eastern
river basin district

URBAN PRESSURES

BACKGROUND DOCUMENT TO THE WATER MATTERS REPORT

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Summary

Urban areas pose a risk of pollution to surface waters, but assessing the risk is complex because of the myriad of potential pollution sources found there. In an urban setting, it can be complicated to develop an understanding of the cumulative risk that these many sources pose to a water body, while at the same time determining the contribution to the cumulative risk assessment that is attributable to individual (or types of) pollution sources. This latter step, however, is fundamental for the selection of measures to remedy pollution sources. Similarly, the assimilative capacity of the receiving water body needs to be determined before a rational Programme of Measures can be derived.

An initial Characterisation of risk to Irish waterbodies was completed and submitted to Europe in March 2005 in the National Article V report, "The Characterisation and Analysis of Ireland's River Basin Districts" (EPA, 2005). The Article V report included several risk assessment tests that either wholly or largely describe risk to river and transitional surface waters from a wide range of activities in urban areas.

- For rivers, the risk tests essentially considered pollutants as point sources, without considering their composite effect or without factoring in the potentially widespread impacts posed by urbanisation. The exception is the general diffuse test, which includes a threshold for percent of urban area in a watershed but does not allow for differentiation of actual or site-specific pressures on the basis of human activities, or the extent and state of local infrastructure.

- In transitional waters, the diffuse tests require impact data, and thus integrate the effects of multiple pollution sources. However, at that time only limited impact data were available to make evaluations. Furthermore the point source assessments in transitional waters were the same as those for rivers in that they did not consider composite effects of pollution.

The reported Article V risk characterisation work provided a foundation on which an understanding of integrated urban pressures to surface waters could begin to be built. Fundamentally however it did not consider cumulative risk which is fundamental for the selection of measures to remedy pollution sources.

Furthermore there were a number of significant data gaps, particularly relating to the spill performance of CSOs, and additional work was needed to understand these pollution sources to build an integrated assessment.

To address these issues an 18 month study – The Urban Pressures Study - was commissioned and commenced in February 2006.

The Urban Pressures Study involves an assessment of impacts for both surface waters and ground waters in all 33 national urban areas with a population in

excess of 10,000 (2002 Census Figure). The location of the 33 urban areas are shown on Figure 1.

However as the requirements for both parts of The Urban Pressures Study are significantly different this document relates specifically to the surface waters aspects of The Urban Pressures Study.

The Urban Pressures Study had three clear objectives for surface waters namely:

- Gather missing data and improve data layers in the national GIS;
- Conduct additional analyses to characterise CSOs in Ireland; in part this work will build on the findings of previous work/studies commissioned by The Department of Environment Heritage and Local Government, DEHLG, and the Local Authorities;
- Develop an assessment methodology that considers assimilative capacity of the surface waters and the combined, pollutant source or type of source-derived, pollutant load from within urban areas and from up gradient.

Significant progress has been made on the project to date, in particular regarding the characterisation of CSO spills and urban diffuse runoff. The remaining tasks to be completed are:

(a) Finalising the up gradient hydrology and water quality assessments;

(b) Running the integrated assessment assimilative capacity analysis for the urban waterbodies;

(c) Preparing a number of interim technical reports and the overall final report;

(d) Outlining the types of technical issues which may have to be overcome in the event that the waterbodies fail the assimilative capacity test.

To date the project has made a number of interesting findings including:

- In a number of urban areas the cumulative yearly CSO spill volumes have been found to be less than 10% of the overall cumulative yearly flows entering the foul/combined sewer networks.
- The existing yearly CSO cumulative spill volumes are predicted to reduce significantly in many towns following the implementation of main drainage projects.
- The need for more comprehensive flow and water quality monitoring at waste water treatment facilities.

It must be stressed however that these findings can only be considered as preliminary at this stage as a number of stages of the project are still ongoing. Therefore these findings may change as project moves to completion.

The project is expected to be completed by late August/early September 2007.

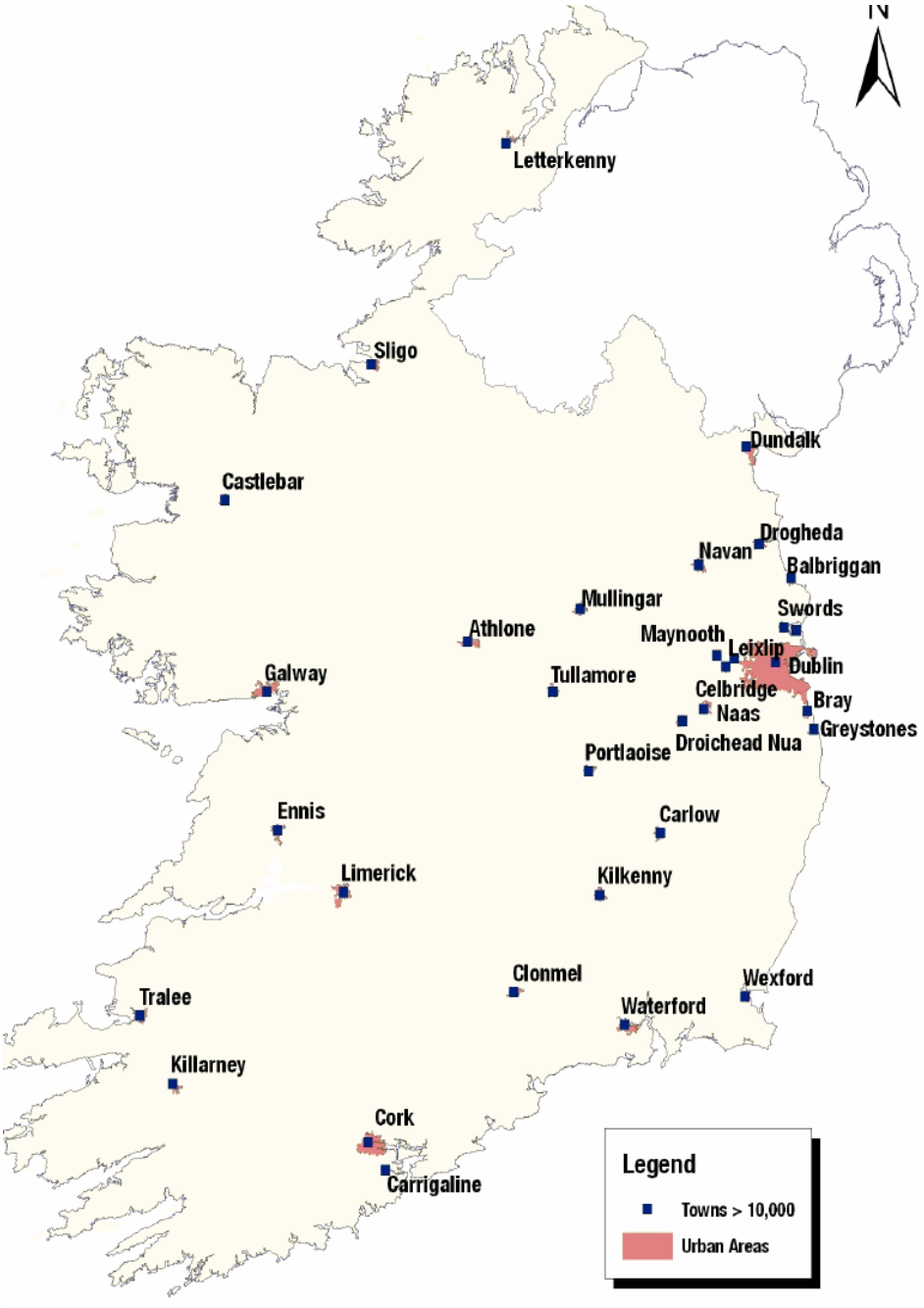


Figure 1 – Study urban areas

Section 1
Study Rationale

The EU Water Framework Directive (WFD) requires characterisation of pressures on surface waters and, including a national risk assessment and regulation on the quantitative status of all types of water bodies. A number of initial river and transitional water pressure characterisation assessments were performed in Ireland by individual river basin district (RBD) projects and reported to Europe in March 2005 by the EPA in the national Article V report, "The Characterisation and Analysis of Ireland's River Basin Districts" (EPA, 2005).

The initial characterisation of risk completed in March 2005 included several risk assessment tests that either wholly or largely describe risk to surface waters from a wide range of activities in urban areas as detailed in (see Table 1 for tests for rivers and transitional waters).

- For rivers, the risk tests essentially considered pollutants as point sources, without considering their composite effect or without factoring in the potentially widespread impacts posed by urbanisation. The exception is the general diffuse test, which includes a threshold for percent of urban area in a watershed but does not allow for differentiation of actual or site-specific pressures on the basis of human activities, or the extent and state of local infrastructure.

- In transitional waters, the diffuse tests require impact data, and thus integrate the effects of multiple pollution sources. However, only limited impact data are available to make evaluations (for instance for ERBD's transitional waters, no impact data were available for hazardous substances, and only 4 of 13 waters had eutrophication related data). The point source assessments in transitional waters are the same as those in rivers and therefore also do not consider composite effects of pollution.

Because urban areas pose a risk of pollution to surface waters there is a need to understand the nature of this risk. However assessing the risk is complex because of the myriad of potential pollution sources found there. In an urban setting, it can be complicated to develop an understanding of the cumulative risk that these many sources pose to a water body, while at the same time determining the contribution to the cumulative risk assessment that is attributable to individual (or types of) pollution sources. This latter step, however, is fundamental for the selection of measures to remedy pollution sources. Similarly, the assimilative capacity of the receiving water body needs to be determined before a rational Programme of Measures can be derived.

Whilst the data and assessments on which the Article V report were founded did not address the issue of cumulative risk they did provide a useful foundation on which to develop a more comprehensive understanding of integrated urban pressures to surface waters in urban areas.

In order to address the combined issues of pressures specific to urban areas and the integrated assessment of these pressures an 18 month further characterisation study – The Urban Pressures Study - was commissioned and commenced in February 2006.

Section 2
Objectives

The Urban Pressures Study also undertook to provide more comprehensive data relating to the yearly spill frequency of Combined Sewer Overflows.

This report has been prepared to;

(a) Provide an overview of the approach to the study

(b) Provide an update on the progress of study

(c) Highlight any project issues which have arisen

(d) Outline any preliminary findings of interest

(e) Advise on a likely completion date for the study

Section 3
Approach and Methodology

The work risk assessment work completed previously as part of the Article V report was based around a number of individual risk tests for both rivers and transitional water bodies. These risk tests are detailed in Table 1.

Table 1: Risk Assessment for pollution in urban areas

Risk Assessments for Pollution	Rivers	Transitional Waters
Diffuse		
General diffuse	RD1	
Road wash for copper, zinc and hydrocarbons	RD2a-c	
Railway marshalling yards	RD3	
Unsewered areas	RD5	
Hazardous substances		TMDI1
Eutrophication (nutrients/algae etc.)		TMDI2
Urban WWTPs		TMDI3
Point Sources		
WWTPs	RP1	TP1
CSOs and pump station overflows	RP2	TP2
Section 4 licensed discharges	RP4	TP3
IPPC licensed discharges	RP3	TP4
WTPs	RP5	TP5
Mines, quarries and landfills	RP5 (6-8)	TP5 (6-8)

In general most of these risk tests were based on individual point source assessments and they were implemented in most cases without reference to the assimilative capacity of the receiving waters.

The Urban Pressures Study was commissioned specifically to extend on and build upon the previous risk assessment work and in particular to consider an integrated waterbody assessment of the pressures in urban areas.

The over riding objectives of the study were threefold:

- Source missing data and improve data layers in the national GIS;
- Conduct additional analyses to characterise CSOs in Ireland; in part this work will build on previous work commissioned by DEHLG including lessons learned from the river Tolka study, the Greater Dublin Strategic Drainage Plan, any relevant data from recent drainage schemes in Cork and Limerick, and will use the data from a study on CSO impacts in the lower Liffey planned by DCC;
- Develop an assessment methodology that considers assimilative capacity of the surface waters and the combined, pollutant source or type of source-derived, pollutant load from within urban areas and from up gradient.

3.1 Pollution Parameters

The Urban Pressures study was scoped to consider pressures from a range of parameters including Nitrogen and Phosphorous and up to ten dangerous substances/toxics. The completed list of substances to be considered in the assessment was determined at the early stage of the study. The list is as per Table 2.

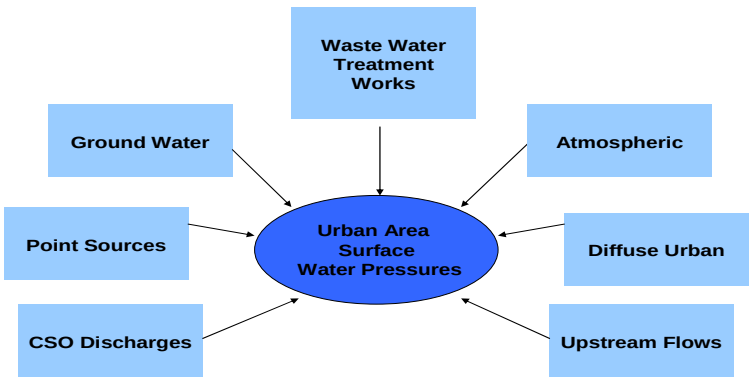
Table 2: Study parameters

Study Parameters
Nitrates(NO3)
Nitrites(NO2)
Total N
Nitrogen(TKN)
Total Phosphorous
Ortho-phosphate
Cadmium, Cd
Chromium, Cr
Copper, Cu
Iron, Fe
Lead, Pb
Mercury, Hg
Nickel, Ni
Zinc, Zn

3.2 Pollution Source Types

Following a review of the pollution source types which were identified as occurring within urban areas six main source types were identified for inclusion within the study as shown in Figure 2.

Figure 2: Main urban pollution source types



3.2.1 CSO Discharges

The Article V risk test for CSOs was based on a spill frequency of 6 spills per annum – greater that 6 spills per year indicates a risk to the receiving waterbody and less than 6 spills per year indicates no risk. This risk test took no account of actual spill volumes or assimilative capacity in the receiving water. The spill frequency used in this test was based on anecdotal evidence from the Local Authorities rather than from modelling or monitoring programmes.

Therefore a significant element of the Urban Pressures project was to undertake a more detailed characterisation of the CSO performance across the country.

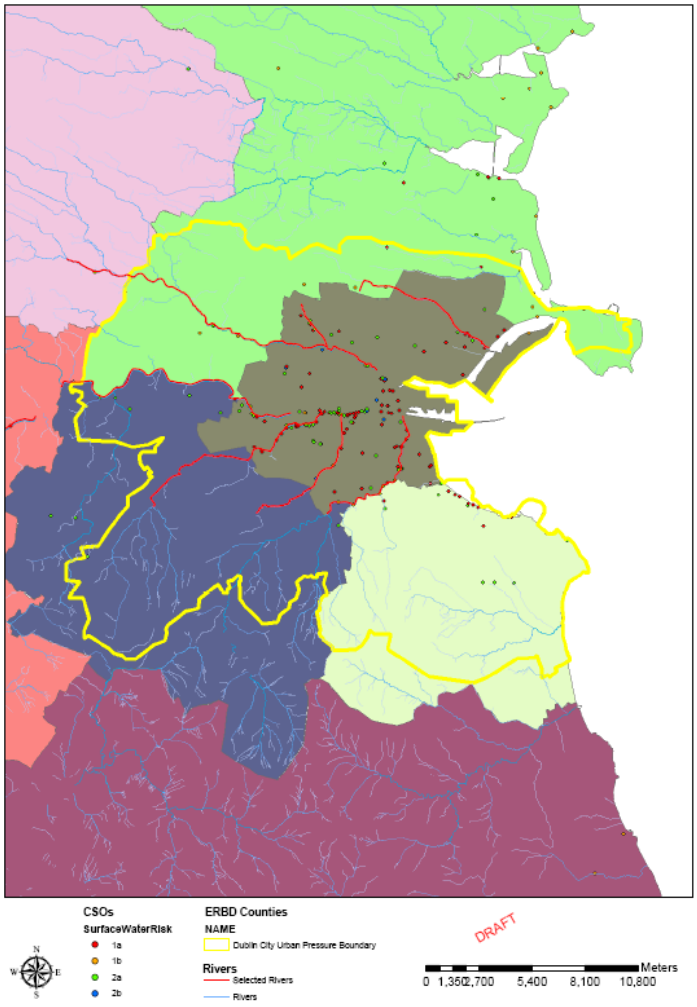
The approach adopted was to undertake a review of both the findings of the National Urban Waste Water Study and the reported modelling results from the National programme of sewer network modelling that has been ongoing over the past 6 years as part of the main drainage upgrade programme being implemented across the country.

From the review it was concluded that:

- The National Urban Waste Water Study did not provide any additional information on CSO performance.
- In the main the national sewer network modelling programme reports did not provide any information of substance regarding additional information on the CSO performance.

More importantly, however, the review did highlight that although the sewer network modelling programme did not specifically report CSO spill performance in detail it did provide detailed and fully calibrated hydraulic sewer modelling tools for many urban areas.

Figure 3 – CSO locations in Dublin region



If these models could be rerun nationally on a standardised basis and using a representative yearly continuous rainfall profile, the detailed continuous yearly spill performance could be generated for each CSO.

In addition the results from the model reruns could be utilised to determine what fraction of the urban area was connected to either foul/combined sewers or storm sewers and what proportion of the yearly rainfall falling on an urban catchment was discharging to either the foul/combined or the storm sewer systems. The remaining yearly rainfall proportion represents the surface water runoff component which drains directly to surfacewaters.

Furthermore, the results from the models can be utilised to determine the yearly inflows entering the downstream waste water treatment plants.

Overall therefore there would be many accrued benefits from rerunning the calibrated sewer network models.

This approach was subsequently adopted and models were rerun for a year 2005 continuous rainfall data set. The details of the number of sewer network models which were rerun are detailed in Table 3.

The remodelling exercise has generated large quantities of data which are currently being processed. Although the data processing exercise is still ongoing the preliminary findings to date indicate that:

- A number of the models will need to be updated.
- The original risk assessment based on a spill frequency <> 6 should be replaced.
- The modelling programme needs to be completed for those towns where no models currently exist.
- Yearly CSO cumulative spill volumes are being predicted to reduce significantly in many towns following the implementation of the main drainage programmes.
- In a number of urban areas the cumulative yearly CSO spill volumes are less than 10% of the overall cumulative yearly flows entering the foul/combined sewer networks.

Table 3: Sewer network remodelling

Urban Area/County	RBD	Remodelling Undertaken
Balbriggan, Fingal	ERBD	Yes
Bray, Wicklow	ERBD	Yes
Celbridge, Kildare	ERBD	Yes
Greater Dublin Area (Ringsend) - (30 - 40 Models)	ERBD	Yes
Leixlip, Kildare	ERBD	Yes
Malahide, Fingal	ERBD	Yes
Maynooth, Kildare	ERBD	Yes
Naas, Kildare	ERBD	Yes
Newbridge, Kildare	ERBD	Yes
Swords, Fingal	ERBD	Yes
Clonmel, Tipperary	SERBD	Yes
Limerick City	SHANNONRBD	Yes
Carrigaline, Cork	SWRBD	Yes
Letterkenny, Donegal	NWRBD	Yes
Mullingar, Westmeath	SHANNONRBD	Yes
Athlone, Westmeath	SHANNONRBD	Yes
Ennis, Clare	SHANNONRBD	Yes
Portlaoise, Laois	SERBD	Yes
Sligo Town	WRBD	Yes
Drogheda, Louth	ERBD	No
Greystones, Wicklow	ERBD	No
Navan, Meath	ERBD	No
Carlow Town	SERBD	No
Kilkenny City	SERBD	No
Waterford City	SERBD	No
Wexford Town, Wexford	SERBD	No
Cork City	SWRBD	No
Killarney Town, Kerry	SWRBD	No
Tralee, Kerry	SWRBD	No
Galway City	WRBD	No
Castlebar, Mayo	WRBD	No
Dundalk, Louth (Model of 25% of town)	NBRBD	No
Tullamore, Offaly	SHANNONRBD	No

The data processing exercise is ongoing and expected to be completed by mid/late July 2007.

3.2.2 Point Sources

The point sources investigated as part of the study included both Section 4 and IPPC licenced discharges. Section 16 discharges to sewer were not assessed due to the paucity of data.

A total of 39 Section 4's were identified within 16 of the 33 urban areas being assessed. From a detailed assessment of these licences it was established that no effluent monitoring information is available for the majority of the 39 Section 4's. For the small number of Section 4's where such monitoring data does exist only phosphorous and nitrates/nitrite discharges are being monitored. Consequently there is no monitoring data for many of the parameters of interest to this study as detailed in Table 2.

Overall therefore, the available datasets for the Section 4 licenced discharges are largely incomplete for either discharge concentration or flow data for many of the parameters for this study. For this reason the Section 4 data will be excluded from the integrated waterbody assimilative capacity assessments which are to be done in the latter stages of the study.

The definitive EPA list of active IPPC's as per October 2006 indicates that there are a total of 139 IPPC licences located within the 33 urban study areas. A total of 59 of the licences apply to discharges to surface waters within the 33 urban study catchments whilst a further 43 of the licences apply to discharges to foul sewers within the same catchments. In both instances, however, there are virtually no monitored results available for either the discharge flow or concentration for many of the parameters of interest to the study.

Therefore it was not possible to calculate the yearly loadings discharging to sewer from these industries/installations. For this reason the IPPC data will be excluded from the integrated waterbody assimilative capacity assessments which are to be completed as part of the latter stages of the study.

The investigation of both the Section 4 and the IPPC data has shown that improved and more comprehensive monitoring and reporting will be necessary to obtain a more detailed understanding of the volume and concentration of discharges from both. Without this level of understanding it will not be possible to assess the potential impact that these licenced dischargers will have on receiving waters.

The point source investigation and review phase of the project is completed.

3.2.3 Ground Water

Following a review and assessment of the work done previously, or currently being undertaken as part of the Further Characterisation process, it was established that meaningful data for groundwater concentrations and discharge

flows to the surface water bodies in the 33 urban study areas could not be generated.

Consequently no groundwater contribution will be included in the integrated waterbody assimilative capacity assessments which are to be completed as part of the latter stages of the study.

The investigation of the ground water contribution has shown that there is a clear need for a more detailed understanding of the source – path – receptor ground water mechanisms within urban areas for many of the parameters of interest to this study.

The ground water investigation and review phase of the project is completed.

3.2.4 Waste Water Treatment

Waste water treatment works are a significant urban pressure. Given that these installations are discharging continuously 24 hours per day and 365 days per year they can have a significant impact on the receiving waters if the level of treatment is inadequate.

The existing waste water treatment capacity for each of the urban areas was reviewed and assessed. From the review it was established that 29 of the 33 urban areas are served by waster water treatment works. Preliminary reports have been completed however for the remaining 4 urban areas with no treatment and contracts are currently pending to build the remaining 4 treatment plants.

An effluent loading matrix has been developed detailing the yearly cumulative effluent discharge loadings from each of the 33 urban areas for each of the parameters listed in Table 2. This effluent loading matrix has been developed using data from the UK and Ireland.

The waste water treatment works investigation and analysis work undertaken to date has identified a number of issues and data gaps whereby improvements could be made including;

- The small number of urban areas currently without waste water treatment plants should have the treatment plants installed as a matter of urgency.

- An improved flow monitoring regime (including the installation of appropriate flow monitoring equipment) should be implemented in the waste water treatment plants to continuously monitor both influent and effluent flows.

- An improved water quality monitoring regime (including the installation of appropriate water quality monitoring/sampling equipment) should be implemented in the waste water treatment plants to monitor both influent and effluent concentrations for a widened range of parameters.

- A more comprehensive monitoring inspection programme should be implemented for the waste water treatment plants to ensure compliance with the requirements of the licence.

- A short term continuous water quality sampling programme would be beneficial in the interim to assist in the characterisation of influent and effluent strengths for the range of parameters listed in Table 2.

The waste water treatment works investigation and review phase of the project is completed.

3.2.5 Atmospheric Deposition

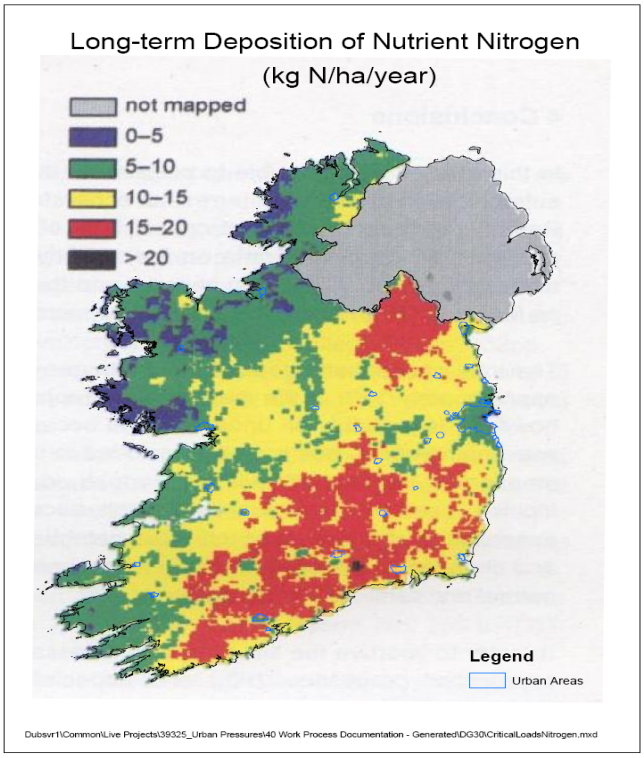
An extensive review and assessment was undertaken of atmospheric deposition within Ireland. Many references were assessed as part of the review process including Irish, UK, and wider European data. Much of the available data specific to Ireland centres on atmospheric deposition related to Phosphorous and Nitrogen. In general there was no data available for many of the other study parameters indicated in Table 2 – particularly the metals.

The only site in Ireland where a more comprehensive suite of the metals parameters - as listed in Table 2 – are monitored is in Valentia in Kerry. Given the general deficit of data in this area the decision was made to utilise the monitoring data from the Valentia site as surrogate data to represent the urban areas throughout the remainder of the country.

The atmospheric deposition investigation and analysis work undertaken to date has identified a number of data gaps whereby improvements could be made including:

- Consideration to expanding the existing national air monitoring programme to gather data relating to the expanded range of parameters which will be scrutinised as a requirement of the Water Framework Directive.

Figure 4: Long-term Deposition of Nutrient Nitrogen - EPA



The atmospheric deposition investigation and review phase of the project is completed and a suggested atmospheric loading matrix has been developed for calculating the yearly deposition loadings directly onto the surface waters within each of the urban areas nationally.

3.2.6 Diffuse Urban Runoff

One of the more significant pressures within the urban footprint emanates from surface water runoff. This type of runoff originates from either grassed permeable areas of hard paved impermeable areas.

The Urban Development Plans have been sourced from the Local Authorities for all 33 urban areas. The land use zoning maps from each of the 33 development plans have been extracted and the land uses were reclassified as revised land uses types using a standardised generic set of 10 landuses. The existing development or proposed future development classifications within the land zoning maps have also been retained to provide the flexibility for assessing the impact of future development on assimilative capacity.

Figure 5: Typical Land Use Zoning map

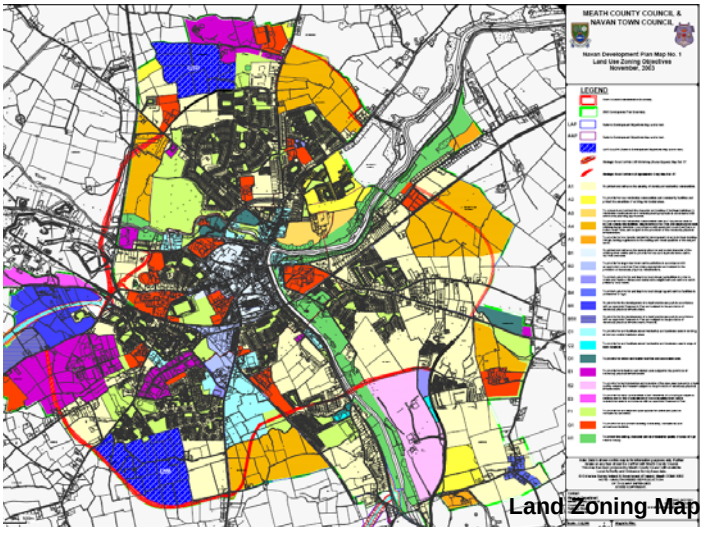


Figure 6: Sample land use reclassification Figure

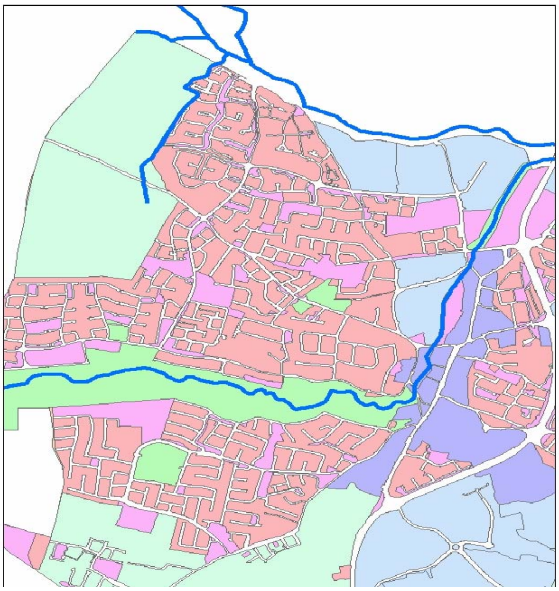
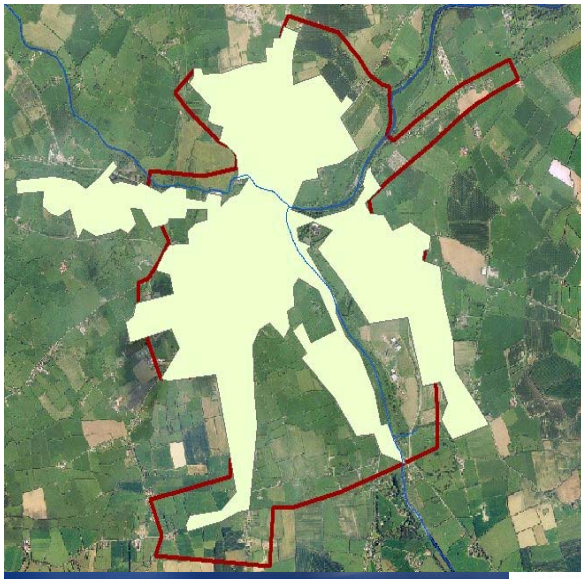


Figure 7: Typical aerial photography



Where necessary this work has been done with reference to the aerial photography whenever such photography has been made available.

A pollution runoff loading matrix has been developed for use on the urban catchments. This matrix is based upon the extensive work done outside of Ireland in America, Europe and Australia on event mean concentrations. The event mean concentrations are a set of urban runoff concentration factors covering a range of parameters which are present within urban environments. The urban runoff concentration factors also vary according to land use types such as residential, highways, commercial etc.

The diffuse urban runoff investigation and analysis work undertaken to date has identified a number of data gaps whereby improvements should be considered including:

- The need to standardise the preparation of land use zoning maps across Ireland so that all Local Authorities use the same standardised zoning classifications.
- A system whereby urban and county development plans are centralised so as to ensure ease of access in dealing with the implications of the Water Framework Directive.
- A system whereby aerial photography is centralised so as to ensure ease of access in dealing with the implications of the Water Framework Directive.
- Implementing a study with the primary objective of developing event mean concentration data specific to Irish urban catchments and land uses.

The diffuse urban runoff analysis and assessment phase of the project is ongoing and at an advanced stage and due to completed by mid/late July 2007.

3.2.7 Upstream Surface Water Loadings

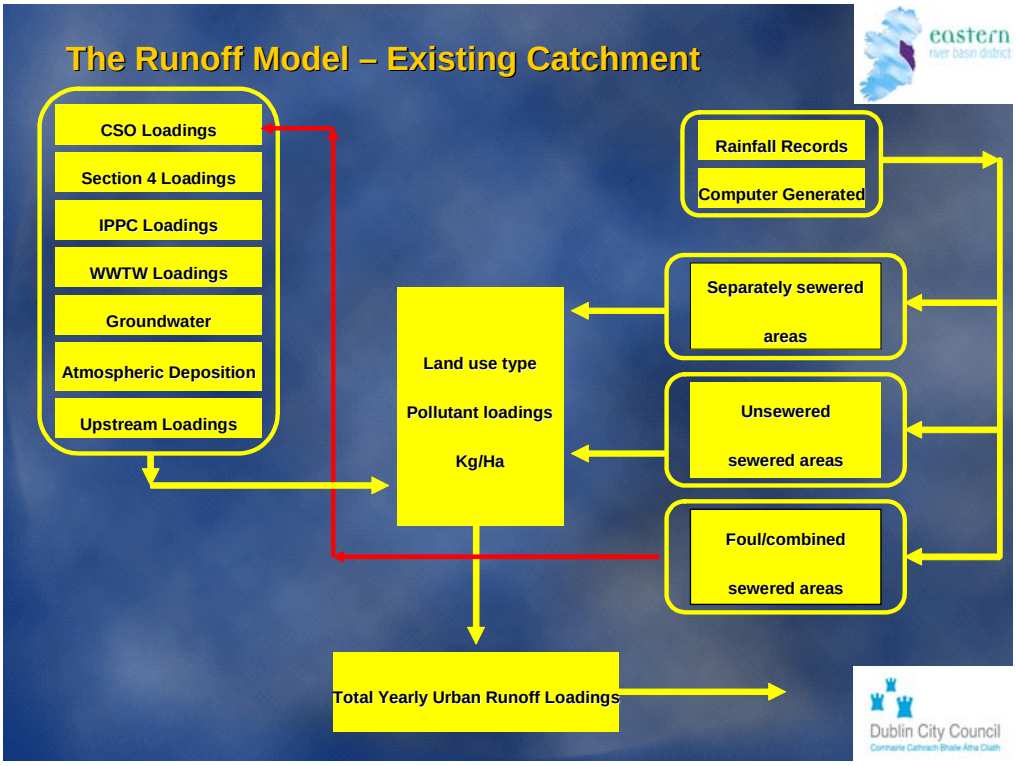
The upstream surface water loadings analysis and assessment phase of the project is at an early stage. The work is ongoing and due to completed by mid/late July 2007. Therefore there is nothing of significance to report at this stage for this aspect of the project.

Section 4
Pollution Runoff Model

A pollution runoff model concept has been developed for use on the project as detailed in Figure 8. The pollution runoff model will generate the yearly cumulative pollution loadings to the urban waterbodies for each individual urban pressure. Wherever possible cumulative pollution loadings will generated for the range of parameters listed in Table 2.1 subject to the data limitations/detail for individual parameters and pressures highlighted earlier throughout section 2.0 of this document.

Yearly cumulative pollution loadings will be calculated using the complete continuous 2 minutes rainfall dataset from the Meteorological Office National Tuscon raingauge network for the year 2005.

Figure 8 – The urban pollution runoff loading model



The work in this area is ongoing and due to completed by mid/late July 2007.

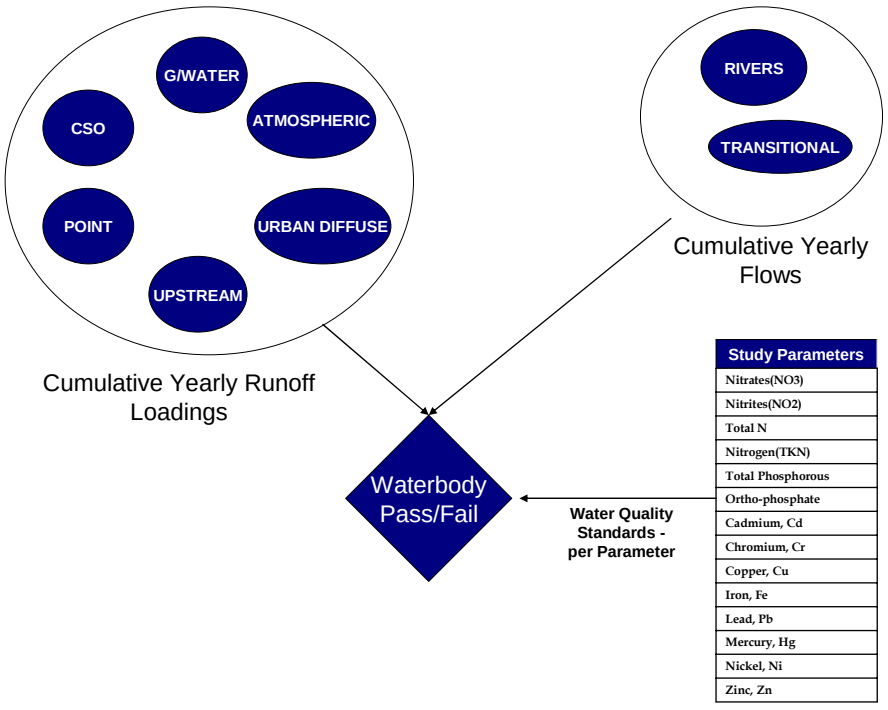
Section 5
Assimilative Capacity Assessment

Work relating to the assimilative capacity assessments is in progress. The main stages for this aspect of the work are:

- Definition of the river and transitional water bodies to be assessed;
- Clarification of the water quality standards which will apply to the waterbodies;
- Calculation of the cumulative yearly pollution loadings to the waterbodies;
- Calculation of the yearly flows in the waterbodies;.

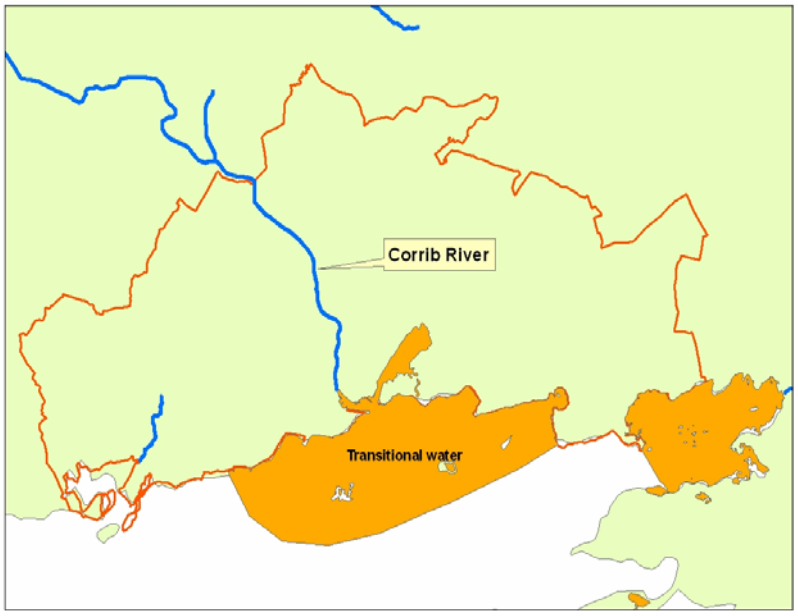
The assimilative capacity assessment procedure is outlined in Figure 9.

Figure 9 – Assimilative capacity assessment procedure



The river and transitional waterbodies to be assessed have been identified. Approximately 25 river and 15 transitional waterbodies will be assessed for assimilative capacity.

Figure 10 – Galway waterbodies to be tested for assimilative capacity



Project specific indicative interim water quality standards have been established in advance of the national water quality standards which are still under development.

The methodology for determining the cumulative yearly loadings to the water bodies is developed and work in this area is ongoing as referred to in section 3.0 previously.

The yearly flows are currently being developed for the river waterbodies by the EPA. The final data is pending and expected within the next month. The methodology for establishing the yearly flows within the transitional waters has been completed.

Section 6
Conclusions

The urban pressures study was commissioned and commenced in February 2006 with an 18 month programme to completion.

The study was commissioned to build upon the foundation work which was reported in the National Article V report, "The Characterisation and Analysis of Ireland's River Basin Districts" (EPA, 2005).

In particular the study was commissioned to address a number of data gaps which became apparent during the preparation of the Article V report, particularly regarding the spill performance CSOs, and the need to obtain a more detailed understanding of urban pressures within Irish urban areas and their potential impact on receiving urban waterbodies.

Although significant progress has been made to date the project has highlighted a number of data gaps and needs which will need to be addressed to obtain a more detailed understanding of Irish urban pressures. Many of these data gaps and needs have been highlighted throughout this document.

One of the more significant issues is the lack of comprehensive flow and quality monitoring data for waste water treatment plant influents and effluents. Another issue is the lack of data relating to the quality of CSO spills for many of the parameters which are expected to come under scrutiny as part of the Water Framework Directive.

One of the more interesting findings is the fact that in a number of urban areas the cumulative yearly CSO spill volumes have been found to be less than 10% of the overall cumulative yearly flows entering the foul/combined sewer networks.

A significant finding is that the existing yearly CSO cumulative spill volumes are predicted to reduce significantly in many towns following the implementation of the main drainage programmes.

The project has progressed well though there have been a number of delays in acquiring data. The project completion date of mid/late July is currently being reassessed to take account of these delays and it is expected that this may result in the completion date slipping by up to two months.

Acknowledgements

The authors wish to acknowledge the advice provided by members of The Urban Pressures Steering Group, as well as the contribution of individual river basin districts in providing supporting data. The authors are especially indebted to staff from a number of third party consultants who undertook the sewer remodelling exercises for a number of the study urban area sewer networks.

A special note of thanks is also due to staff in the EPA including Michael Mc Carthaigh who provided hydrology support.

Finally the authors would like to recognise the significant effort of Dublin City Council staff including Don McEntee and Ray Earle who have been instrumental in ensuring that the project direction has remained focused throughout.