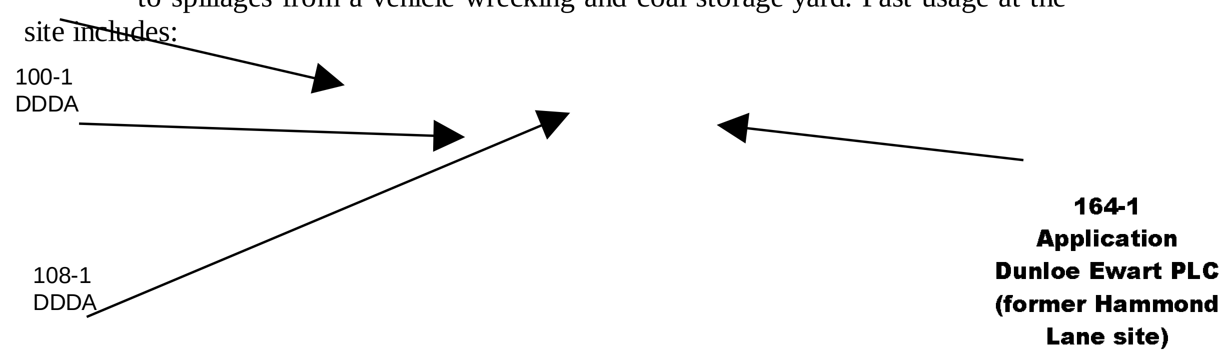
This waste licence application is for activities involving the remediation of contaminated soil by soil stabilisation and contaminated groundwater by permeable reactive barrier at a facility in the south Dublin Docklands to be developed for commercial and residential use by Dunloe Ewart PLC.

The US EPA defines a permeable reactive barrier (PRB) as:

> *'an emplacement of reactive materials in the subsurface designed to intercept a contaminant plume, provide a flow path through the reactive media, and transform the contaminant(s) into environmentally acceptable forms to attain remediation concentration goals downgradient of the barrier'.*

The proposed waste licence facility straddles four street fronts - Sir John Rogerson's Quay; Britain Quay; Green St East; Benson Street - and lies 500m east of the current Dublin Docklands Development Authority (DDDA) licensed remediation gasworks facility (108-1). The facility block of land is surrounded by water on three sides: Grand Canal Dock (south); River Dodder (east); and River Liffey (north). The facility setting is derelict apart from warehouse/small business units which lie on the south side. The nearest residential area lies 250m to the south-east across the Grand Canal Dock where there are new apartment schemes. **A plan showing the location of the facility to which the application relates is provided in the Figure 1 below:**

The facility is rectangular shaped with a total area of 2.1 hectares (180m x 120m). Chemical contour plans supplied with the application show a combination of 'hot spots' lie randomly across the site (and are concentrated in the shallow made ground), [illegible]ated concentrations of arsenic, copper, lead, PAH[1]s, and mineral oil, chemicals [illegible] to spillages from a vehicle wrecking and coal storage yard. Past usage at the site includes:



[1] PAH: Polycyclic Aromatic Hydrocarbons (2 benzene ring compounds).

- Lime Works (1859 – 1868)
- Alkali Manufacturers (1867 – 1895)
- Chemical Fertiliser Manufacturer (1868 – 1976)
- Shipping Yard (1900 – 1911) *Storage of oil and materials*
- Coal Yard (1946 – 1959)
- Hammond Lane Metal Co. (1977 – 1996): *Scrap Yard: metals, oil, hydrocarbons*

Groundwater in the underlying gravels is contaminated by similar parameters to those found in the overlying soils and made ground. However there are higher concentrations of PAHs, chemicals more common to the chlorinated solvent or gasworks type facility of which there is no history. Therefore it is considered that the PAH contamination may have migrated from the two nearby historic gaswork facilities (now DDDA 100-1 & 108-1) to the west.

Considerable demolition and site clearance during January and February 2002 was undertaken across the entire site to a depth of +1.0mAOD (watertable is approx 0.0mAOD) from the original surface elevation of +1.5m to +3m AOD (causing an apparent drop of c 2.5m when viewed from the road). Information supplied by the applicant (dated 22 March 2002) in response to an Agency Section 18 Notice specified that 24,500 tonnes of clearance material consisting of concrete, brick/rubble, and some soil were removed to Balleally landfill. The entire compound now consists of open ground awaiting a waste licence for soil and groundwater remediation. The intended period of the waste licence is 4 years, after which time long-term operations and monitoring will be undertaken in accordance with the after care management plan provided for in Attachment G.2 of the application *(Condition 4.1)*.

The applicant has applied for Third Schedule Class 13 under licensed waste disposal activities, and Fourth Schedule Classes 2, 3, 4, and 13 under licensed waste recovery activities. The principal activity has been set as Fourth Schedule, Class 2 (Recycling or reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes)).

Facility Visits:

DATE	**PURPOSE**	**PERSONNEL**
27 September 2001	Facility Notice Check	M. Doak
5 March 2002	Facility Visit	M. Doak

General Information:

Date of Application	12th September 2001
Quantity of Waste to be removed	60,000T soils exported.
EIS required	Yes I have assessed the EIS and am satisfied that it

	complies with Article 13 of the Licensing Regulations.
Number of Submissions received	2

(2) Soil and Groundwater Contamination

A detailed ground investigation which included trial pitting and borehole drilling was undertaken for the applicant by O'Connor Sutton Cronin during May and during December 1999, and additional site investigation works were carried out during August 2001 – January 2002 by *Questor* (Queen's University). A total of thirty-three trial pits were excavated and thirty-four boreholes were drilled at the facility. Of the boreholes, three were drilled into the underlying limestone bedrock (to determine geology only), and the balance were installed as groundwater monitoring wells in the overlying subsoils and made ground. Tracer tests and pumping tests were also carried out by *Questor* to determine groundwater flow directions and contaminant travel times to a theoretical PRB on the north side of the site mid-way along Sir John Rogerson's Quay.

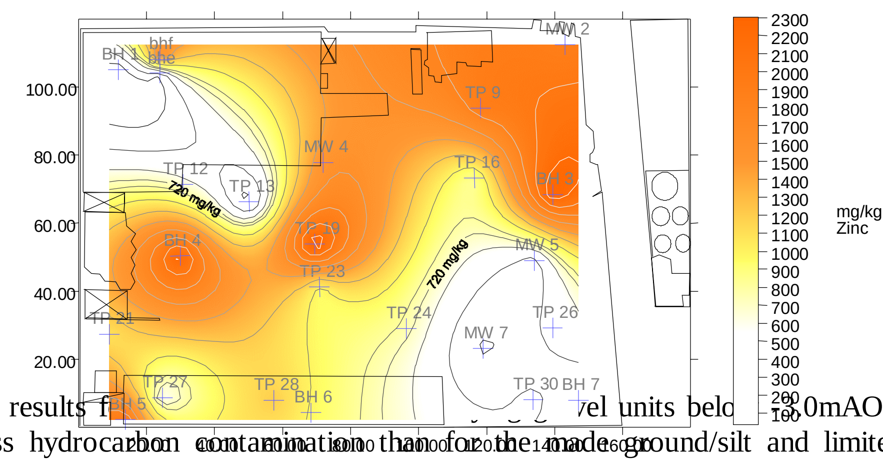
In general the facility (current ground level is +1.0mAOD) is underlain by made ground (comprising clay, ash, clinker, concrete, brick and mortar with occasional pieces of timber, tarmac and steel) to a depth of approximately -3.0mAOD across the facility. The made ground is underlain by silt (0.5m thick, absent in places), two units of sand and river gravels (depth ranges of -3.0mAOD to -5.5mAOD and -8.0mAOD to –13.0mAOD) which are separated by estuarine clays, in turn underlain by stiff boulder clay to a depth range of -15.5m to -18.2m, at which limestone bedrock lies (grey fine grained 'Lane limestone formation').

Groundwater is present in three aquifers – the madeground, the upper gravel unit, and the lower gravel unit. Hydrogeological investigations via pumping tests, tracer tests and slug injection tests verify that the two gravel units react independently to hydraulic stress on site, the lower aquifer exhibiting semi-confined conditions and the upper aquifer exhibiting mainly unconfined conditions. Both aquifers have hydraulic conductivities expected for sand and gravel units ($7x10^{-5}$). **The upper gravel aquifer has a relatively flat water table and groundwater flow is considered to be relatively stagnant with slight variation as a result of tidal variations in the Rivers Liffey and Dodder**. No monitoring wells were drilled into the limestone aquifer by the applicant in order to avoid cross contamination of any bedrock groundwater; this is standard practice in contaminated land studies. The limestone bedrock aquifer is confined by the stiff boulder clay which is up to 5m thick, and is considered to be a poor aquifer.

Soil Contamination

Laboratory analyses of the made ground samples and estuarine silt (+1.0m to -3.0mAOD) indicate various hot spot contamination zones lie across the site with very elevated levels of arsenic (5 - 2,195mg/kg), copper (1 - 4,521 mg/kg), zinc (21 - 4,304mg/kg), mineral oil (2 - 41,622mg/kg), and poly-aromatic hydrocarbons (0.5 - 8,270 mg/kg). <u>Over 46% of the soil samples tested exceeded their relevant Dutch Intervention levels which is indicative of serious contamination levels warranting</u>

immediate cleanup. Furthermore, the high levels of mineral oil indicate that the soils are saturated by free phase product which has the potential to act as a long term source for mass transfer to the aqueous phase. Figures 2 and 3 illustrate the hotspots for mineral oil and zinc. **Note that mineral oil contamination is more concentrated (at two hotspots in the south-east and east of facility) than metals contamination (such as zinc) which is more dispersed. This issue will determine the type of cleanup whether by soil stabilisation or by soil removal and disposal.** In soil the only LIST 1 parameters present are cadmium and mercury which occur in the made ground at trace level concentrations of less than 12mg/l.



Laboratory results f[illegible]vel units belo[illegible] 3.0mAOD indicate less hydrocarbon contamination than for the made ground/silt and limited metal contamination.

Fig 3: Zinc Concentration Contour Plot SOILS +1mAOD

Groundwater

The US EPA *Permeable Reactive Barrier Technologies for Contaminant Remediation* (USEPA/600/R-98/125) guidance document specifies that a thorough understanding of system hydrogeology and plume boundaries is needed prior to implementing a PRB, due to the need for the plume to passively flow through the reactive zone of the PRB. The hydrogeologic characterisation must also yield information suitable for determining the rate of ground-water flow through the reactive zone of the PRB.

Much work has been done by the applicant on assessing the hydrogeological issues which would meet the US EPA criteria above. The application contains several volumes on groundwater aspects alone. In order to more easily understand the situation on-site this section of the report is written in terms of hydrocarbon contamination since it is the more mobile and easier contaminant to assimilate, particularly with regard to understanding the source-pathway-target flow across the site, in the made ground and the two gravel aquifers. Contamination arising from metals and other parameters are dealt with in summary form thereafter.

Chemical contour plots for groundwater indicate that hydrocarbon contamination (6mg/l mineral oil) in the shallow groundwater (made ground) is concentrated to the centre of the facility and has travelled as a plume 30m north from the hotspot in the made ground (in Figure 2) in the south of the facility. Such a concentration is ten times above the Dutch Intervention Value (0.6mg/l). The plots also show that hydrocarbons (2.8mg/l mineral oil) are entering the site at the south-east corner, from an off-site source*. For the upper gravel aquifer contour plots indicate that the hydrocarbon (2.3mg/l mineral oil) plume lies at the very northern edge of the facility at the mid-point coincident with the site of the proposed PRB. The contour plots for the lower gravel aquifer indicates no hydrocarbon plume. Overall the hydrocarbon contamination plots indicate that contamination in the groundwater is moving as a plume from the madeground concentrated hotspots to the north side, and exits at the River Liffey via the upper gravel aquifer.

*Condition 5.1.2 of the Proposed decision specifies that further investigations are carried out to determine the risk of ongoing contamination of the south-east of the facility from the off-site source. If necessary the ongoing contamination can be controlled by soil stabilisation or by an extension of the bentonite cut-off wall barrier detailed in Section 3 of this report.

The table next page summarises groundwater quality for the other parameters in the three aquifers, and these are compared to the Dutch Intervention Values:

Parameter	Made Ground Range (µg/l)	1st Sand /Gravel Aquifer Range (µg/l)	2nd Sand /Gravel Aquifer Range (µg/l)	Dutch Intervention Value (µg/l)*
Cadmium	<0.4 – 2	<0.4 – 73	<0.4 – 2	LIST 1
Cyanide (free)	<10 - 80	<10 - 20	not detected	LIST 1
Mercury	not detected	<0.05 – 0.13	not detected	LIST 1
Arsenic	4 - 2894	4 - 262	<2 - 513	60
Copper	<5 - 125	<5 - 17	<5 - 20	75
Lead	<5 - 289	<5 - 89	<5 - 36	0.3
Zinc	<5 - 2056	5 - 534	15 - 330	800
Total PAHs	2.1 – 43.5	0.98 – 453.6	0.21 – 20.3	-
DROs	32 - 20093	53 - 11358	76 - 1694	-

Mineral Oil	<10 - 6028	<10 - 2272	<10 - 169	600

* Note: (µg/l); 999 shading indicates exceedance of Dutch Intervention Values

A general review of all groundwater chemistry results for LIST 1 substances indicates that the only parameters present are trace levels of cadmium and cyanide in the made ground and upper gravel aquifers.

The applicant has identified the upper gravel unit as the major pathway for contaminant transport and that most risk is centered on groundwater as a vector for transport of contaminants to the Rivers Liffey and Dodder. The conceptual frame for the lower aquifer is one of less risk of direct contamination, and a moderate pathway for contaminants. Seawater intrusion is a strong possibility (in fact site investigation has identified between 25 and 50% seawater) in the lower aquifer.

(3) Facility Development

An Article 16(1) reply (March 2002) prepared by the applicant proposes a source/pathway/target risk assessment and a remediation strategy for the facility in:

> *'An Assessment of Risk to Human Health and the Environment posed by a proposed Soil and Groundwater Remediation Strategy at the former Hammond Lane / Molloy & Sherry Site, Sir John Rogerson's Quay, Dublin 2' (Questor, QUB, March 2002).*

The results in Section 3.3 of the above report indicate the major risk driver for the site is the elevated residual contamination in soil and subsequent potential migration of contaminant loads to surface water receptors via the upper gravel aquifer. Groundwater is not considered a receptor at this site due to the natural effects of seawater intrusion which renders the aquifer systems unusable as a viable resource.

In summary the remediation strategy for the facility (as per scenario 3, p67 of above report) is (A) the redevelopment of the site with a Permeable Reactive Barrier (PRB) providing a pathway interception[2], (B) targeted shallow source zone stabilisation using soil mixing to treat mineral oil mainly, and (C) contaminated soil removal and off-site disposal/recovery. The following aspects comprise the remediation strategy:

(A)

- Installation of a bentonite slurry cut-off wall along the boundaries which lie adjacent to the River Liffey and River Dodder to intercept groundwater flow and channel this flow to a PRB cell for water treatment. This will be installed using standard techniques and will be keyed into the sub-glacial till unit (c. –13mAOD). The Specified Engineering Works requires a proposal to be made to the Agency regarding the engineering aspects of the cut-off wall to include permeability and

[2] Principal Activity: Fourth Schedule, Class 2.

exact location since such items have yet to be confirmed pending further ground investigations.

- Installation of a PRB Cell that will use:
    i. Zero Valent Iron to remove trace metals from groundwater;
    ii. Air-sparged bioremediation to degrade organic contaminants;
    iii. Granulated Activated Carbon as a precautionary/backup stage to provide a high degree of confidence between monitoring periods.

  The contaminants will be removed from or degraded within the permeable reactive barrier system and the residual water allowed to flow along its natural flow path to the receiving gravels on the quay side. The Specified Engineering Works require a proposal to be made to the Agency regarding the engineering aspects of the PRB to include an updated drawing of the PRB in cross-section, and in plan. Importantly the chemical and redox aspects of the PRB treatment system need to be addressed to avoid any possible metal liberation from the treatment media during change in redox or pH.

(B) & (C)

- The characterisation and determination of soil quality (*ie* whether soil is hazardous waste or not) by way of a 20m x 20m grid as specified in the Method Statement for Excavation Works. Questor, QUB, March 2002 (page 5). This is adopted as per *Conditions 5.1.1 (d) and 5.1.2* of the licence.

- Elimination of residual mineral oil and metal contaminants (source material) in the made ground between ca. –1.0mOD and ca. +1.0mOD as a precautionary measure to manage the risk of contaminant migration at the water table by (i) Soil Stabilisation <u>and</u> (ii) Soil Removal.
    i. It is proposed to carry out *insitu* soil mixing and soil stabilisation techniques (by hollow stem auger) on (as a minimum) <u>the two hydrocarbon hotspots in the madeground</u> and groundwater at the +1m and –1m depth contour. The soil mix columns will mix the contaminated medium with a slurry comprised of cement, bentonite and other reagents in order to stabilise and solidify the contamination left in place. This action will prevent the rapid movement of the hydrocarbons (some free-phase) to the PRB Cell (or off-site should hydrogeological conditions change dramatically due to unforeseen changes in land use), and will diminish the risk to human indoor inhalation (finished development residents). It would be better site practice to install the soil mix columns to the base of estuarine silt or top of upper gravels rather than to –1m as specified in the application to ensure that the total depth of made ground is treated. Condition 5.1.3 specifies such and stipulates that the finished soil mix columns be tested in accordance with the *Leaching Tests for Assessment of Contaminated Land, UK National Rivers Authority, 1994*. The applicant considers that soil stabilisation may be an option on the other contaminated hotspots. However this is complicated by the applicant's request to 'enhance' stabilisation with *insitu* chemical oxidation using peroxide products. Further information would be needed on this and as a result the Specified Engineering Works require a proposal to be made to the Agency on the matter before it can be agreed.

ii. Where *insitu* soil stabilisation is not carried out it is envisaged that the remainder of the contaminated soils will be excavated for disposal via ship to licensed hazardous waste facilities in Europe. The ship is to lie alongside the north wall of the facility at Sir John Rogerson's Quay. Transport by ship is provided for in Condition 7.3. Potential nuisances caused by soils dispatched off-site by road haulage are controlled by Conditions 3.7 and 7.4.

- Classification and stockpiling of all material or soil arising from the remediation works prior to any off-site disposal or recovery (*Condition 5.4.1*). Chemical analysis parameters and maximum concentrations shall be as agreed in advance with the Agency. The results of this analysis must be submitted to the Agency for agreement before the first batch of material is taken off-site.

Risks resulting from exposure by inhalation post-development will be managed by construction of a vapour/gas collection system installed beneath the concrete slab of the building. This, together with the floor slab and the ventilation with a large volume of fresh air in the under-building car park will provide an effective risk management strategy to reduce any possible build up of vapours. Typically, a number of air volumes will be exchanged every hour. Additionally, those contaminants of greatest concern at the site generally have no vapour transport properties (metals) or are in relatively low concentrations or have low vapour pressures (mineral oils and PAHs respectively).

Therefore, on completion of the development the presence of the residual soil and groundwater contamination below the building will not pose a risk of causing significant harm to the environment (Rivers Liffey and Dodder) or the occupiers of the building.

(4) Waste Types and Quantities

Condition 1.4 and Schedule A of the proposed decision controls the quantities and types of waste to be removed from the facility. The total quantity of soils and made ground to be excavated, classified and exported from the facility shall not exceed 60,000 tonnes total. The programme of soil stabilisation will treat an element of this tonnage *in situ*, the exact quantity cannot be confirmed until the detailed grid investigations are carried out.

The application specifies that the total quantity of groundwater to be treated in the:

(a) construction phase (12 week period) is 42,000 m^3, in an above ground temporary granulated activated carbon unit prior to discharge to sewer. These groundwater volumes will arise from the dewatering associated with the excavation of source area, the installation of the cut-off wall, and the installation of the PRB cell.

(b) operational phase is from 3,000 m^3 – 20,000m^3 per annum in the PRB cell, although more recent pilot tests (see Section 5) show that the groundwater treatment would more likely to be in the region of 4,000m^3. It is estimated that the reactive media within the PRB will be spent within 4 years. Its disposal is specified in Condition 5.4.2.

(5) Emissions to Soil & Groundwater

The main risk-driver identified during the risk assessment was one of off-site migration of contaminants at levels which are above drinking water standards. Therefore, the applicant considers that the use of boundary/pathway interception where all contaminants which reach the site boundary are treated effectively manages this risk. Groundwater numerical modelling was undertaken by the applicant using a 5-layer 3D model in order to determine the pattern of flow and pathway across the site which is to be intercepted with a permeable reactive barrier system.

Permeable Reactive Barrier Design

Groundwater flow is considered to be relatively stagnant but in general the flow direction is northeastwards towards the River Liffey. The groundwater treatment design consists of a three sided bentonite slurry cut-off wall on the north and east sides with a PRB cell/gate installed midway along Sir John Rogerson's Quay to capture and treat the groundwater. The bentonite slurry cut-off wall will be approximately 300m long and will be keyed 0.7m into the natural clay till soils. Figure 4, next page, is a schematic diagram of the system in plan.

The design of the slurry wall controls the groundwater head inside the site to ca. -0.35m OD. There will be a sump pump at the base of the PRB cell to augment the slow flows of groundwater and drive the groundwater through the PRB cell and on into the River Liffey. The daily flow of contaminated groundwater through the PRB cell is envisaged to be no more than 2m^3 per day, but the PRB cell pump will be designed for a maximum volume of 11m^3 per day (4,015m^3). **Full design details are still to be completed. These shall be forwarded to the Agency for agreement as per the Specified Engineering Works, Schedule B of the proposed decision (Condition 3.11.2).**

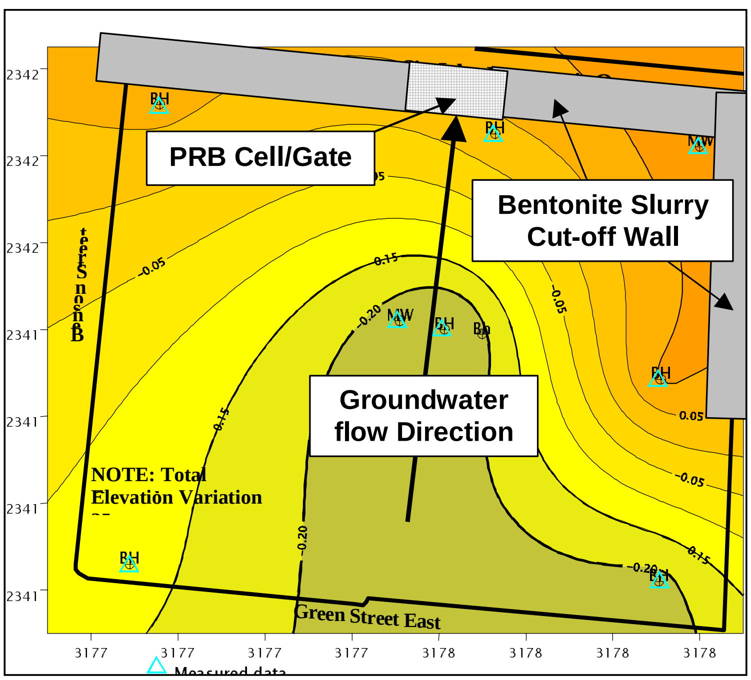


Figure 4:
Schematic diagram of PRB Cell within the bentonite slurry cut-off wall.

A laboratory based feasibility study indicates that the PRB cell will successfully remove the metal and PAH contaminants from the groundwater. For the metals column studies with zero valent iron (ZVI) they have shown that at a flow rate of 0.792 L day^{-1} arsenic concentrations dropped from a maximum of 3592µg/L to 60µg/L (Dutch Target Level) within 4cm of the column. Dissolved copper concentrations decreased from a maximum level of 259µg/L to 4µg/L (below Dutch Target Levels) within 4cm, and dissolved chromium concentrations fell from a maximum level of 103µg/L to 1µg/L (Dutch Intervention Level) within the first 4 cm of the column.

Baseline groundwater quality monitoring has been undertaken at the application site on up to 34 permanent monitoring wells. It is understood that wells are currently being installed off-site for planning purposes. As part of the operation and maintenance of the PRB Cell and the verification of the bench test results above, it will be important to monitor the water levels and quality near the reactor, at the outlet of the reactor and within the reactor, and most likely at the perimeter of the site. Schedule D, Table D.1.1 of the PD specifies two monitoring points at the PRB, five monitoring wells on-site and four well locations off-site the positions of which shall be as agreed in advance with the Agency. Parameters for analyses are specified in Table D.4.1; monthly monitoring and analysis are required at the PRB cell. However once verification of treatment at the PRB is completed the Agency can amend the frequency to less frequent monitoring as per Condition 8.2. Condition 3.12.2 specifies that all other monitoring wells on-site be decommissioned within three months.

Condition 3.11.3 specifies the maintenance of the PRB and reactive cell recharge.

(6) Emissions to Air

Odour

The main odours expected at the facility will be dominantly hydrocarbon/mineral oil related since contaminated soil excavation/ removal/treatment is only to occur in the shallow ground. The excavations are to take place in an area where there is little to no residential population and small <20 working population on the south side. The nearest residential neighbours lie 370m south at the Charlotte Quay apartment schemes. Fugitive hydrocarbon emissions and associated oil type odours may result on soil excavation and movement to a screening process for loading onto ship via conveyor. Conditions 7.1, 7.2, 7.3, and 7.8 detail the monitoring requirements for odour nuisances as per Agency experience of enforcing the neighbouring DDDA 100-1 licence.

Dust

Monitoring requirements and emission limit values are set as schedule D1 and D2 to control any fugitive dust emissions from activities on facility.

Noise

Noise monitoring at the facility is required by Schedule D3 of the proposed decision.

(7) Emissions to Surface Waters/Sewer

The Hammond Lane development already holds a Dublin City Council Discharge Licence (No. PCLA/19/01 – 27/11/01) granted in respect of discharge of groundwater from pilot tests and this permits the discharge of up to 500 cubic metres/day to the Benson Street Sewer with certain chemical ELVs. The applicant will be requiring similar discharge volumes.

A Section 52 consent has been obtained from Dublin City Council for the discharge of treated groundwater during two stages of work associated with implementation of a Permeable Reactive Barrier System namely the Construction Phase and the Operational Phase.

During the <u>construction phase</u> (12 week period) a maximum volume of 42,000 m^3 (500 m^3/d) of groundwater will be treated in an above ground temporary granulated activated carbon unit prior to discharge to sewer. Should the groundwater treatment facility require shutting down it is proposed that the excavation operations shall cease therefore eliminating the need for dewatering. Excavations shall be allowed to fill with groundwater until natural hydraulic equilibrium is achieved. These excavations will be fenced off until normal operations can resume.

During the <u>operational phase</u> groundwater discharge from the permanent PRB reactive cell shall be via infiltration trenches to the local groundwater system as described in Section 5 above. However, maintenance of the PRB or occasional removal of PRB sections/emergency access requires the contingency of possible discharge to sewer. Therefore Condition 6.4, Emissions to Sewer applies throughout the duration of waste licence. Schedule C3 specifies a maximum of 500m^3/day discharge to sewer.

The long term management of the Permeable Reactive Barrier remediation system is specified as Condition 4.1 as part of Restoration and Aftercare. Attachment G (Decommissioning and Aftercare) of the application is detailed in this regard and would need to be formalised as part of the licence surrender process. The UK Environment Agency: *Guidance on the Design, Construction, Operation and Monitoring of Permeable Reactive Barriers*, National Groundwater & Contaminated Land Centre Report (NC/01/51, March 2002) - Section 7.8 'Closure and Decommissioning' should be incorporated into the Restoration and Aftercare plan, Condition 4.2. *It is reproduced as Attachment 1 to this Inspector's Report.*

(8) Other Significant Environmental Impacts of the Development

None

(9) Waste Management, Air Quality and Water Quality Plans

The Dublin Waste Management Plan, 1998, makes reference to contaminated soils and states that soil from large-scale sites is unlikely to be treated in facilities in the region due to the volume of the material and the nature of the contamination, such as gasworks and heavy metals.

(10) Submissions

Two submissions were received relating to the application on 22/10/01 and 7/5/02 from Duchas. Both letters are to inform the Agency that Duchas has no objections to the proposed works. I have had regard to this submission in making my recommendation to the Board.

(11) Reasons for the Recommendation

I recommend the grant of a licence that will allow activities involving the remediation of hazardous contaminated soil and ground water present at the Former Hammond Lane Metal Company\Molloy & Sherry facility for Class 13 under licensed waste disposal activities, and Classes 2, 3, 4, and 13 under licensed waste recovery activities, in accordance with the Third and Fourth Schedules of the Waste Management Act, 1996 for the following reasons:

1. I am satisfied that emissions from the soil removal and soil mixing activities will not result in the contravention of any relevant standard, including any standard for an environmental medium, or any relevant emission limit value, prescribed under any other enactment.
2. I am satisfied that the activity concerned, carried out in accordance with the conditions proposed will not cause environmental pollution particularly with regard to the stabilisation of the contamination within the madeground and the treatment of groundwater via the PRB cell. These activities will ensure no environmental pollution of the Rivers Liffey and Dodder will be caused.
3. I am satisfied that the best available techniques will be used to prevent or eliminate groundwater and air emissions from the activity due to the use of soil mixing columns and the installation of a PRB groundwater cut-off wall. Furthermore

certain contaminated soils will not have to be disposed off-site; they will remain stabilised on site.

Signed: ______________________ Dated : ____________________

Mr Malcolm Doak

ATTACHMENT 1

Guidance on the Design, Construction, Operation and Monitoring of Permeable Reactive Barriers

National Groundwater & Contaminated Land Centre
Report NC/01/51

M. A. Carey, B. A. Fretwell, N. G. Mosley & J. W. N. Smith

ISBN: 1 85705 665 5

Environment Agency, 2002

7.8 Closure and Decommissioning

The criteria for closure and decommissioning should be documented in the working plan. Typically closure will occur when:

1) Contaminant concentrations in the groundwater up and down-hydraulic gradient of the PRB have reached background levels. Decommissioning should only occur when the pollutant source has been fully depleted, or controlled by some other (effective and durable) means, and it no longer poses an unacceptable risk; *or*
2) Remedial objectives have been met for the site as a whole; *or*
3) Remedial objectives have been substantially met and falling trends in contaminant concentrations (up and down-gradient of the PRB) have been defined to the extent that there is a high degree of confidence, given the performance of the PRB, that the remedial objectives will be achieved in the near future;
4) Agreement with the relevant regulator(s) has been obtained.

Once the remedial objectives have been achieved, a decommissioning plan for the PRB will need to be agreed with the regulator and other stakeholders as to whether the barrier needs to be removed, left in place or other works undertaken. This is required since:

- a future change in site conditions (e.g. bio-geochemical environment) may result in remobilisation of contaminants from the reactive material (e.g. by subsequent desorption of sorbed substances or remobilisation of precipitated substances). Even where PRBs destroy contaminants, there is a potential for other contaminants in groundwater to be accumulated by the reactive material (by sorption, precipitation etc.) and that a subsequent change in the geochemical environment could remobilise these contaminants;

- the permeability of the PRB may change with the potential for an unacceptable rise in groundwater levels;
- the deterioration of the reactive media may itself give rise to pollution.

The recommended approach would be to remove the PRB. Where a PRB is to left in place then this must be justified by demonstrating that contaminants will not be remobilised, or that the likely rate of any remobilisation is sufficiently slow to avoid affecting the identified receptors. This may require additional (post-closure) monitoring (albeit at a much reduced frequency) to be undertaken to confirm that it does not represent a secondary source of contamination.