Bassetlaw Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables	

Site details

Site Code	**N/A**
Address	Cottam Power Station. Grid Reference: SK 81998 79238
Area	357ha
Current land use	Power Station and Greenfield
Proposed land use	Mixed Use- Residential and community facilities

Sources of flood risk

Location of the site within the catchment	The site is located in the catchment of the tidal River Trent. The River Trent is an Environment Agency designated main river and flows in a northerly direction towards its confluence with the River Humber.
Existing drainage features	Three large land drains are located on the site. The first rises 1.8km south west of the site and flows in a north easterly direction before flowing along the southern boundary of the site. The second drain is the Seymour Drain which rises 540m south of the site and flows north through the site. The third boarders the western part of the power station and is artificially modified to flow around the western and southern boundary before being channelled into the Seymour Drain. Several small unnamed land drains and surface water ponds are also located around the site.
Fluvial	**The proportion of site at risk:** **Environment Agency Flood Zones** **FZ3b –** 18% **FZ3a –** 45% **FZ2 –** 73% **FZ1 –** 27% **Defended Scenario (X%AEP Fluvial Event with 50% AEP Tidal Event)** **5%-** 18% **1%-** 18% **0.1%-** 68% *The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%).* **Available data:** Flood Zones are based on the Environment Agency's 2015 detailed 1D-2D Flood Modeller-Tuflow model. The undefended outputs of this model have been incorporated into the Flood Map for Planning. As the majority of the site lies behind an embankment, defended runs have been undertaken for the purposes of this assessment. These runs are based on the 5%, 1% and 0.1% AEP fluvial event combined with the 20% AEP tidal event. **Flood characteristics:** The site is significantly affected by fluvial flooding and most of the site is flooded during the most extreme event extent (0.1% AEP). In the 5% AEP and 1% AEP fluvial flood events, flooding is limited to the two areas of the site on the river side of the embankments. These areas are part of the functional floodplain and should not feature built development (although could be used for open space).

	In the 0.1% AEP flood event, the embankment is overtopped and there is significant flooding across the majority of the site, with flood depths ranging from 2.3-2.6m across the flooded area. The modelled flood hazard rating for the entire flooded area is 'dangerous for most' to 'dangerous for all' In this event the only parts of the site not flooded are three dry islands. These represent artificially raised areas housing the old power station buildings and infrastructure. Flooding is widespread across the area and extends far beyond the site boundaries.
Tidal	**Available data:** Results are based on the Environment Agency's 2015 detailed 1D-2D Flood Modeller-Tuflow model. The undefended outputs of this model have been incorporated into the Flood Map for Planning. However as the majority of the site lies behind an embankment, defended runs have been undertaken for the purposes of this assessment. This assessment is based on the 0.5% and 0.1% AEP Tidal events with the 50% fluvial event. **Flood characteristics:** In the present day defended scenarios, the site is not at significant risk from tidal flooding. In the 0.1% AEP event, flooding is limited to those areas on the river side of the existing embankments. Flood depths adjacent the embankments range from 1.5-3.2m.
Surface Water	**Proportion of site at risk (RoFfSW):** **3.3% AEP** – 1% Max depth 0.6-0.9m Max velocity 0.5-1m/s **1% AEP** – 2% Max depth 0.6-0.9m Max velocity 1-2m/s **0.1% AEP** – 11% Max depth >1.2m Max velocity 1-2m/s *The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 1% AEP extent includes the 3.3 % AEP extent)* **Description of surface water flow paths:** In the 3.3% AEP flood event, surface water ponding on the site is minor and localised. Surface water ponding forms in topographic depressions on the site as well as in the drainage channels located around the site. No significant surface water flow paths are present on the site. Flood depths in the depressions are 150-300mm for the majority of the site with some small areas up to 900mm. The areas of surface water ponding have a flood hazard rating of 'caution' to 'dangerous for most'. In the 1% AEP scenario, the extent of surface water flooding is not significantly increased from the 3.3% AEP event. Surface water ponding is still confined to topographic depressions and drainage channels around the site. Flood depths are between 300-600mm, with some areas up to 900mm in depth. The surface water ponding areas on the site have 'caution' to 'dangerous for most'. In the 0.1% AEP flood event, the extent of surface water flooding across the site is significantly increased. Several large surface water ponding areas are present around the site, primarily along the boundaries of the existing drainage channels where it appears the channels capacity has been exceeded. Flood depths range between 300-600mm, with some areas up to 1.2m. The surface water ponding areas on the site have a modelled flood hazard rating of 'caution' with 'dangerous for all' in isolated areas. A large surface water flow path is present to the north west of the site and this flows in a south-easterly direction, into the site before ponding along Torksey Ferry Road, in the south western part of the site. The flow path depths are primarily shallow and are up to 300mm. The flow path velocities range between 0.25-0.5m/s and have a flood hazard rating of 'caution' to 'dangerous for some'.
Reservoir	The site is shown to be at risk of reservoir flooding from the available online maps. It is unclear whether these maps account for the River Trent embankments and this should be investigated further in a site specific FRA.
Canals	The site is a significant distance from the Chesterfield Canal and would not be affected if the canal was to breach.
Groundwater	The Environment Agency Areas Susceptible to Groundwater Flooding dataset, provided as 1km grid squares, shows an area's susceptibility to groundwater flood emergence. The following comments can be made about groundwater flood risk:

	• The majority of the site has a > = 75% susceptibility to groundwater flood emergence from superficial deposits. This assessment does not negate the requirement that an appropriate groundwater regime assessment should be carried out at the site-specific FRA stage.
Sewers	The Level 1 SFRA indicates that 2 incidences of sewer flooding have occurred in the NG23 0 postcode area.
Flood history	The Environment Agency's historic flooding map shows that the majority of the site has previously been flooded. NCC holds 1 record of flooding within 100m of the site. The source of flooding is unknown.
Flood risk management infrastructure	
Defences	**Defence type** – Embankment **Standard of Protection** – 100 years **Condition** – Very Good to Fair There are embankments along the course of the River Trent which are mostly set back from the riverbanks to provide flood storage. These are currently maintained by the Environment Agency. The remaining asset life of the embankments is unknown. The surface water for the site outfalls to pumping stations maintained by the Trent Valley Internal Drainage Board at Cottam/ Sturton.
Residual risk	The identified embankments are providing significant fluvial and tidal flood defence for the site. The embankments have a standard of protection of 100 years. The design life of these assets is unknown and a survey and assessment of these banks would be required as part of a site-specific FRA. Early engagement should be undertaken with the Environment Agency and IDBs to understand the strategic aims for the area and long term vision for the maintenance of these assets. The benefits of any development on the site should be carefully considered against the commitment to ongoing maintenance of the embankments throughout the life of the development. A breach during the 100-year upper-end climate change scenario (+50%) was modelled.In this scenario, the west of the site is flooded to depths of 1.8-2.5m. Three dry islands are formed in the east of the site. Flood depths along the eastern boundary of the site, adjacent the river reach up to 5m. Due to the widespread extent of flooding beyond the boundaries of the site, providing access and egress to these islands during an event will be very challenging. Given the likely long duration of any flood event due to the need to potentially pump water over the defences to reduce water levels, a shelter in situ policy is not suitable for this site.
Emergency planning	
Flood warning	The site is in the Environment Agency's 'River Trent at Cottam including Coates, Littleborough and North Leverton with Habblesthorpe' flood warning area. The site is located in the Environment Agency's 'River Trent from Cromwell Weir to Gainsborough' flood alert area.
Access and egress	The Risk of Flooding from Surface Water dataset shows that most of the site and parts of the existing access roads are affected by flooding during the 0.1% AEP flood event. Surface water flooding during this event is shallow and is unlikely to affect access and egress. During an extreme fluvial event (0.1% AEP), the entire site is flooded to significant depth (>2m at the deepest) with the exception of 3 dry islands. Safe access and egress will need to be demonstrated in the 1 in 0.1% AEP plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. In the 0.1% AEP plus the upper end (+50%) fluvial the flooded area and depths increase significantly, with depths up to 3.5m across most of the site, with the exception of the dry islands. Given the size of the development and the fact it contains residential development it is essential that a raised access route is provided as part of the enabling infrastructure for the development. This will need to be raised above the 1 in 0.1% AEP plus climate change fluvial event and ensure all parts of the site are able to access the raised route in the event of a flood. A flood warning and evacuation plan will be necessary that considers both the event of a breach in the flood defences during a 1% event (fluvial) or 0.5% (tidal), both considering climate change and a severe event that overtops the defences for the 0.1% plus climate change event. Given the likely long duration of any flood event due to the need to potentially pump water over the defences to reduce water levels, a shelter in situ policy is not suitable for this site.

Climate change	
Implications for the site	• The site is highly sensitive to increasing risk as a result of climate change. The upper end climate change scenario (+50%) was applied to the 1% AEP and 0.1% AEP fluvial and 0.5% AEP tidal event for this assessment. • Currently, during the 1% AEP fluvial event, the embankments are not overtopped and most of the site is not at risk. In the 1% AEP plus the upper end (+50%) climate change scenario, the embankments are overtopped and the western portion of the site is flooded to depths of 0.8-1.2m. The raised area currently housing the old power station buildings and infrastructure remains dry in this scenario however there are likely to be significant impacts on access and egress in this scenario. In the 0.1% AEP plus the upper end (+50%) fluvial event most of the site is flooded to depths of up to 3m, with the exception of the dry islands. • There is a significant increase in surface water flood extent between the 1% and 0.1% surface water events, indicating that surface water flood risk on site is highly sensitive to climate change. • With the exception of those areas of the site on the river side of the embankments, the site is not at risk during the 0.5% plus the upper end (+50%) tidal event.
Requirements for drainage control and impact mitigation	

Broad scale assessment of possible SuDS	**Geology & Soils**
	• Geology at the site consists of:
	  ○ Bedrock- Mercia Mudstone Group- Mudstone.
	  ○ Superficial- Alluvium- Clay, Silt, Sand and Gravel, Holme Pierrepoint Sand and Gravel Member- Sand and Gravel, Till, Mid-Pleistocene- Diamicton.
	• Soils at the site consist of:
	  ○ Loamy and clayey floodplain soils with naturally high groundwater, naturally wet very acid sands with some areas of slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils.
	
	SuDS
	• The site is considered to be highly susceptible to groundwater flooding. Groundwater flooding could occur at the surface which may flow to and pool within topographic low spots during very wet winters. Detention and attenuation features should be designed to prevent groundwater ingress from impacting hydraulic capacity and structural integrity. Additional site investigation work may be required to support the detailed design of the drainage system. This may include groundwater monitoring to demonstrate that a sufficient unsaturated zone has been provided above the highest occurring groundwater level. Below ground development such as basements are not appropriate at this site.
	• Given the brownfield nature of the site, a restoration scheme for watercourses running through the site needs to be developed alongside the surface water drainage strategy, with the potential for online storage of higher flows in attenuation areas integrated into green infrastructure for the site.
	• BGS data indicates that the underlying geology is Mudstone and is likely to be poorly draining. Any proposed use of infiltration should be supported by infiltration testing. Off-site discharge in accordance with the SuDS hierarchy is required to discharge surface water runoff.
	• The site is not located within a Groundwater Source Protection Zone and there are no restrictions over the use of infiltration techniques with regard to groundwater quality.
	• The site has areas within its boundary designated by the Environment Agency as being a historic landfill site. A thorough ground investigation will be required as part of a detailed site-specific FRA, to determine potential mitigation for contamination and the impact this may have on SuDS. As such, proposed SuDS should be discussed with the relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints.
	• Proposed attenuation features such as basins, ponds and tanks should be located outside of Flood Zone 2 and 3 to avoid the potential risks to the hydraulic capacity or structural integrity of these features. Surface water outfalls that discharge into the River Trent may be susceptible to surcharging due to water levels in the River Trent. The impacts of flood flows will need to be considered in terms of the attenuation storage requirements of the site and placement of the outfalls.
	• Surface water discharge rates should not exceed pre-development discharge rates for the site and should be designed to be as close to greenfield runoff rates as reasonably practical in

	consultation with the LLFA. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. • The site is within the Trent Valley Internal Drainage Board district who may have additional requirements regarding discharge rates (directly or indirectly) into their district. The IDB should be consulted during the detailed design of the site to establish the Board's requirements, and determine whether there will be a need to apply for surface water discharge or ordinary watercourse consents. Currently, should the site discharge into any open or culverted watercourse within the IDB this will require the Boards formal consent. Consent shall not be required where sites discharge into soakaways or directly into an EA Main River (the River Trent) however the Lead Local Flood Authority should be consulted. Developers should consult the IDB's **website** for further guidance. • The Risk of Flooding from Surface Water (RoFSW) mapping indicates the presence of surface water flow paths during the 3, 1 and 0.1% AEP event. Existing flow paths should be retained and integrated with blue-green infrastructure and public open space. • If it is proposed to discharge runoff to a watercourse or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and the discharge rate agreed with the asset owner.
Opportunities for wider sustainability benefits and integrated flood risk management	• Implementation of SuDS at the site could provide opportunities to deliver multiple benefits, including volume control, water quality, amenity and biodiversity. This could provide more comprehensive sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. • Development at this site should not increase flood risk either on or off-site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development
NPPF and planning implications	
Exception Test requirements	The Local Authority will need to confirm that the sequential test has been carried out. The Sequential Test will need to be passed before the Exception Test is applied. Residential development is classified as 'More Vulnerable' development, and community buildings are classed as 'less vulnerable development'. As More Vulnerable development is proposed in Flood Zone 3, the Exception Test will need to be applied. Significant works will be required to allow the exception test to be passed. The main risk to the site is fluvial flooding from the River Trent. Embankments on the Trent currently defend against a 1% AEP flood event, although there remains a risk from a breach or a severe 0.1% AEP event if the defences overtop. The risk will increase from climate change and during the lifetime of the development. Modelling shows that the defences would overtop in a future 1% fluvial event (upper end scenario), which means the standard of protection will be lower than the 1% design event for fluvial flooding. To ensure the users of this site would be safe from flooding over the lifetime of the development, either the defences along this stretch of the Trent would need to be raised (over a considerable distance beyond the immediate site boundaries to account for water reaching the site across the floodplain) or site level mitigation would be required. Any work undertaken on site would need to be undertaken cautiously, to ensure there was no overall loss of floodplain or displacement of water onto other areas. The feasibility of this level of site mitigation needs to be taken into account when considering if the site would pass the Exception Test. It is possible that the overall capacity of the site for the required level of the development could be affected by the need for flood mitigation measures.
Requirements and guidance for site-specific Flood Risk Assessment	**Flood Risk Assessment:** • A site-specific Flood Risk Assessment will be required at the planning application stage as the development is in Flood Zones 2 and 3. • All flooding sources, particularly the risk of fluvial flooding, tidal flooding, and surface water should be considered part of a site-specific flood risk assessment. This should include considering additional tidal and fluvial breach modelling. • The site-specific FRA should be carried out according to the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance, Bassetlaw Council's Local Plan policies, and the Nottinghamshire County Council Lead Local Flood Authority's Statutory Consultee for Planning Guidance Document. • The development should be designed using a sequential approach. Where possible, development should be steered away from fluvial flood risk areas and surface water flow routes, preserving these spaces as green infrastructure.

- The development should be designed to ensure that the most vulnerable parts of the development are located outside of areas at risk from flooding.

Guidance for site design and making development safe:

- **Major reprofiling, flood defences and sustainable drainage work would be required to bring forward such as high flood risk site. This will involve sacrificing some areas as functional floodplain and increasing flood storage to allow other areas of the site to be defended against fluvial flooding.**
- **Given the size of the development and the fact it contains residential development it is essential that a raised access route is provided as part of the enabling infrastructure for the development. This will need to be raised above the 1 in 0.1% AEP plus climate change fluvial event and ensure all parts of the site are able to access the raised route in the event of a flood. Raising of access routes should not contribute to a loss of floodplain storage. A flood warning and evacuation plan will be necessary.**
- **Consideration should be given to the benefits of development against the commitment to maintain the existing defences throughout the lifetime of the development, particularly considering the increase in fluvial risk as a result of climate change and the residual risk from asset failure.**
- **The Environment Agency and Trent Valley IDB should be consulted at the earliest stages of any proposal to understand their strategic objectives for the area with regard to managing water levels and maintenance of the existing embankment and downstream pumping stations.**

- As a significant new development, any proposal should be accompanied by an overall Surface Water Management Masterplan and Strategy (SWMMS) which should cover:
    - How the cumulative effects of potential peak rates and volumes of water from development sites would impact on peak flows, duration of flooding and timing of flood peaks on receiving watercourses. This should be used to develop and implement appropriate drainage sub catchments and specific runoff rate and volume requirements for each phase of the development.
    - The risk of flooding from all sources, including for rainfall events greater than the design standard of the surface water drainage system should be taken into account to ensure there is no flood risk to new properties and that exceedance flows in extreme events are safely routed around those properties.
    - The consideration of how SuDS, natural flood management techniques, green infrastructure and green-blue corridors can be designed into the development master plan to facilitate drainage flood risk management and ensure wider benefits such as biodiversity, amenity, water quality and recreation are realised. This should be integrated with a restoration plan for watercourses and drains on site.
    - Based on the above, a Drainage Phasing Plan should be developed, based on the SuDS train method (considering firstly how water can be infiltrated/stored at a plot level, then conveyed through the site and any regional storage needs at a settlement level).
    - The provision of drainage during the building phase shall be based on the Drainage Phasing Plan to ensure adequate drainage is provided and implemented throughout the development life.
- The LLFA, Environment Agency and IDB should be consulted during the development of the Surface Water Management Masterplan and Strategy
- Compensatory flood storage is required for any land raising and all proposed buildings whenever built on land within the 1% + climate change flood extent.
- As part of the site-specific FRA, surface water flooding risk should be quantified, including a detailed surface water flooding model and the existing drainage system using topographical and asset survey data. To further determine the site's risk and ensure that runoff from the development is not increased by development across any surface water flow routes, a drainage strategy should help inform site layout and design to ensure no increase in runoff beyond current rates. Surface water mitigation measures should be designed for the 1% plus climate change event. The modelling should also determine the risk from surface water flooding further and ensure that overland flows do not overwhelm future sustainable drainage features.
- Plans to address both fluvial and surface water flooding should integrate green infrastructure, presenting wider opportunities to improve biodiversity and amenity and climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised.
- Brownfield sites should discharge surface water at the original pre-development (greenfield) runoff rate. If this is not possible, a significant reduction in the current rate of discharge should be achieved and agreed with the relevant drainage body (LLFA). Development on greenfield land

	should discharge at rates no more significant than the existing greenfield rates for the 100% and the 1% rainfall events. As the site is within Trent Valley IDB, should the site discharge into any open or culverted watercourse it will require the Boards formal consent. Consent shall not be required where sites discharge into soakaways or directly into an EA main River (the River Trent) however the LLFA should be consulted. Developers should consult the IDB's **website** for further guidance. • Developers should refer to Nottinghamshire County Council's 'Nottinghamshire County Council's Guidance Note on the Validation Requirements for Planning Applications and the Level 1 SFRA for information on SuDS guidance on the information required by the LLFA from applicants to enable it to respond to planning applications.

Key messages

The main risk to the site is fluvial flooding from the River Trent. Embankments on the Trent currently defend against a 1% AEP flood event, although there remains a risk from a breach or a severe 0.1% event if the defences overtop. The risk will increase from climate change and during the lifetime of the development, the modelling shows that the defences would overtop in a future 1% fluvial event (upper end scenario), which means the standard of protection will be lower than the 1% design event for fluvial flooding.

To ensure the users of this site would be safe from flooding over the lifetime of the development, either the defences along this stretch of the Trent would need to be raised (over a considerable distance to account for water reaching the site across the floodplain) or site level mitigation would be required. Any work undertaken on site would need to be undertaken cautiously, to ensure there was no overall loss of floodplain or displacement of water onto other areas. The feasibility of this level of site mitigation needs to be taken into account when considering if the site would pass the Exception Test. It is possible that the overall capacity of the site for the required level of the development could be affected by the need for flood mitigation measures.

Should the Exception Test be considered to be able to be passed, to be able to proceed the site would require:

- A carefully considered and integrated flood resilient and sustainable drainage design, with habitable floor levels above the fluvial design flood event (1% AEP) taking into account climate change and safe access route during an extreme fluvial event (0.1% AEP) taking into account climate change. The residual risk from a severe flood or breach scenario must be considered if areas of the site are defended in future.
- If flood mitigation measures are implemented, they are tested to ensure that they will not displace water elsewhere (for example, if the land is raised to permit development on one area, compensatory flood storage will be required in another).
- Space for surface water to be stored on the site is provided, and rainwater harvesting should be considered.
- Brownfield sites should discharge surface water at the original pre-development (greenfield) runoff rate. If this is not possible, a significant reduction in the current discharge rate should be achieved and agreed upon with the relevant drainage body (LLFA and Trent Valley IDB).
- Given the size of the development and the fact it contains residential development it is essential that a raised access route is provided as part of the enabling infrastructure for the development. This will need to be raised above the 1 in 0.1% AEP plus climate change fluvial event and ensure all parts of the site are able to access the raised route in the event of a flood. A flood warning and evacuation plan will be necessary

Mapping Information

The key datasets used to make planning recommendations regarding this site were the Environment Agency's Flood Map for Planning, modelling of the River Trent, and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below.

Flood Zones	Flood Zones are based on the Environment Agency's 2015 detailed 1D-2D Flood Modeller-Tuflow model. The undefended outputs of this model have been incorporated into the Flood Map for Planning. As the majority of the site lies behind an embankment, defended runs have been undertaken for the purposes of this assessment. These runs are based on the 5%, 1% and 0.1% AEP fluvial event combined with the 20% AEP tidal event.
Tidal Flooding	Results are based on the Environment Agency's 2015 detailed 1D-2D Flood Modeller-Tuflow model. The undefended outputs of this model have been incorporated into the Flood Map for Planning. However as the majority of the site lies behind an embankment, defended runs have been undertaken for the purposes of this assessment. This assessment is based on the 0.5% and 0.1% AEP Tidal events with the 50% fluvial event.
Climate change	The upper end climate change scenario (+50%) was applied to the 1% AEP fluvial and 0.5% AEP tidal events from 2015 detailed Flood Modeller-Tuflow models for this assessment. As More Vulnerable (residential) development is planned for this area this is an appropriate scenario in line with the current Environment Agency guidance on climate change allowances.
Fluvial depth, velocity and hazard mapping	Outputs are taken from the defended runs of the Environment agency's 2015 detailed 1D-2D Flood Modeller-Tuflow model.
Surface Water	The Risk of Flooding from Surface Water map has been used to define areas at risk from surface water flooding.
Surface water depth, velocity and hazard mapping	The surface water depth and hazard mapping for the 1 in 0.1% AEP event is taken from the Environment Agency's Risk of Flooding from Surface Water mapping.