PRELIMINARY FLOOD RISK ASSESSMENT

DRAIN LONDON

LONDON
BOROUGH OF
CROYDON

GREATER LONDON AUTHORITY

Thames Water

LONDON COUNCILS

Environment Agency

CROYDON COUNCIL

Quality Management

DOCUMENT INFORMATION

Title:	London Borough of Croydon PFRA
Owner:	David Carlisle
Version:	V05
Status:	Final Report
Project Number:	D134786
File Name:	DLT2-GP8-PFRA-CroydonReport-V05.doc

REVISION HISTORY

Summary of Changes	Completed By	Date of Issue	Version
Interim Draft Report	Sarah Littlewood	17-03-2011	V3
Draft Final including Comments from LB Croydon	Sarah Littlewood	14-04-2011	V4
Final Report including Comments from LB Croydon	Sarah Littlewood	13-05-2011	V5

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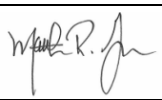
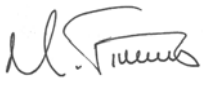
Mathew Graham	URS/Scott Wilson Reviewer		14-03-11
Michael Timmins	URS/Scott Wilson Approver		17-03-11

DISTRIBUTION

Name	Organisation and Role

RELATED DOCUMENTS

Doc Ref	Document Title	Author	Date of Issue	Version

Executive Summary

This document forms a Preliminary Flood Risk Assessment (PFRA) report for London Borough of Croydon as required in accordance with the Flood Risk Regulations 2009.

The PFRA provides a high level summary of significant flood risk, based on available and readily derivable information, describing both the probability and harmful consequences of past and future flooding. The scope of the PFRA is to consider flooding from the following sources; surface runoff, groundwater, sewers and ordinary watercourses and any interaction these have with main rivers.

According to readily available datasets, the London Borough of Croydon has experienced a number of past surface water flooding events, most notably that of July 2007. This event is considered to have had significant harmful consequences for human health, economic activity and cultural heritage and has therefore been recorded in Annex 1 of the PFRA spreadsheet.

It has been agreed, in conjunction with Environment Agency and Council members, that the Drain London Surface Water Management Plan (SWMP) outputs from the Drain London Project will form the locally agreed surface water information for the London Borough of Croydon. A review of this information demonstrates that an estimated 65,260 residential properties and 3,860 non-residential properties in the London Borough of Croydon could be at risk of surface water flooding of greater than 0.03m depth during a rainfall event with a 1 in 200 annual chance of occurring. Approximately 1,910 residential properties and 480 non-residential properties are estimated to be at risk of flooding to a depth of greater than 0.5m during the same modelled rainfall event. Details of these consequences are recorded in Annex 2 of the PFRA spreadsheet.

The London Borough of Croydon is included in the Flood Risk Area for Greater London. No changes are proposed to this Flood Risk Area.

Glossary

Term	Definition
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan
Asset Management Plan	A plan for managing water and sewerage company (WaSC) infrastructure and other assets in order to deliver an agreed standard of service.
AStSWF	Areas Susceptible to Surface Water Flooding
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CDA	Critical Drainage Area
Critical Drainage Area	A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Culvert	A channel or pipe that carries water below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DTM	Digital Terrain Model
EA	Environment Agency
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and WAG and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
FMfSW	Flood Map for Surface Water
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG.
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRR	Flood Risk Regulations
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
LB	London Borough
LDF	Local Development Framework
LFRZ	Local Flood Risk Zone

Term	Definition
Local Flood Risk Zone	Local Flood Risk Zones are defined as discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location
Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
Local Resilience Forum	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner.
LPA	Local Planning Authority
LRF	Local Resilience Forum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Ordinary Watercourse	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDBs
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Flooding from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
PPS25	Planning and Policy Statement 25: Development and Flood Risk
PA	Policy Area
Policy Area	One or more Critical Drainage Areas linked together to provide a planning policy tool for the end users. Primarily defined on a hydrological basis, but can also accommodate geological concerns where these significantly influence the implementation of SuDS
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Risk Management Authority	As defined by the Floods and Water Management Act
RMA	Risk Management Authority
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems
Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Surface water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan
TfL	Transport for London
TWUL	Thames Water Utilities Ltd
WaSC	Water and Sewerage Company

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Annexes

1. Introduction

1.1 WHAT IS A PRELIMINARY FLOOD RISK ASSESSMENT?

1.1.1 A Preliminary Flood Risk Assessment (PFRA) is a high level screening exercise to identify areas of significant flood risk within a given study area. The PFRA involves collecting information on past (historic) and future (potential) floods, assembling the information into a PFRA report, and identifying Flood Risk Areas.

1.1.2 This PFRA report for London Borough of Croydon provides a high level summary of significant flood risk, based on available and readily derivable information, describing both the probability and harmful consequences of past and future flooding. The development of new information is not required, but new analysis of existing information may be needed.

1.1.3 This PFRA has been based on existing and readily available information and brings together information from a number of available sources such as the Environment Agency's national information (for example Flood Map for Surface Water) and existing local products such as Strategic Flood Risk Assessments (SFRAs) and Surface Water Management Plans (SWMPs). The methodology for producing this PFRA has been based on the Environment Agency's Final PFRA Guidance and Defra's Guidance on selecting Flood Risk Areas, both published in December 2010.

1.2 BACKGROUND

1.2.1 The primary driver behind the PFRA is the Flood Risk Regulations 2009, which came into law on the 10th December 2009 and seek to transpose the EC Floods Directive (Directive 2007/60/EC on the assessment and management of flood risks) into domestic law in England and Wales and to implement its provisions.

1.2.2 In particular the Regulations place duties on the Environment Agency and Lead Local Flood Authorities (LLFA) to prepare a number of documents including:

- Preliminary Flood Risk Assessments;
- Flood hazard and flood risk maps;
- Flood Risk Management Plans.

1.2.3 The purpose of the PFRA report under the Regulations is to provide the evidence for identifying Flood Risk Areas. The report will also provide a useful reference point for all local flood risk management and inform local flood risk strategies.

1.2.4 The scope of the PFRA is to consider past flooding and potential future flooding from the sources of flooding other than main rivers, the sea and reservoirs. In particular this includes surface runoff, flooding from groundwater and ordinary watercourses and any interaction these have with local drainage systems.

1.3 OBJECTIVES

1.3.1 The key objectives of the PFRA are summarised as follows:

- Collect information on past (historic) and future (potential) floods within the study area and record it within the PFRA spreadsheet;
- Assemble the information into a PFRA report;
- Review the indicative Flood Risk Areas delineated by the Environment Agency and where necessary provide explanation and justification for any amendments required to these;
- Provide a summary of the systems used for data sharing and storing and the provision for quality assurance, security and data licensing arrangements;
- Describe arrangements for partnership and collaboration for ongoing collection, assessment and storage of flood risk data and information;
- Identify relevant partner organisations involved in future assessment of flood risk; and summarise means for future and ongoing stakeholder engagement;
- Provide a useful reference point for all local flood risk management and inform future local strategies.

1.4 STUDY AREA

1.4.1 The study area is defined by the administrative boundary of the London Borough of Croydon. LB Croydon is located in the southern part of Greater London and covers an area of approximately 87km^2. It is the largest London Borough by population and contains three parliamentary constituencies, Croydon North, Croydon Central and Croydon South.

1.4.2 The study area is characterised by steep topography in the south of the Borough which contributes to the catchment of the River Wandle and the Norbury Brook which flow northwards out of the north west of the Borough.

1.4.3 The underlying geology is divided, with London Clay in the north and Chalk present in the south of the Borough. There is a Thames Water surface water drainage network in the north of the borough and the south of the Borough is managed through linked soakaway systems.

1.4.4 The study area falls into the Thames River Basin District (RBD) (as defined by the Environment Agency) and is located in the Environment Agency Thames Region.

1.4.5 Thames Water Utilities Ltd is responsible for all foul water sewers in the Borough. In the northern part of the Borough, a system of public storm sewers is operated by Thames Water fed by highway gullies and roof drainage from properties. In the southern half of the Borough, highway surface water is captured and then dispersed via a network of soakaways forming a highway drainage system owned by the Council. Surface water from property in the southern half of the Borough, is generally drained to private soakaways on private land. In addition, the two main trunk roads in the Borough (A23 and A22) are served by a Thames Water storm sewer both in the north and south of the Borough.

2. LLFA Responsibilities

2.1 LEGISLATIVE BACKGROUND

2.1.1 The key drivers behind the PFRA are two pieces of new legislation, the Flood Risk Regulations 2009 which became law on the 10th December 2009, and the Flood & Water Management Act (FWMA) which gained Royal Assent on the 8th April 2010.

2.1.2 The Flood Risk Regulations 2009 were created to transpose the EC Floods Directive (Directive 2007/60/EC) into domestic law in England and Wales. The Floods Directive provides a framework to assess and manage flood risks in order to reduce adverse consequences for human health, the environment (including cultural heritage) and economic activity.

2.1.3 The Flood and Water Management Act 2010 makes specific provision for the recommendations provided by Sir Michael Pitt in his independent review of the flooding experienced across much of England and Wales in 2007.

2.1.4 Under these pieces of legislation, all Unitary Authorities and London Boroughs are designated 'Lead Local Flood Authorities' (LLFA) and have formally been allocated a number of key responsibilities with respect to local flood risk management.

2.2 LEADERSHIP & PARTNERSHIP

2.2.1 The Flood and Water Management Act 2010 defines London Borough of Croydon as the Lead Local Flood Authority (LLFA). As such, the London Borough of Croydon is responsible for leading local flood risk management, including establishing effective partnerships within their local authority as well as with external stakeholders such as the Environment Agency, Thames Water Utilities Ltd, Transport for London, Network Rail and London Underground as well as others. Ideally these working arrangements should be formalised to ensure clear lines of communication, mutual co-operation and management through the provision of Level of Service Agreements (LoSA) or Memorandums of Understanding (MoU).

Local Strategic Partnership Climate Change Group

2.2.2 London Borough of Croydon has an existing Local Strategic Partnership strategy group dedicated to climate change, the aim of which is to ensure that long-term climate change adaptation is considered in all areas of relevant work across the council. Current objectives include the delivery of the GLA community flood plan pilot in Purley, as part of the Drain London project. The Group meets every 6 to 8 weeks.

2.2.3 This group is currently being reformed, however, up until now, members have included representatives from Council departments such as Business Continuity, Street Services, Regeneration and Asset Management, Planning, Highways, Planning, Risk and Insurance, as well as the Environment Agency, Natural England, Thames Water, NHS Croydon, Primary Care Trust, and the Greater London Authority.

Structures and Drainage Meetings

2.2.4 Officers from the structures and drainage teams at London Borough of Croydon attend meetings such as the Association of Thames Drainage Authorities (ATDA), and have semi regular meetings with Surrey County Council and neighbouring Local Authorities to discuss cross border issues with respect to highway drainage and flooding issues when required. They also meet representatives from Thames Water to discuss flooding issues when required. Officers are engaged in the Communities@local.gov.co.uk discussion forum. Officers are also obviously involved in ongoing discussions with schools and residents affected by flooding issues.

South West London Strategic Flood Group

2.2.5 As part of the Drain London Project, London Borough of Croydon have been working closely with neighbouring Boroughs to forge partnerships with respect to local flood risk management as part of the preparation of Surface Water Management Plans for all 33 London Boroughs.

2.2.6 As part of this work, suggestions have been put forward for a South West London Strategic Flood Group that would report to the Regional Flood Defence Committee through Councillor Osborne at Royal Borough of Kingston. A potential structure may look something like that shown in Figure 2-1.

Figure 2-1 Organogram of Potential South West London Flood Partnership

2.2.7 At the moment the responsibility for flood risk management at Croydon Council is shared across the following four departments:

- Planning and Building Control;
- Economy and Environment;
- Street Services; and
- Civil Contingencies.

2.2.8 However discussions are currently underway to determine future governance arrangements for local flood risk management in London Borough of Croydon.

2.3 STAKEHOLDER ENGAGEMENT

2.3.1 As part of the preparation of PFRAs and SWMPs across London, stakeholders have been engaged representing the following organisations and authorities:

- Environment Agency
- Thames Water Utilities Ltd
- Neighbouring London Boroughs
- Network Rail
- Transport for London
- Highways Agency
- Natural England
- London Fire Brigade

2.4 PUBLIC ENGAGEMENT

2.4.1 Members of the public may also have valuable information to contribute to the PFRA and to an improved understanding and management of local flood risk within the study area. Public engagement can afford significant benefits to local flood risk management including building trust, gaining access to additional local knowledge and increasing the chances of stakeholder acceptance of options and decisions proposed in future flood risk management plans.

2.4.2 However it is also recognised that it is crucial to plan the level and timing of engagement with communities predicted to be at risk of flooding from surface water, groundwater and ordinary watercourses. This is to ensure that the potential for future management options and actions is adequately understood and costed without raising expectations before solutions can reasonably be implemented.

2.4.3 It is important to undertake some public engagement when formulating local flood risk management plans, following the designation of Flood Risk Areas within the study area as this will help to inform future levels of public engagement. It is recommended that the London Borough of Croydon follow the guidelines outlined in the Environment Agency's "Building Trust with Communities"[1] which provides a useful process of how to communicate risk including the causes, probability and consequences to the general public and professional forums such as local resilience forums.

2.5 OTHER RESPONSIBILITIES

2.5.1 Aside from forging partnerships and coordinating and leading on local flood management, there are a number of other key responsibilities that have arisen for Lead Local Flood Authorities from the Flood & Water Management Act 2010, and the Flood Risk Regulations 2009. These responsibilities include:

- **Investigating flood incidents** – LLFAs have a duty to investigate and record details of significant flood events within their area. This duty includes identifying which authorities have flood risk management functions and what they have done or intend to do with respect to the incident, notifying risk management authorities where necessary and publishing the results of any investigations carried out.
- **Asset Register** – LLFAs also have a duty to maintain a register of structures or features which are considered to have an effect on flood risk, including details on ownership and condition as a minimum. The register must be available for

[1] Environment Agency, Building Trust with Communities
http://www.ncl.ac.uk/ihs/research/environment/rehmarc/pdfs/workingwithothers.pdf

inspection and the Secretary of State will be able to make regulations about the content of the register and records.

- **SuDS Approving Body** – LLFAs are designated the SuDS Approving Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new sustainable drainage systems (SuDS) within their area. This responsibility is anticipated to commence from April 2012.

- **Local Flood Risk Management (LFRM) strategies** – LLFAs are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area. The LFRM strategy will build upon information such as national risk assessments and will use consistent risk based approaches across different local authority areas and catchments.

- **Works powers** – LLFAs have powers to undertake works to manage flood risk from surface runoff and groundwater, consistent with the local flood risk management strategy for the area.

- **Designation powers** – LLFAs, as well as district councils and the Environment Agency have powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management. Once a feature is designated, the owner must seek consent from the authority to alter, remove or replace it.

3. Methodology & Data Review

3.1 Data Sources & Availability

3.1.1 Table 3-1 provides a summary of the data sources held by partner organisations with responsibility for local flood risk management with London Borough of Croydon. The table includes a description of the dataset and its availability at the time of writing.

Table 3-1 Data Sources

	Dataset	Description
Environment Agency	Environment Agency Flood Map (Fluvial)	Shows the extent of flooding from rivers with a catchment of more than 3km^2 and from the sea.
	Areas Susceptible to Surface Water Flooding	A national outline of surface water flooding held by the EA and developed in response to Pitt recommendations.
	Flood Map for Surface Water	A second generation of surface water flood mapping which was released at the end of 2010.
	Areas Susceptible to Groundwater Flooding	Mapping showing areas susceptible to groundwater flooding.
	National Receptors Dataset	A nationally consistent dataset of social, economic, environmental and cultural receptors including residential properties, schools, hospitals, transport infrastructure and electricity substations.
	Indicative Flood Risk Areas	National mapping highlighting key flood risk areas, based on the definition of 'significant' flood risk agreed with the Defra.
	Historic Flood Map	Attributed spatial flood extent data for flooding from all sources.
London Borough of Croydon	Strategic Flood Risk Assessments (SFRA)	SFRAs may contain useful information on historic flooding, including local sources of flooding from surface water, groundwater and flooding from canals.
	Historical flooding records	Historical records of flooding from surface water, groundwater and ordinary watercourses.
	Anecdotal information relating to local flood history and flood risk areas	Anecdotal information from authority members regarding areas known to be susceptible to flooding from excessive surface water, groundwater or flooding from ordinary watercourses.
	Highways Flooding Reports	Highways Flooding Reports for a number of locations including analysis of the flood risk at each location.
Thames Water	DG5 Register for Thames Water Utilities areas	DG5 Register logs and records of sewer flooding incidents in each area.
London Fire Brigade	Historical flooding call-out records	Records of all London Fire Brigade callouts for 'flooding' events since 2000. However, no flooding source is provided, so could be a result of water mains bursting as well as heavy rainfall / surface water flooding.

Network Rail	Areas Prone To Flooding	A list of areas prone to flooding across their South East Territory.
London Undergroun	Flooding records – July 2007	Records relating to station closures (location and duration) on 20th July 2007 due to heavy rainfall.

3.2 LIMITATIONS

3.2.1 A number of issues arose during the data collection process, as described below:

3.2.2 The Council's drainage team holds digital records (excel) of locations affected by flooding in July 2007. However, there are no records of flooding either prior to or following this event, while there is evidence that flooding has occurred on numerous other occasions (supported by local newspaper articles). This has resulted in incomplete flood record datasets and corresponding gaps in flood data.

3.2.3 The Civil Contingencies Team log all incidents that are reported, however this only captures the incidents that they hear about and does not include specific details about the flooding incidents such as the individual areas that experience flooding or details about the source and consequences of the flooding.

3.2.4 At the present time there is no official procedure in place to record flooding incidents within the drainage and structures team. Many of the incidents of highway flooding are initially reported to Streetscene/Highways (Community Services Department) and are then forwarded onto other relevant departments such as the Structures and Drainage, Environmental Health or Housing.

3.2.5 The lack of a consistent flood data recording system for London Borough of Croydon has led to major inconsistencies in the recording of flood event data. While in some cases electronic records of flooding incidents have been created, they are often only known by one person within the council and much of the information is not written down, or is contained on paper records which are not accessible.

3.3 SECURITY, LICENSING AND USE RESTRICTIONS

3.3.1 A number of datasets used in the preparation of this PFRA are subject to licensing agreements and use restrictions.

3.3.2 The following national datasets provided by the Environment Agency are available to local authorities and their consultants for emergency planning and strategic planning purposes:

- Flood Map for Rivers and the Sea;
- Areas Susceptible to Surface Water Flooding;
- Flood Map for Surface Water;
- National Receptor Database.

3.3.3 The analyses to prepare the indicative Flood Risk Areas issued to accompany the final PFRA Guidance were based on the National Receptors Database (NRD) version 1.0 (for the counts of properties and other receptors). Receptor information was prepared for all London Boroughs in December 2010 in order to undertake property counts required for the SWMPs, also using NRD version 1.0. Version 1.1 of the NRD has subsequently been issued and contains modifications and corrections since version 1.0. However, in order to avoid repetition of work, and ensure consistency between the SWMP and the PFRA, it was decided to complete the PFRA using NRD version 1.0.

3.3.4 A number of the data sources used are publically available documents, such as:

- Strategic Flood Risk Assessment;
- Catchment Flood Management Plan;
- Surface Water Management Plan.

3.3.5 The use of some of the datasets made available for this PFRA has been restricted and is time limited, licensed to the London Borough of Croydon via the Greater London Authority for use under the Drain London project, which includes the production of a PFRA for the London Borough of Croydon. The restricted datasets include records of property flooding held by the Council and by Thames Water Utilities Ltd, and data licensed by the Environment Agency. Necessary precautions must be taken to ensure that all information given to third parties is treated as confidential. The information must not be used for anything other than the purpose stated in the agreement. No information may be copied, reproduced or reduced to writing, other than what is necessary for the purpose stated in the agreement.

3.4 QUALITY ASSURANCE

3.4.1 The datasets used to inform this PFRA were collected centrally for all London Boroughs as part of the Tier 1 Drain London work package of works. All data received was subject to quality assurance measures to monitor and record the quality and accuracy of the data and information. A data quality score was given to all the data which is a qualitative assessment based on the Data Quality System provided in the SWMP Technical Guidance (March 2010). This system is explained in Table 3-2.

Table 3-2 Data Quality System (SWMP Technical Guidance March 2010)

Data Quality Score	Description	Explanations	Example
1	Best available	No better available; not possible to improve in the near future	2D Pluvial Modelling Outputs
2	Data with known deficiencies	Best replaced as soon as new data is available	Historic Flood Records
3	Gross assumptions	Not invented but based on experience and judgement	Location, extent and depth of surface water flooding
4	Heroic assumptions	An educated guess	Impact of a historic flood event

3.4.2 The use of this system provides a basis for analysing and monitoring the quality of data that is being collected and used in the preparation of the PFRA. As mentioned in Section 3.2, some of the datasets collected for this PFRA were of poor quality, and this has been identified and recorded using this system.

4. Past Flood Risk

4.1 Summary of Past Floods

4.1.1 Table 4-1 provides a summary of past flood incidents in the study area. Not all of these events are considered to have had 'significant harmful consequences' and therefore not all have been included within Annex 1 of the PFRA spreadsheet.

Table 4-1 Past Floods & Consequences

Flood Event	Description
1958 Surface Water Flooding	Croydon was hit by the heaviest rainfall in 20 years. Three ferocious thunderstorms occurred in the space of 10 days. The South Norwood of Portland and Hollands Roads were worst hit. Rivers of contaminated flood water were recorded in Thornton Heath. Phone lines were down. Traffic halted. Basements flooded. The flood water had to be pumped from the cellars of Cricketers pub in Addington Village.
1960 Surface Water Flooding	1.6 inches of rainfall fell in 1 hour over the Purley Corner area, now Purley Cross. The Council opened a public inquiry at the town hall relating to the flooding in this area.
1968 Surface Water Flooding	2 months worth of rainfall fell in 2 days. A 58-year old man drowned in floodwater. 12,000 telephone lines were down. Lower Addiscombe Road was completely submerged near the Bingham Road railway bridge. The Fire Service answered more than 1,000 distress calls.
1970s, Fluvial Flooding associated with the Norbury Brook	Significant flooding occurred associated with the insufficent capacity of the Norbury Brook. The County Council pledged an estimated £1m to implement measures to prevent the Norbury Brook from overflowing.
Winter 2000-2001 Groundwater flooding	A22 blocked for nearly one month during winter 2000-2001.
July 2007 Surface Water Flooding	Tram links brought to a stand still. Road lane restrictions due to presence of surface water flooding (evident at Fantail Junction in Locksbottom before the split into the A232 towards Croydon and the A21 to Bromley). A land slip onto a railway line resulting from the ensuing instability caused by heavy flow within a drainage ditch lead to the enforcement of speed restrictions and cancelation of some rail services.
July 2007 Surface Water Flooding	Residential properties on Chipstead Valley Road and Westleigh Avenue experience regular surface water flooding. Properties are located as much as 1.5m below road level on one side of the road, creating well defined flowpaths into the properties. Notably severe during floods of July 2007.
Regular Surface Water Flooding	Residential properties on Asmar Close experience regular surface water flooding. Flowpath along Greenfield Link and Hilars Heath Road into Asmar Close. The drainage system, which comprises soakaways into the underlying chalk, was designed solely for the development area and not the runoff generated from adjoining roads

	in the upper part of the catchment. The capacity is therefore often exceeded. Four properties regularly affected.
Regular Surface Water Flooding	Properties and highway route along Brighton Road experiences surface water flooding during heavy rainfall. This is due to the topography; Brighton Road is located along the route of a former watercourse.
July 2007 Surface Water Flooding	July 2007 flooding at Purley Cross. Flood water several metres deep. Buses and cars submerged. Property flooding in the area. Supermarket flooding. Significant danger to life.
October 1993, 2001, July 2007 Surface Water Flooding	Properties in the Hamsey Green area have historically experienced severe surface water flooding. Notable events in October 1993, 2001, July 2007. Flooding of properties and gardens along Kingswood Way, Audley Drive, Kingswood Avenue and Harewood Gardens. Main source of flooding thought to be surface water from the field south of Kingswood Lane which is directed along a natural gully between Kingswood Lane and Harewood Gardens. Also likely that the capacity of the drainage system, which is designed solely to manage runoff from the highways, was exceeded, thereby contributing further to flooding. Drainage engineer recommended the construction of a bund along the edge of the field to alleviate flooding in Hamsey Green. The local drainage system comprises road gullies connected to a system of linked soakaways in the underlying chalk strata. Any siltation of these soakaways will also exacerbate flooding in these areas.
July 2007 Surface Water Flooding	Surface water flooding of Kenley Lane and Kenley Station recorded regularly, including in July 2007. Flow along Welcomes Road contributes to flooding in this area; Welcomes Road is a steep private road and does not have any formal drainage, therefore significant flow is directed towards the Kenley Station area from the higher ground. There is an electrical substation in this area and properties and gardens that experience flooding.
July 2007 Surface Water Flooding	Five households had to be evacuated due to risk of electrical explosion after the basements were flooded during a heavy rainfall event resulting in flooding.
Regular Surface Water Flooding	Marlpit Lane regularly floods underneath the railway bridge. This is located in a topographic depression and the capacity of the drainage system is regularly exceeded. During times of flood the road is closed to vehicles.
July 2007 Surface Water Flooding	Purley Oaks Road and Store was severely affected by surface water flooding during July 2007 flood event. Purley Oaks Road channels water down-slope and into the properties at the end. Flooding driven by local topography.

4.1.2 The following figures are included in Annex 6 and show records of past flooding:

- 1 Surface Water Flooding Incidents
- 2 Groundwater Flooding Incidents
- 3 Sewer Flooding Incidents (DG5 Register provided by Thames Water June 2010).

4.2 SIGNIFICANT HARMFUL CONSEQUENCES

4.2.1 The Flood Risk Regulations require PFRAs to report detailed information on past flood events that had 'significant harmful consequences'. There is no national definition of what constitutes 'significant harmful consequences'; it is a matter for local decision based on local information collected through the PFRA process.

4.2.2 In the case of London Borough of Croydon, the flood events of July 2007 described in Table 4-1 are considered to have had significant harmful consequences for human health, economic activity, the environment or cultural heritage and have therefore been included in Annex 1 of the PFRA spreadsheet.

4.3 INTERACTIONS WITH OTHER FLOODING SOURCES

4.3.1 Flooding is often the result of water from more than one source, or water building up because another source (such as a river, or the sea) has prevented it from discharging normally. Information about past flooding will often be about an unknown source (i.e. it is not clear where the water came from), or flooding as a result of interactions between sources (in which case more than one source may be recorded).

4.3.2 Where flood records within the study area are known to be from more than one flood source, this has been recorded in the PFRA spreadsheet. Where the source of flooding is not known this has also been recorded.

5. Future Flood Risk

5.1 Summary of Future Flood Risk

5.1.1 Information about future flood risk, or potential flooding, is usually produced by computer models. The Environment Agency has several national datasets showing risk of flooding from surface water, groundwater, main rivers and ordinary watercourses that are available to LLFAs. These datasets have been used to undertake an assessment of the number of properties and any important receptors that may be at risk of future flooding. Further details are provided in Annex 2 of the PFRA spreadsheet.

Surface Water Flooding

5.1.2 The Environment Agency has undertaken a property count for each LLFA for both their national Flood Map for Surface Water (FMfSW) and Areas Susceptible to Surface Water Flooding (AStSWF) datasets. It is intended that these are used to provide an indication of the number of residential and non-residential properties that are a risk from surface water flooding within each LLFA.

5.1.3 Using the Environment Agency Flood Map for Surface Water (FMfSW) dataset, it is estimated that 40,200 residential properties and 5,100 non-residential properties in London Borough of Croydon could be at risk of surface water flooding of greater than 0.1m depth during a rainfall event with a 1 in 200 annual chance of occurring. Approximately 15,400 residential properties and 2,300 non-residential properties are estimated to be at risk of flooding to a depth of greater than 0.3m during the same modelled rainfall event.

5.1.4 Details are provided in Annex 2 of the PFRA spreadsheet.

Ordinary Watercourses

5.1.5 The Detailed River Network has been used to identify the ordinary watercourses and the Environment Agency Flood Map, showing flooding from rivers and the sea, has been used to identify the risk of future flooding from ordinary watercourses.

5.1.6 However there is insufficient data in the Flood Map regarding critical ordinary watercourses within the study area to make an accurate assessment of the future flood risk associated with these watercourses.

5.2 Locally Agreed Surface Water Information

Surface Water Flooding

5.2.1 In addition to these national datasets more locally specific surface water information is available for the study area. The London Borough of Croydon is currently undertaking a Surface Water Management Plan as part of the Drain London Programme. As part of this study, direct rainfall modelling has been undertaken to simulate surface water flooding in the study area.

5.2.2 It has been agreed, in conjunction with Environment Agency and Council members, that the SWMP outputs will form the locally agreed surface water information for London Borough of Croydon.

5.2.3 Figures 4 and 5 in included in Annex 6 show the results from this modelling for the rainfall event with a 1 in 200 annual chance of occurrence. For a full methodology, the reader is referred to the Surface Water Management Plan for London Borough of Croydon.

- Figure 4 Maximum Flood Depth – 1 in 200 chance of rainfall event occurring in any given year (0.5%);
- Figure 5 Flood Hazard – 1 in 200 chance of rainfall event occurring in any given year (0.5%).

5.2.4 Pluvial modelling completed as part of Tier 2 of the Drain London Project affords an improved understanding of the level of flood risk facing the London Borough of Croydon. As part of the SWMP produced for each LLFA, a property count has been undertaken using the Environment Agency's National Receptor Dataset (NRD). Using the Drain London property count, it is estimated that 66,260 residential and 3,860 non-residential properties in the London Borough of Croydon could be at risk of surface water flooding of greater than 0.03m[2] depth during a rainfall event with a 1 in 200 annual chance of occurring. Approximately 1,920 residential and 480 non-residential properties are estimated to be at risk of flooding to a depth of greater than 0.5m during the same modelled rainfall event. Further information on the property count methodology and property counts for other return periods are provided in the London Borough of Croydon's SWMP.

Groundwater Flooding

5.2.5 Large areas within the Drain London area are underlain by permeable substrate and thereby have the potential to store groundwater. Under some circumstances groundwater levels can rise and cause flooding problems in subsurface structures or at the ground surface. The mapping technique described below aims to identify only those areas in which there is the greatest potential for this to happen and in which there is the highest possible confidence in the assessment.

5.2.6 The following four data sources have been utilised to produce the increased Potential for Elevated Groundwater map:

- British Geological Survey (BGS) Groundwater Flood Susceptibility Map;
- Jacobs Groundwater Emergence Maps (GEMs);
- Jeremy Benn Associates (JBA) Groundwater Flood Map; and
- Environment Agency/Jacobs Thames Estuary 2100 (TE2100) groundwater hazard maps.

5.2.7 To produce the iPEG map for consolidated aquifers, an area was defined as having increased potential for elevated groundwater levels if at least two of the three mapping techniques listed above produced a corresponding area. For the permeable superficial deposits, only Band 1 Very High of the BGS and the TE2100 data were used as this was judged to best represent the hazard.

[2] Building thresholds have been represented in the modelling as 'stubs' raised 100mm above the average ground level within the building footprint. A depth of >0.03m will result in a water level 0.03m above the property threshold, which is therefore considered to flood.

5.2.8 The techniques used to generate the iPEG map produced some small areas of increased potential and some dry islands within increased potential areas. These have not been cleaned in order to best represent the original data.

How to Use and Interpret the Map

5.2.9 The increased Potential for Elevated Groundwater map shows those areas within the Borough where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2 m of the ground surface.

5.2.10 Groundwater may become elevated by a number of means:

- Above average rainfall for a number of months in Chalk outcrop areas;
- Shorter period of above average rainfall in permeable superficial deposits;
- Permeable superficial deposits in hydraulic continuity with high water levels in the river;
- Interruption of groundwater flow paths; and
- Cessation of groundwater abstraction causing groundwater rebound.

5.2.11 With the exception of groundwater rebound which is not covered, the iPEG map will identify those areas most prone to the mechanisms described above. The map shows those areas considered to have the greatest potential for elevated groundwater. Additional areas within the London Boroughs have permeable geology and therefore could also produce elevated groundwater levels. However, to produce a realistic map, only where there is the highest degree of confidence in the assessment are the areas delineated. This ensures resources are focused on the most susceptible areas. In all areas underlain by permeable substrate, groundwater should still be considered in planning developments.

5.2.12 Within the areas delineated, the local rise of groundwater will be heavily controlled by local geological features and artificial influences (e.g. structures or conduits) which cannot currently be represented. This localised nature of groundwater flooding compared with, say, fluvial flooding suggests that interpretation of the map should similarly be different. The map shows the area within which groundwater has the potential to emerge but it is unlikely to emerge uniformly or in sufficient volume to fill the topography to the implied level. Instead, groundwater emerging at the surface may simply runoff to pond in lower areas.

5.2.13 For this reason within iPEG areas, locations shown to be at risk of surface water flooding are also likely to be most at risk of runoff/ponding caused by groundwater flooding. Therefore the iPEG map should not be used as a “flood outline” within which properties at risk can be counted. Rather it is provided, in conjunction with the surface water mapping, to identify those areas where groundwater may emerge and if so what would be the major flow pathways that water would take.

5.2.14 The iPEG mapping is presented in Figure 2 and shows the A23 corridor and the north eastern part of the Borough to be at greater risk.

5.3 IMPACT OF CLIMATE CHANGE

5.3.1 There is clear scientific evidence that global climate change is happening now. It cannot be ignored.

5.3.2 Over the past century around the UK we have seen sea level rise and more of our winter rain falling in intense wet spells. Seasonal rainfall is highly variable. It seems to have decreased in summer and increased in winter, although winter amounts changed little in the last 50 years. Some of the changes might reflect natural variation; however the broad trends are in line with projections from climate models.

5.3.3 Greenhouse gas (GHG) levels in the atmosphere are likely to cause higher winter rainfall in future. Past GHG emissions mean some climate change is inevitable in the next 20-30 years. Lower emissions could reduce the amount of climate change further into the future, but changes are still projected at least as far ahead as the 2080s.

5.3.4 We have enough confidence in large scale climate models to say that we must plan for change. There is more uncertainty at a local scale but model results can still help us plan to adapt. For example we understand rain storms may become more intense, even if we can't be sure about exactly where or when. By the 2080s, the latest UK climate projections (UKCP09) are that there could be around three times as many days in winter with heavy rainfall (defined as more than 25mm in a day). It is plausible that the amount of rain in extreme storms (with a 1 in 5 annual chance or rarer) could increase locally by 40%.

Key Projections for Thames River Basin District

5.3.5 If emissions follow a medium future scenario, UKCP09 projected changes by the 2050s relative to the recent past are:

- Winter precipitation increases of around 15% (very likely to be between 2 and 32%);
- Precipitation on the wettest day in winter up by around 15% (very unlikely to be more than 31%);
- Relative sea level at Sheerness very likely to be up between 10 and 40cm from 1990 levels (not including extra potential rises from polar ice sheet loss);
- Peak river flows in a typical catchment likely to increase between 8 and 18%.

Implications for Flood Risk

5.3.6 Climate changes can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability.

5.3.7 Wetter winters and more of this rain falling in wet spells may increase river flooding in both rural and heavily urbanised catchments. More intense rainfall causes more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so we need to be prepared for the unexpected.

5.3.8 Rising sea or river levels may increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses.

5.3.9 There is a risk of flooding from groundwater-bearing chalk and limestone aquifers across the district. Recharge may increase in wetter winters, or decrease in drier summers.

5.3.10 Where appropriate, we need local studies to understand climate impacts in detail, including effects from other factors like land use. Sustainable development and drainage will help us adapt to climate change and manage the risk of damaging floods in future.

Adapting to Change

5.3.11 Past emission means some climate change is inevitable. It is essential we respond by planning ahead. We can prepare by understanding our current and future vulnerability to flooding, developing plans for increased resilience and building the capacity to adapt. Regular review and adherence to these plans is key to achieving long-term, sustainable benefits.

5.3.12 Although the broad climate change picture is clear, we have to make local decisions against deeper uncertainty. We will therefore consider a range of measures and retain flexibility to adapt. This approach, embodied within flood risk appraisal guidance, will help to ensure that we do not increase our vulnerability to flooding.

Pluvial Modelling Including Allowance for Climate Change

5.3.13 As part of the pluvial modelling completed for the Surface Water Management Plan for London Borough of Croydon, a model scenario has been undertaken including an allowance for climate change. Figure 6 in Annex 6 shows the results for the maximum flood depth during the rainfall event with a 1 in 100 annual chance of occurrence, including an allowance for climate change. Figure 7 shows the flood hazard rating for the same return period.

- Figure 6 Maximum Flood Depth – 1 in 100 Chance of rainfall event occurring in any given year (1% AEP) plus Climate Change;
- Figure 7 Flood Hazard – 1 in 100 Chance of rainfall event occurring in any given year (1% AEP) plus Climate Change.

5.3.14 As part of the SWMP produced for each LLFA, a property count has been undertaken using the Environment Agency's National Receptors Dataset (NRD). Using the Drain London property count, it is estimated that 66,520 residential properties and 3,950 non-residential properties in the London Borough of Croydon could be at risk of surface water flooding of greater than 0.03m[3] depth during a rainfall event with a 1 in 100 annual chance of occurring including an allowance for climate change. Approximately 2,080 residential properties and 510 non-residential properties are estimated to be at risk of flooding to a depth of greater than 0.5m during the same modelled rainfall event. Further information on the property count methodology and property counts for other return periods are provided in the London Borough of Croydon SWMP.

5.4 MAJOR DEVELOPMENTS

5.4.1 London Borough of Croydon have prepared a Strategic Housing Land Availability Assessment and factored these sites into the growth plans for the Borough for the next 20 years during which they plan to deliver 21,500 homes before 2031.

5.4.2 Growth is concentrated in the following areas:

- Croydon Opportunity Area;
- A23 corridor;

[3] Building thresholds have been represented in the modelling as 'stubs' raised 100mm above the average ground level within the building footprint. A depth of >0.03m will result in a water level 0.03m above the property threshold, which is therefore considered to flood.

- Cane Hill Hospital Site.

5.4.3 The following areas have been identified to be at risk of surface water flooding in the future and the following number of homes are proposed for each area:

- Purley - 1500 homes;
- Coulsdon – 1200 homes;
- North Croydon – 8400 homes;
- South Croydon – 900 homes.

5.5 LONG TERM DEVELOPMENTS

5.5.1 It is possible that long term developments might affect the occurrence and significance of flooding. However current planning policy aims to prevent new development from increasing flood risk.

5.5.2 In England, Planning Policy Statement 25 (PPS25) on development and flood risk aims to "ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall."

5.5.3 Adherence to Government policy ensures that new development does not increase local flood risk. However, in exceptional circumstances the Local Planning Authority may accept that flood risk can be increased contrary to Government policy, usually because of the wider benefits of a new or proposed major development. Any exceptions would not be expected to increase risk to levels which are "significant" (in terms of the Government's criteria).

6. Review of Indicative Flood Risk Areas

6.1 Extent of Flood Risk Areas

6.1.1 The figure included in Annex 5 shows the Indicative Flood Risk Areas that have been identified by the Environment Agency.

6.1.2 The administrative area of Greater London, including London Borough of Croydon is shown to be included in an Indicative Flood Risk Area with the exception of the very southern most part of Coulsdon in the south of the Borough (approximately 1.2km^2).

6.2 Review Comments

6.2.1 No changes are proposed to the Greater London Indicative Flood Risk Area with respect to the area covered by London Borough of Croydon.

7. Identification of Flood Risk Areas

7.1 Amendments to Flood Risk Areas

7.1.1 London Borough of Croydon is not proposing any amendments to the Indicative Flood Risk Area for Greater London.

7.2 New Flood Risk Area

7.2.1 London Borough of Croydon is not proposing any new Flood Risk Areas.

8. Next Steps

8.1 Scrutiny & Review

8.1.1 As the Lead Local Flood Authority, London Borough of Croydon is required to review and approve this PFRA in accordance with their own internal processes, such as consideration by Cabinet, Council or an overview and scrutiny committee.

8.1.2 It is planned that this PFRA report be reviewed by the Cabinet; however the dates of Cabinet meetings mean that this will not be possible until Summer 2011. In order to meet the 22nd June deadline for submission of this PFRA to the Environment Agency, the PFRA will be submitted to the Environment Agency prior to the report being presented to Cabinet.

8.1.3 The PFRA process will be reviewed on a 6-year cycle and for future iterations of the PFRA for London Borough of Croydon an increasing level of information will be required including information which was optional for this first cycle relating to past flooding.

8.1.4 In order to ensure that this information is available for future reviews, a number of steps have been implemented as part of the Action Plan for the Surface Water Management Plan for London Borough of Croydon. A number of key actions have been identified in the following sections.

8.2 Data Collection & Management

8.2.1 At the present time there is no consistent approach across the Local Authority for recording flood risk incidents and managing historic datasets including details of the sources and consequences of flood events.

8.2.2 During the course of the discussions on future governance for flood risk management it will be necessary to identify and detail ownership of the processes that will need to be embedded to ensure robust data collection and management arrangements are in place.

8.3 Other Requirements under the Flood Risk Regulations 2009

8.3.1 Table 8-1 provides a summary of the elements of work required from London Borough of Croydon under the Flood Risk Regulations 2009, along with the timescales of their respective delivery. The first two elements of work are covered by the preparation of this PFRA report.

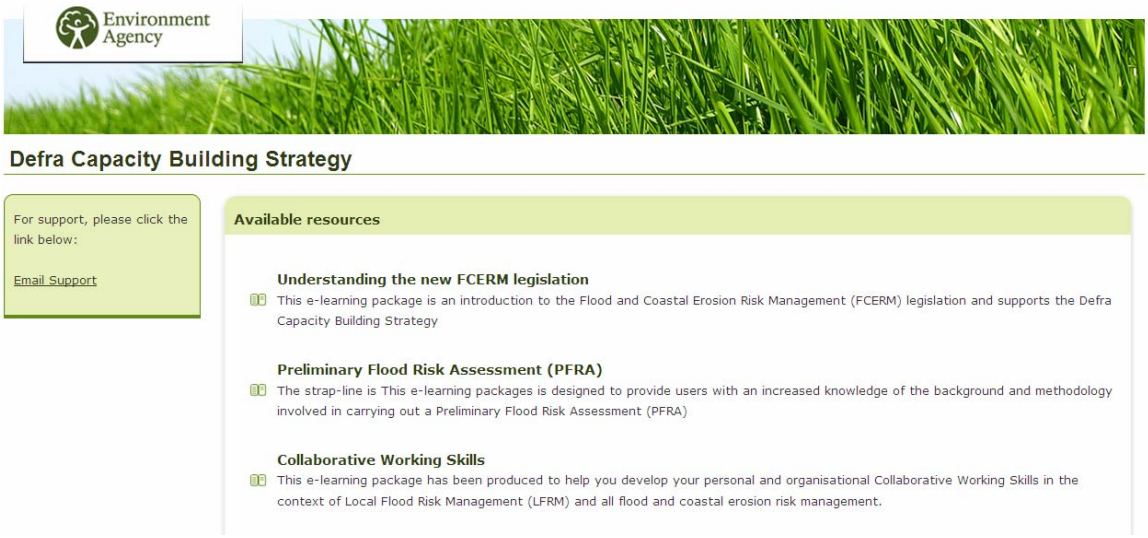
Table 8-1 Elements of Work required under the Flood Risk Regulations 2009

22nd June 2011	**Prepare Preliminary Assessment Report.**	*The PFRA should focus on local flood risk from surface water, groundwater, ordinary watercourses and canals.*
22nd June 2011	On the basis of the PFRA, identify **Flood Risk Areas.**	*Flood Risk Areas are areas of significant risk identified on the basis of the findings of the PFRA, national criteria set by the UK Government Secretary of State and guidance provided by the Environment Agency.*
22nd June 2013	Prepare **Flood Hazard Maps** and **Flood Risk Maps** for each Flood Risk Area.	*Used to identify the level of hazard and risk of flooding within each Flood Risk Area to inform Flood Risk Management Plans.*
22nd June 2015	Prepare **Flood Risk Management Plans** for each Flood Risk Area.	*Plans setting out risk management objectives and strategies for each Flood Risk Area.*

8.3.2 As part of the next phase of work, due for submission in June 2013, London Borough of Croydon will be required to prepare Flood Hazard Maps and Flood Risk Maps for their local authority area. These will be required to inform Flood Risk Management Plan which will be due for submission in June 2015 setting out risk management objectives and strategies for the Flood Risk Area. The findings of this PFRA as well as that of the Surface Water Management Plan for London Borough of Croydon should form the basis of the local flood risk management strategy for the area.

8.3.3 Further information can be found on the Environment Agency PFRA e-Learning module http://learning.environment-agency.gov.uk/courses/FCRM/capacity which has been developed as part of Defra's Capacity Building Strategy and is designed to provide users with an increased knowledge of the background and methodology involved in carrying out a PFRA.

Figure 8-1 Environment Agency e-Learning module



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Annex 1 – Past Floods

Please refer to Annex 1 of the Preliminary Assessment Spreadsheet. As discussed in Section 4.3, the flood events of July 2007 have been considered by London Borough of Croydon to have had 'significant harmful consequences', and have therefore been recorded in Annex 1 of the Preliminary Flood Risk Assessment.

Annex 2 – Future Floods

Please refer to Annex 2 of the Preliminary Assessment Spreadsheet.

Annex 3 – Flood Risk Areas

Please refer to Annex 3 of the Preliminary Assessment Spreadsheet.

Annex 4 – Review Checklist

Annex 5 – GIS Layer of Flood Risk Areas

Annex 6 – Mapping

1 Surface Water Flooding Incidents

2 Groundwater Flooding Incidents & increased Potential for Elevated Groundwater (iPEG)

3 Sewer Flooding Incidents

4 Maximum Flood Depth – 1 in 200 chance of rainfall event occurring in any given year (0.5% AEP)

5 Flood Hazard – 1 in 200 chance of rainfall event occurring in any given year (0.5% AEP)

6 Maximum Flood Depth – 1 in 100 chance of rainfall event occurring in any given year (1%) plus Climate Change

7 Flood Hazard – 1 in 100 chance of rainfall event occurring in any given year (1%) plus Climate Change