JBA consulting

Stonehaven FAS Arbuthnott Drain Improvement

Option Study

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Aberdeenshire Council
Carlton House
Arduthie Road
Stonehaven AB39 2DP

Aberdeenshire COUNCIL

JBA Project Manager

Stephen Farrar
Port Neuk
1 Longcraig Road
South Queensferry
EH30 9TD

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Contract

This report describes work commissioned by William Murdoch, on behalf of Aberdeenshire Council, by Purchase Order No. NC1190958 dated 27/06/2012. Aberdeenshire Council's representative for the contract was Joanna Cubbage. Stephen Farrar and Michelagh O'Neill of JBA Consulting carried out this work. The work was reviewed by Caroline Anderton and David Bassett of JBA Consulting.

Prepared by ..... Stephen Farrar MEng CEng MICE
Senior Chartered Engineer

And

Prepared by ..... Michelagh O'Neill MEng
Engineer

Reviewed by ..... Caroline Anderton BSc MSc CEnv CSci MCIWEM C.WEM
Principal Analyst

Approved by ..... David Bassett BSc MSc CEnv MCIWEM C.WEM
Director

Purpose

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Executive Summary

Arbuthnott Place has a history of flooding. The Flood Alleviation Study for the River Carron, Stonehaven (2011) identified that this is likely to happen at return periods less than 1 in 25 years. JBA were commissioned by Aberdeenshire Council to investigate options to reduce flood risk in the area of Arbuthnot Place.

This report reviews three main options, which have been divided into two sub-options;

- Option 1a looks at formalising the existing flow routes to Arbuthnott Place by improving the surface water collection and connecting into the existing Arbuthnott Drain. Option 1b is similar to Option 1a, but discharges via the shortest route directly to the sea, following a path between houses, where flood waters are currently observed to flow.
- Options 2a and 2b consist of pumping stations at Arbuthnott Place and Arbuthnott Court respectively. These discharge along the same line as the gravity drainage.
- Options 3a and 3b looks at introducing storage along the line of the gravity drainage in 1a and 1b

The Options were modelled using JFlow+ and WinDES to assess the level of surface water (pluvial) flooding and the efficacy of the proposed options. Sensitivity tests were carried out assuming that the existing urban drainage system would be ineffective, and the effects of flood walls were also checked as they may impound surface water behind the wall. Reductions in volumes of water reaching site may possibly be achieved by re-landscaping works at the end of Dunnottar Avenue. This may be investigated as part of detailed design.

A cost analysis was carried out to enable comparison to be made across the options.

Formalising and improving the existing gravity drainage reduces flood risk, providing a level of protection somewhere between 1 in 75 and 1 in 100 years. As expected the sensitivity testing showed that the maximum flood depths could increase and the effectiveness of protection could be reduced to between 1 in 25 and 1 in 75 years. In the absence of a formal cost benefit and lifetime analysis it is not known whether this represents the most cost beneficial solution, however, this would still represent a considerable improvement over the current situation.

Adding a pump station could protect homes up to the 1 in 200 year event, but is more expensive.

Adding storage would be a difficult option to implement in this urbanised area so has not been investigated in detail. It would also be difficult to increase capacity to allow for climate change.

Climate change, including sea level rise, is likely to increase the severity and frequency of flooding and therefore if a gravity system is installed it may require to be retrofitted with a pump station in the short to medium term. Therefore it would be prudent to design any gravity system with this in mind, if this is the option the Council prefer to pursue.

It is recommended that before a final decision is made, a threshold survey is undertaken and then a more detailed cost benefit analysis produced.

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Abbreviations

2D	Two Dimensional (modelling)
DDF	Depth Duration Frequency
DEM	Digital Elevation Model
DTM	Digital Terrain Model
FAS	Flood Alleviation Scheme
FEH	Flood Estimation Handbook
JFLOW	2-D hydraulic modelling package developed by JBA
mAOD	metres Above Ordnance Datum
MCC	Motor Control Centre
OS	Ordnance Survey

1 Introduction

In 2011 JBA Consulting were commissioned to carry out a Flood Alleviation Study for the River Carron, Stonehaven. The study identified that in addition to the flooding due to the River Carron and Glaslaw Burn, the area around the Arbuthnott Drain was at risk of surface water flooding due to local rainfall pooling in the area near the drain. The depth of flooding is likely to be sufficient to cause substantial damage to surrounding properties and prevent safe access/egress.

The Arbuthnott Drain is a former mill lade, which originally discharged directly into the channel of the River Carron on the beach; it now discharges into a soakaway at the top of the beach.

To relieve potential surface water flooding it was thought that the discharge from the drain could be improved either through a free or pumped discharge, therefore JBA were commissioned to:

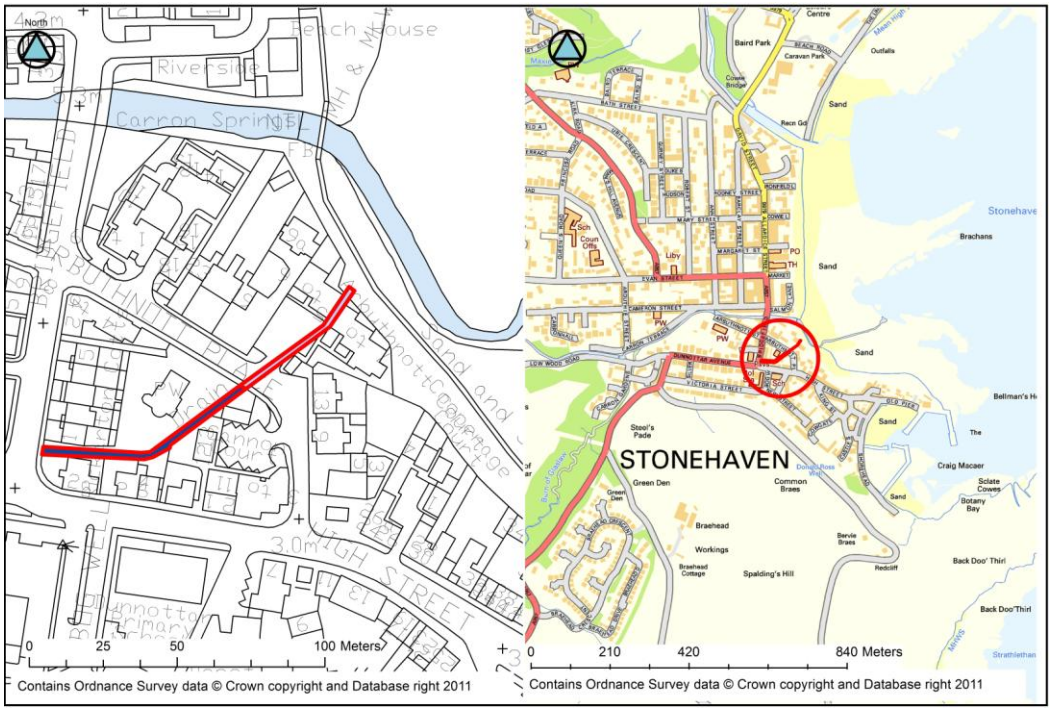
- Assess the drain capacity against known contributions.
- Assess the necessity and requirements for a pumped discharge.
- Assess overland flow routes and potential for improvement of surface water collection.
- Produce options for pumping stations/discharge.
- Produce outline drawings and budget costs for the preferred option.

For the purposes of the study it is assumed that the Stonehaven Flood Protection Scheme would be in place and that additional capacity to intercept flood water due to banks overtopping from the River Carron or Glaslaw Burn would not be required.

1.1 Site Location

The location of Arbuthnott Drain is shown in Figure 1-1, its approximate National Grid Reference is NO 8755 8571, and goes from the corner of Bridgefield and Dunnottar Avenue through to Arbuthnott Court.

Figure 1-1: Site Location



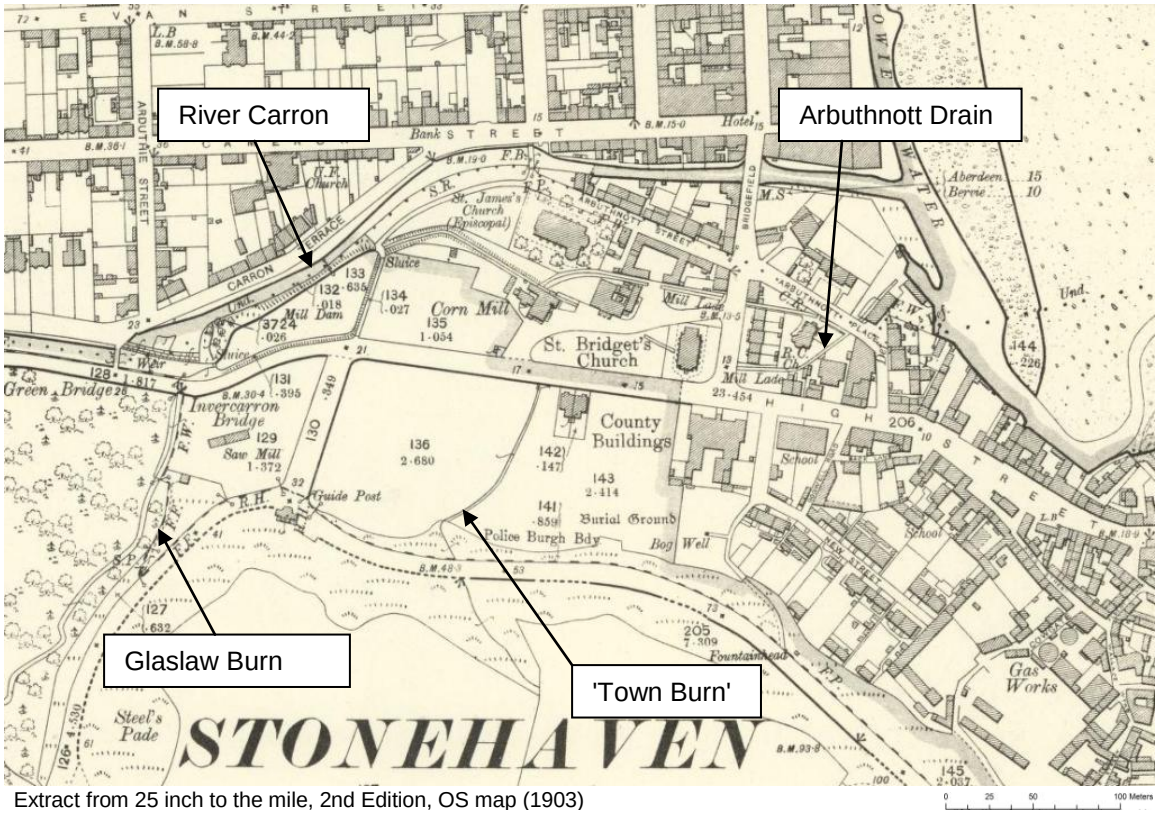
2 Existing Information

2.1 Desktop Survey

2.1.1 Historic Maps

The Arbuthnott Drain forms a small part of a partially culverted system, to the south of the River Carron. The 25 inch to the mile, 2nd Edition, OS map (1903), shows the mill pond and lades, which have now been largely filled in or built over.

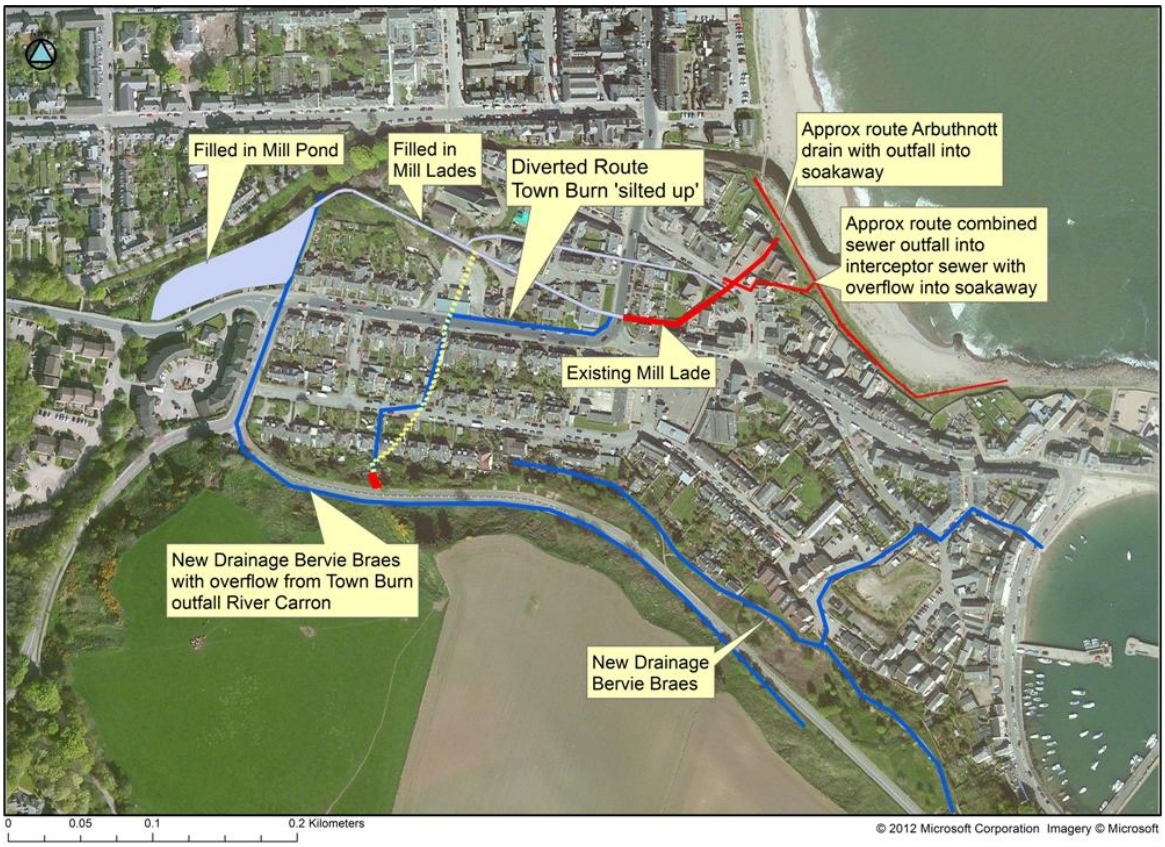
Figure 2-1: Plan showing original routes of water courses



Extract from 25 inch to the mile, 2nd Edition, OS map (1903)

To the south a small burn known as the 'Town Burn' enters the catchment, which now stops just south of Victoria Street. However historic maps show it stopping where it meets Dunnottar Road. The Figure 2-2 shows the approximate presumed route.

Figure 2-2 : Disused Mill Pond & Lades



The historic OS maps showed a combined sewer discharging via an outfall pipe to the sea. The route of this pipe went from Arbuthnott Place. This has now been intercepted by the Scottish Sewer network, but an 'overflow' into a soakaway remains.

2.1.2 Bervie Braes

In February 2010, heavy rain caused a landslip in Bervie Braes. Works to stabilise the landslip included installing new drainage and improving the existing drainage. Investigative works were carried out on the existing drainage and a scheme developed.

This drainage would appear to be well positioned to catch the surface water flow coming into the catchment. However, although catching a proportion of the surface runoff it is unlikely that this will have sufficient capacity to be able to intercept all the runoff from a high intensity event. In addition it may not be able to discharge to the River Carron under flood conditions, especially as the lower sections do not appear to be sealed.

The route of the 'Town Burn' was surveyed by JBA in March 2011, and has been diverted via a series of stone culverts into the Arbuthnott Drain. Although connectivity has been established[1] the culverts are heavily silted up and may be assumed to be ineffective at conveying significant quantities of surface water.

2.1.3 Scottish Water

JBA were provided with a copy of the InfoWorks CS model of the existing combined and surface water infrastructure by Scottish Water as well as asset plans for Stonehaven.

The InfoWorks CS model has not been fully verified and is incomplete, and in its current state would unlikely accurately model all the existing surface water routes without substantial improvement. However it was useful to inform connectivity and to assist in understanding the drainage and flood risk. It is understood that this model is likely to be improved in 2013 as part of the integrated catchment modelling study for Aberdeen.

[1] Drainflow CCTV survey 19/01/2011 & 09/03/2011

The asset plans received from Scottish Water in August 2011 show a rising main and combined sewer across the route of the potential new discharge.

2.1.4 Other Utilities

Plans from Scottish Gas Networks, Scottish Southern Energy and BT were obtained; these are shown in Appendix A.

2.2 Site Walkover Survey

A site walkover survey was carried out on 18 July 2012, during wet conditions. The route of the Arbuthnott Drain was observed; the flow in the drain appeared to be low despite the wet conditions. This would tend to indicate that it does not normally pick up much surface water. The ground levels surrounding the drain are also higher than the lowest area of ponding on the High Street. This means that it is not located in the optimum position for collecting surface water flows.

Figure 2-3: Arbuthnott Drain

Arbuthnott Drain during Heavy Rainfall

Arbuthnott Drain during Dry Weather

Extensive sections of linear drainage were located along the north side of the High Street. This would indicate that surface water collects in this area, which is confirmed by the levels on the topographic survey, and historic records of flooding.

Figure 2-4: Arbuthnott Place and High Street

Junction Arbuthnott Place & High Street

High Street, with linear drain highlighted

High Street, with linear drain highlighted (cont.)

High Street, with linear drain highlighted (cont.)

A new drain has been constructed along Fountainhead (the road above Victoria Street) as part of the works to stabilise the landslip at Bervie Braes, this will discharge into the River Carron, alongside the in-filled mill pond as shown on Figure 2-2. Although primarily designed to stabilise the slope, it will have the effect of intercepting some of the surface water flows from the hillside at Braehead. It should be possible to ensure sealed manholes and flap valves are used so that the drain may discharge when the river is high.

Low and high level informal continuous boundary walls along the sea front would appear to provide some additional protection to properties from tidal flooding and wave overtopping, but would also impede the natural flow of water to the sea.

Figure 2-5: Sea Front behind Arbuthnott Place

2.3 Topographic Survey

JBA undertook a topographic survey on 15/16 August 2012, the survey included Arbuthnott Place and the junction with the High Street, where previous information suggested water might collect.

2.4 Flood History

An extensive account of the flood history is contained within the 'Flood Alleviation Study (FAS) for the River Carron, Stonehaven', 2012 by JBA. However a couple of photographs showing flooding at Arbuthnott Place from the 2009 event are shown in Figure 2-6. Although this event was primarily due to water from the Carron, it shows the potential of water to collect in the area.

Figure 2-6: Flooding Junction of Arbuthnott Place and High Street

Arbuthnott Place

High Street

This suggests that surface water flooding poses a significant risk to properties in Stonehaven, with potential depths during the 0.5% Annual Probability (AP) (200 year) surface water event reaching approximately 0.7 m in the Cameron Street / Barclay Street area and approximately 1.1 m in the low-lying area of High Street. Works to reduce fluvial flood risk are unlikely to mitigate against surface water flooding unless they comprise individual property defences. Additional measures may thus be required to reduce the risk to properties from surface water flooding.

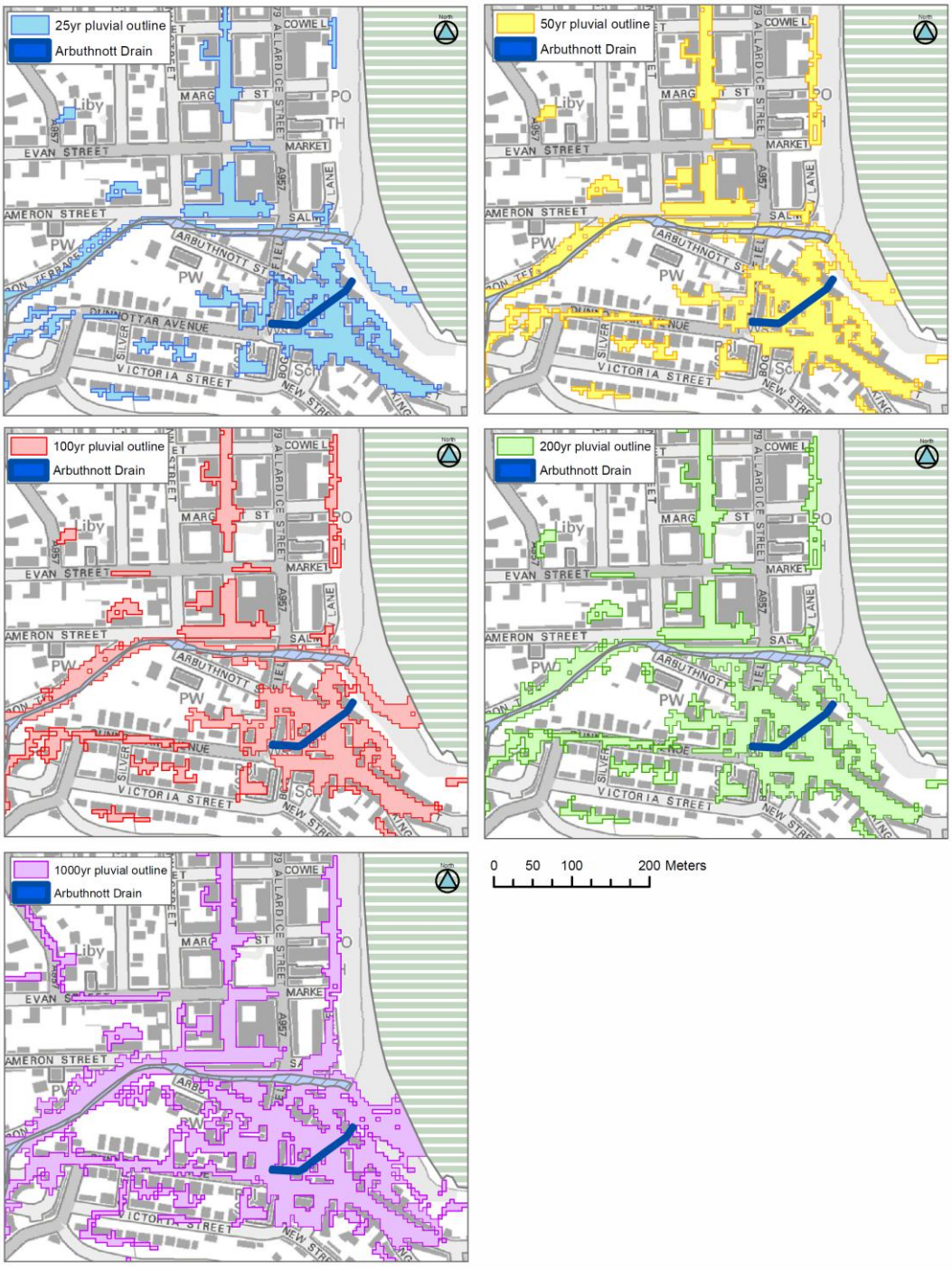
3 Existing Flood Risk

3.1 Surface Water Flooding

Surface water flooding (often described as Pluvial Flooding) occurs whenever rainfall either cannot enter the drainage network, or the drainage network does not have enough capacity. This excess water then flows overland or gathers at low points and can cause flooding.

As part of the River Carron Flood Alleviation Study JBA undertook surface water (pluvial) mapping using JFLOW+, 2D raster-based modelling software developed by JBA Consulting. The resulting flood outlines are reproduced in Figure 3-1. As can be seen the area around the Arbuthnott drain is shown to flood for the 1 in 25 year event upward. More detailed information is contained within the study report.

Figure 3-1: Surface Water or Pluvial Flooding



The mapping applies rainfall to a digital terrain model and routes the water overland. A deduction equivalent to the 5 year rainfall was made to allow for existing surface water drainage.

3.2 Extreme Sea Levels

Extreme sea levels were estimated using 'Coastal flood boundary conditions for UK mainland and island, Project: SC060064/TR2: Design sea levels' published by the Environment Agency, (February 2011). The extreme sea levels are based on the Skew Surge Joint Probability Method SSJPM, whereby the effects of tide levels and storm surge are combined using joint probability methods.

The extreme sea levels including the effects of tide and surge at Aberdeen and Leith are given for the base year of 2008 together with a graph showing MHWS against chainage (around the coast). This relationship was used to interpolate the values for Stonehaven. There is some uncertainty within these levels, but may be considered to be accurate within 0.1m. The results are shown in Table 3-1 below.

Table 3-1: Extreme Sea Levels (mAOD)

	Return Period									
	2	5	10	20	25	50	75	100	150	200
Stonehaven	2.81	2.91	3.00	3.06	3.08	3.14	3.20	3.23	3.26	3.28

Although a full survey was not carried out along the sea front Cover cover levels of manholes along the sea front are in the region of 3.05 mAOD to 3.64 mAOD, which are slightly lower than the crest of the embankment along the sea front. This combined with the informal walls may provide a degree of protection against tidal effects.

However the lowest levels in Arbuthnott Place, behind the sea front are around 2.80 mAOD, which equates to a tidal return period of about 1 year. The invert level of the underground section of the Arbuthnot Drain goes from approx. 2.50 mAOD to 1.86 mAOD at its lowest level. As can be seen if it was opened up it could be tide locked during fairly low return periods events.

3.3 Tidal Harmonics

Full tidal graphs were required for the modelling, as opposed to just the peak extreme sea level.

Tidal harmonics were derived using the methodology presented within the Defra Coastal Extremes project[2]. The method uses a base astronomical tidal curve and combines this with a surge curve to give the required resultant tidal peak for a given return period. The parameters used within the analysis are noted below, with the resultant tidal graph for the 0.5% AP (200 year) event displayed in Figure 3-2.

Table 3-2: Parameters for Tidal Harmonic

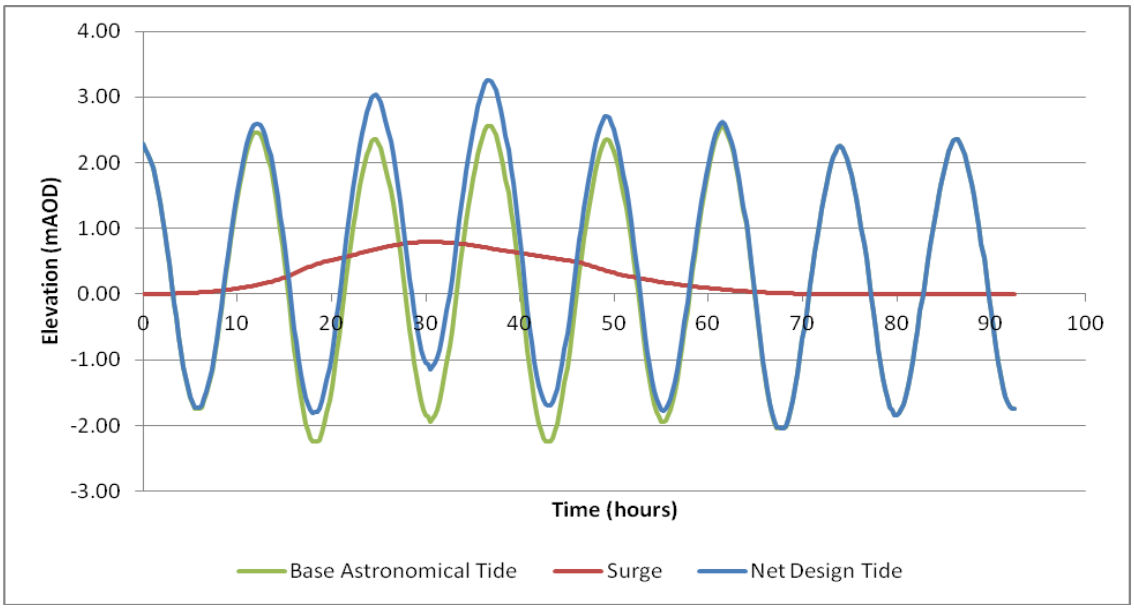
Base tide curve peak level for Stonehaven, based on Aberdeen (Highest Astronomical Tide (HAT))[3]	2.55 mAOD
Surge shape	Aberdeen (profile 3)

The maximum surge was set to coincide with the low tide prior to the peak, thus resulting in the worst case scenario in terms of potential flood risk.

[2] Coastal Flood Boundary Conditions for UK Mainland and Islands – Project SC060064TR2: Design Sea Levels, February 2011

[3] Admiralty Tide software

Figure 3-2: 200 year Tidal Graph for Stonehaven



3.4 Wave Overtopping

Although historic evidence would suggest that there are areas within Stonehaven susceptible to wave overtopping, this is not considered relevant to this study as it unlikely to affect the drainage design to remove water from Arbuthnott Place.

3.5 Ground Water Flooding

Since extreme sea levels are slightly higher (3.28mAOD for the 0.5% AP (200 year) event) than the lowest point on Arbuthnott Place (2.79mAOD) there is a risk of the water table rising to cause flooding. The degree of flooding will be dependent on the porosity of the underlying deposits, head difference and duration of head difference. In this case the head difference (approx max. 0.5m) may be considered relatively low and short lived, so whilst a degree of ground water flooding may be possible it is unlikely to be large for events up to the 0.5% AP (200 year) event, and is unlikely to affect the design of a proposed solution.

3.6 Climate Change

Global sea levels have been rising and are predicted to rise further. Current predictions using UKCP09 for Stonehaven suggests that by 2080 sea levels are expected to rise between 64mm and 427mm, based on 5% and 95% percentiles under the High Emission Scenario.

For the planning of new development 20% is normally added to flood flows[4], in accordance with the 'precautionary' principle. It is difficult to predict what effects global warming will have on 'weather', although the UKCP09 would tend to indicate drier summers and wetter winters. There is some evidence for recent increases in flows, (except for Banff & Buchan), this trend has not been confirmed over the long term[5] as the data set is not long enough to confirm it. Storm surges may also become more intense and frequent[6], and joint probability events may become more strongly 'dependent'. Other sources of flooding for example tidal and ground water flooding may therefore become more dominant, and flooding due to rainfall may become more frequent.

A pumped scheme would be less affected by climate change, since the pump sets may be changed to cope with additional flows, and higher heads, (providing sufficient space is left for more/larger pumps).

[4] Technical Flood Risk Guidance for Stakeholders, SEPA, 2009
[5] The Effects of Climate Change on River Flows in Scotland, SEPA, 2009
[6] SEPA Climate Change Plan – SEA Environmental Report, December 2007

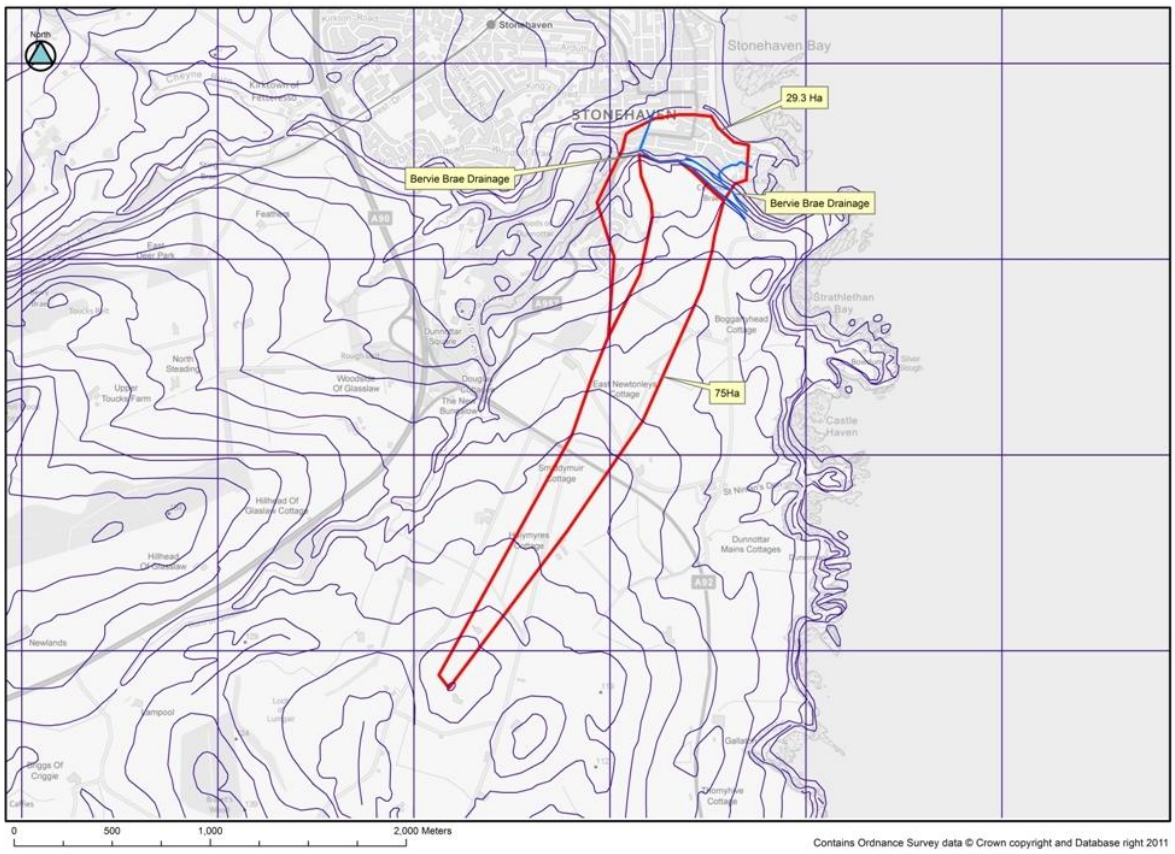
A gravity system is more likely to be affected by increased flows and rising sea levels. However, rather than design a system to cope with predicted flows and sea levels, which may be unjustifiably expensive, it may be more effective to retrofit a system at a later date, for example by adding supplemental pumping, or more storage. This could for example be 25 to 50 years in the future.

4 Surface Water Flows

4.1 Catchment

The upper part of the catchment is characterised by arable fields with some pasture. The lower part may be considered moderately urbanised. The total catchment area is estimated to be 104.3 Ha, of which 75 Ha contributes to the Town Burn/Bervie Brae Drainage and 29.3 Ha to the catchment below 'Town Burn / Bervie Brae Drainage, of which 8.1 Ha is rural'. The geology of the upper catchment consists of Mill of Forest glacial till overlying Dunnottar Castle Conglomerate, whilst the lower catchment consists of mainly River Terrace Deposits or Alluvium overlying the Carron Sandstone Formation.

Figure 4-1: Estimated Catchment Area



4.2 Choice of Methodology

Conventional approaches would not be capable of estimating flows with sufficient accuracy due to:

- Mixed nature of catchment (part urban/part rural)
- Effect of existing drainage. Conventional approaches would overestimate flows as there is no easy way of calculating the flows intercepted. The number of different drainage networks, and lack of a verified Scottish Water model, would make this approach extremely difficult and time consuming.

Therefore in order to assess the flow reaching the low point in Arbuthnott Place, surface water (pluvial) modelling using JFLOW+ was undertaken.

4.3 Description of model

Surface water modelling utilises JFLOW+ modelling software, a specialist tool for assessing pluvial flood risk. JFLOW+ is a 2-D flood routing model, which uses a raster-based approach driven by the underlying Digital Terrain Model. Water movement between cells is driven by

gravity and depends on the ground level and water depth in adjacent cells. Velocity is also influenced by the roughness coefficient specified for the cells. Thus blanket rainfall applied across the study area will be routed according to the topography to low-lying areas, where it will pond until the water level is high enough to spill to surrounding cells. JFLOW+ incorporates full implementation of the Shallow Water Equations providing reliable flood depth and velocity modelling.

4.3.1 Model set-up

The maximum numbers of cells that can be used in a JFLOW+ simulation at one time are approximately 1,500,000. The study run area used was therefore approximately 5 x 5 km using a 5 m grid.

4.3.2 Model assumptions

The following assumptions apply to the JFLOW+ model:

- Filtered LiDAR and contour data used in the DTM gives an accurate representation of the ground surface and presence of streamlines and low topography;
- Flow will pass around buildings rather than 'through' them (no volume accommodated within buildings);
- A Manning's 'n' coefficient of 0.03 is used as a blanket surface roughness;
- Water is lost from the model at the edges of the DTM (volume lost is recorded)
    - [in this case because the area of interest may in the future be surrounded by sea and river defences a sensitivity check was carried out with the defences included. This is discussed in Section 6.6];
- The model run time extends beyond the end of the input hydrograph in order to allow water to continue to run off across the ground surface to create final flood depths. The model run continues for 5 times the hyetograph length.

4.4 Digital terrain model

Pluvial modelling uses a 2-D raster approach to simulate rainfall runoff over the topography of the study area. For this purpose a Digital Terrain Model (DTM) is required. This section outlines the methodology for preparing DTMs for use in JFLOW+.

4.4.1 Data type and availability

Where available, LiDAR data provides topographical data of generally high quality and precision (1 m cell size and vertical accuracy of approximately 20 cm is standard). In this case LiDAR was available which was flown by Infoterra in 2010. LIDAR data was provided to a 1m resolution and generally has a vertical accuracy of approximately ±0.2m.

4.4.2 DTM

LiDAR was clipped to take the boundary of the model as the Glaslaw Burn and River Carron, i.e. there was no input from flows transferred from higher in the catchment along the watercourse and then out of bank across the floodplain.

Buildings were stamped onto LiDAR at a height of 5m and this was used as the base for the final pluvial DTM.

4.5 Rainfall methodology

The hydrological input required by JFLOW+ pluvial modelling is depth-time hyetograph to represent the storm's rainfall profile, which is applied as a blanket rainfall over the run area.

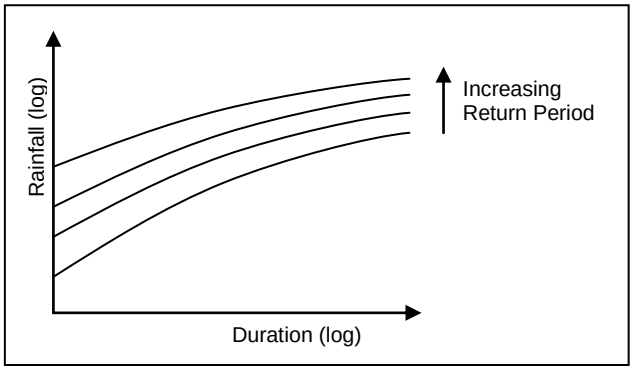
4.5.1 Rainfall depth

For the purposes of this project, rainfall estimations were generated using the Flood Estimation Handbook (FEH)[7]. FEH Depth-Duration-Frequency modelling was used to generate baseline rainfall.

4.5.2 DDF Model

The Flood Estimation Handbook (FEH) can be used to generate Depth-Duration-Frequency (DDF) curves for any 1 km grid point. A DDF curve relates storm duration to total rainfall depth, with different curves representing different return periods of event. See Figure 4-2 below for an example.

Figure 4-2: Example of DDF curves



4.5.3 Effect of urban drainage

The following has been extracted from the Flood Alleviation Study report:

'Drainage systems in urban areas remove some surface water runoff volume from the ground surface. Within an urban area such as Stonehaven, the capacity of the drainage system will vary substantially between locations and therefore to account for drainage, application of a standardised value is appropriate. Research by JBA Consulting during national surface water mapping exercises has suggested that a standardised allowance equating to the average of the 20% AP (5 year) return period event is appropriate for UK cities following testing against historical datasets.

For Stonehaven, a sewer model (in InfoWorks-CS) was provided by Scottish Water, and this was examined to determine whether an improved estimate of the urban drainage capacity could be made. The model suggested that flooding would occur from manholes even down to the lowest return period (1 year) event in a few locations, and with increasing return period there was a slow increase in the number of manholes at which flooding occurred. However there was no particular return period at which substantially more flooding occurred, i.e. no clear indication of a generalised capacity of the sewer system in terms of a return period. As a result, the 5 year return period capacity was used as has been demonstrated to be a reasonable estimate and at this return period a number of manholes in Stonehaven were shown to be flooding.'

This is the primary approach used for Stonehaven, however given its flood sensitive nature, once the primary models were run for the proposed options; a sensitivity test was carried out for the worst case scenarios, with all drainage allowances removed. i.e., all rainfall remains above ground. The results are discussed in Section 6.6.

4.5.4 Rainfall duration

The scope of this study was that a single duration event should be modelled for the 0.1% AP (1000 year), 0.5% AP (200 year), 1% AP (100 year), 1.33% AP (75 year), 4% AP (25 year), and 10% AP (10 year) storm events. However, previous pluvial studies have shown that the duration of event used has a significant influence on the areas and depths of pluvial flooding predicted. A range of durations were tested which found the critical duration to be 10 hours. Smaller steeper catchments tend to have lower critical durations than larger flatter catchments.

[7] Institute of Hydrology (1999). Flood Estimation Handbook, Vols 1-5. Wallingford: Institute of Hydrology.

Given the size of catchment and topography within Stonehaven a 10 hour event would be considered appropriate for this study.

4.5.5 Design rainfall profiles

The final choice of design rainfall for this study is therefore:

- 10% AP (10 year), 4% AP (25 year), 0.133% (75 year), 1% AP (100 year), 0.5% AP (200 year) and 0.1% AP (1in 1000 year).
- 10 hour duration.
- 20% AP (5 year) allowance for urban drainage subtracted (average of the storm subtracted at each timestep).

4.6 Results

4.6.1 JFLOW+ output

The output from the pluvial model is a raster of final flood depths across the model grid, which includes Stonehaven.

The depth raster was used to generate filtered flood outline polygons. Depths of less than 0.1 m were removed from the flood outline as standard. Isolated areas of pluvial flooding of less than 200 m^2 in size were also removed from the outline (note that the latter applies to the polygon but not the raster). These are standard procedures developed by JBA Consulting during nationwide pluvial modelling work.

4.6.2 Monitor Points

JFLOW+ allows the user to select points within the model domain for which extra information, such as the rise in level over time, can be extracted. In this case, several points were chosen along Arbuthnott Place. The rise in level over time was used in conjunction with the DTM to calculate the volume and the input hydrograph for the proposed drainage system.

Figure 4-3: Location of Monitoring Points

5 Joint Probability

Joint probability methods attempt to calculate the possibility of two related events happening at the same time. In this case we are interested in surge/tide and flow, which usually have some dependence on each other due to low pressure systems, being responsible for both storm surge and flow (rainfall and surge/tide are independent). R&D Technical Report FD2308/TR2 published by Defra / Environment Agency, (March 2005), outlines the desk study approach, whereby correlation or dependency values between events are given for different sections of coast. These results range from ρ=0.11, CF = 2 (independent) to ρ=0.70, CF = 1500 (super dependent).

The map in the guidance only shows the values for England, however the report states that dependence on the east coast is lower than the south and west, but is greater in Scotland than England. As such, a value was taken from the upper end of the range for eastern England, i.e. 0.1.

The joint probability analysis results in a number of flow-surge/tide combinations that all have a joint probability of 0.5 % AP (200 year) which may be tested in the model to get the worst case.

Table 5-1: Flow and Maximum Sea Level Return periods giving a joint probability of 0.5% AP (200 year)

Reference	Flow (m^3/s)	Flow Return Period (yrs)	Max. Sea Level (mAOD)	Sea Level Return Period (years)
F10-T40	0.09	10	3.11	40
F25-T16	0.25	25	3.02	16
F75-T5.3	0.55	75	2.91	5.3
F100-T4	0.62	100	2.88	4
F200-T2	0.88	200	2.81	2

5.1 Tidal Boundary Condition

The tidal harmonic used for the downstream boundary was derived using the extreme sea levels (see Section 3.2).

The curve was timed so that peak sea level coincided with peak flows at the downstream limit of the WinDes model, in order to be conservative. The minimum water level was limited in line with the surveyed cross section.

6 Modelling of Options

All options were modelled using WinDes W.12.6.1. WinDes is generally used for the design of new piped drainage systems, and may also be used to model pumped systems. The default values for pipe roughness and headloss coefficients were used.

The depths of flooding were calculated using the volume depth relationship created from the DTM.

Drawings of each option are shown in Appendix A, and the pipe layouts, numbering and calculations are shown in Appendix C.

6.1 Option 1a - Gravity Outfall Arbuthnott Drain

In this option surface water flows are intercepted and diverted to the Arbuthnott drain, which is extended so it discharges into the river/sea (See Drawings in Appendix A). A channel 1200x750 mm deep is used to collect the water which then discharges into the drain, via a similar sized culvert. The channel has been kept as shallow as possible to keep it above existing services and tie into the Arbuthnott drain.

The size of the outfall is assumed to be similar to that for the drain. The modelling showed that flooding would occur for the 0.5% AP (200 year) event. The table below shows the flooded volumes from the system.

Table 6-1: Flow and Tidal Return periods giving a joint probability of 0.5% AP (200 year)

	Volume of flooding for each (1 in 200 year) Joint Probability Scenario (m^3)				
Pipe No.	F10-T40	F25-T16	F75-T5.3	F100-T4	F200-T2
1	100	165	117	84	103
1.001	88	151	87	37	47
2	0	0	0	0	0
1.002	0	0	0	0	0
1.003	0	0	0	0	0
Total Volume (m^3)	188	316	204	121	150

The maximum volume of flooding was 316 m^3 and occurred for a flow return period of 1 in 25 years combined with a tidal return period of 1 in 16 years. The maximum depth of flooding for this scenario is estimated to be about 220 mm, with a level of 3.12 mAOD, and an estimated 24 properties affected (allowing 100 mm freeboard). This would reduce flood risk when compared to the situation without the gravity drain installed[8], where flooding would occur to a depth of about 810 mm, with a level of 3.71 mAOD and affect an estimated 91 properties (with 100mm freeboard).

To try to assess the return period at which flooding would start to occur additional joint probability scenarios were tested for the 1 in 25 year, 1 in 75 year and 1 in 100 year joint probability event. This showed that flooding would start to occur between the 1 in 75 year and 1 in 100 year event.

[8] This assumes that flood defences on River Carron are in place.

Table 6-2: Flow and Tidal Return periods giving a joint probability of 1 in 75 years

	Volume of flooding for each (1 in 75 year) Joint Probability Scenario (m^3)		
Pipe No.	F10-T5.63	F25-T2.25	F75-T0.75
1	Flood Risk	Flood Risk	Flood Risk
1.001	Flood Risk	Flood Risk	Flood Risk
2	OK	OK	OK
1.002	Surcharged	Surcharged	OK
1.003	Surcharged	Surcharged	Surcharged
Total Volume (m^3)	0	0	0

Joint probability scenarios with lower flow return periods that would give higher tidal return periods were not tested. It is assumed that the existing urban drainage system would be able to cope with these lower return periods, since it is known that Scottish Water operates a pumping station at the end of the Old Pier that takes flows from the combined sewer. However sensitivity testing was carried out assuming the local urban drainage system was ineffective (see section 6.6).

The volume of flooding for each of the 1 in 100 year joint probability scenarios is estimated as follows:

Table 6-3: Flow and Tidal Return periods giving a joint probability of 1 in 100 years

	Volume of flooding for each (1in 100 year) Joint Probability Scenario (m3)			
Pipe No.	F10-T10	F25-T4	F75-T1.33	F100-T2.74
1	69	29	1	0
1.001	52	15	0	0
2	0	0	0	0
1.002	0	0	0	0
1.003	0	0	0	0
Total Volume (m^3)	121	44	1	0

This would give a maximum depth of flooding of about 160mm, with a level of 3.04mAOD, with the number of properties affected estimated to be 8 (with 100mm freeboard).

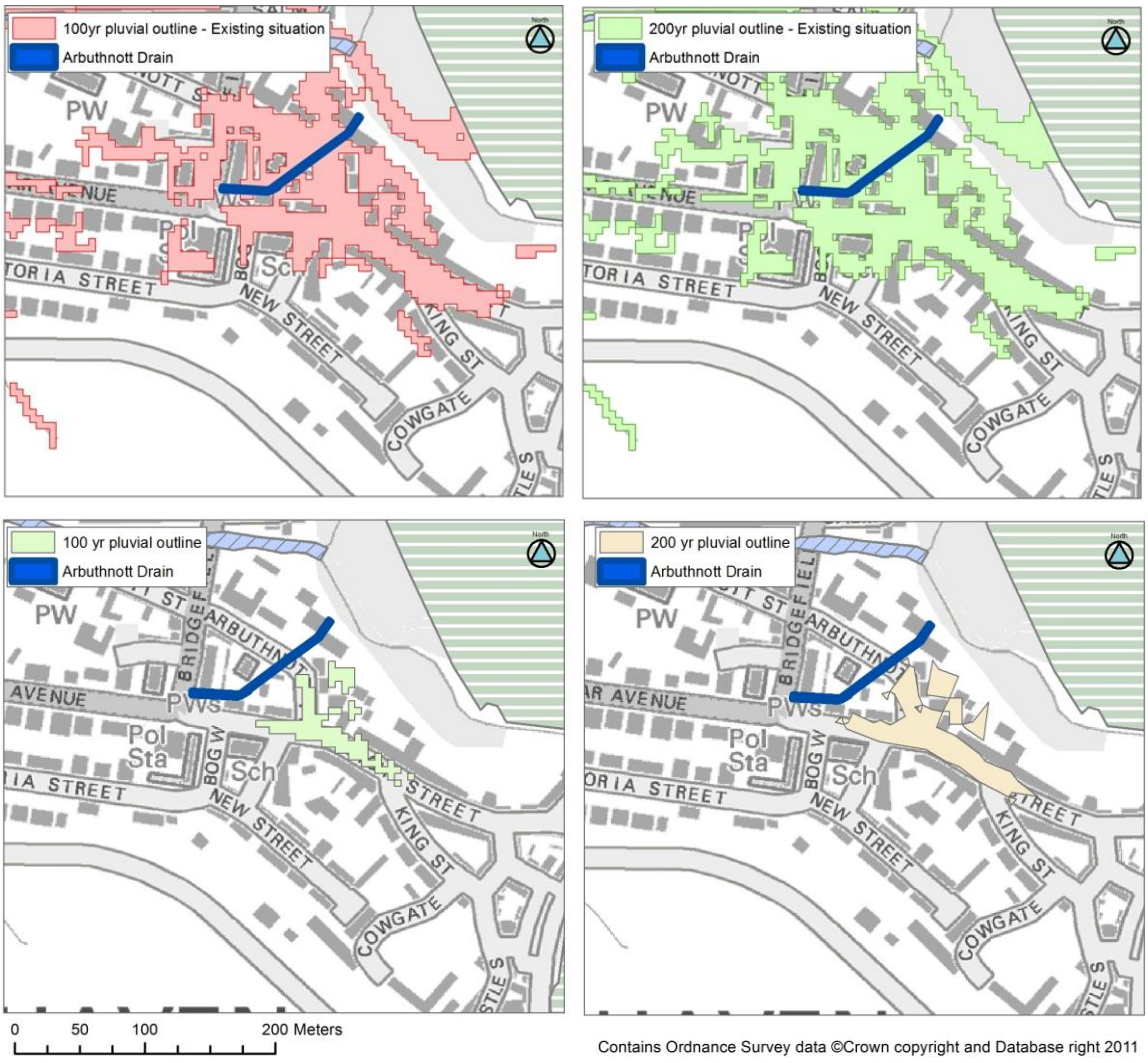
It is standard practice to add freeboard to flood levels, to account for modelling inaccuracies; however no standard method has been established for pluvial flooding (as opposed to fluvial flooding). Settlement of flood defences etc whilst applicable to fluvial flood defences would not be directly applicable to pluvial flooding although inaccuracies due to flow and local wave action would. A generic allowance for freeboard may not therefore be suitable. Applying the 'quick method' which attempts to factor in a number of uncertainties a figure of 100 mm freeboard may be obtained[9].

The lowest floor level in the area is estimated to be about 2.96 mAOD, although a detailed threshold survey has not been carried out. It is noted that some properties are fitted with property defences, if necessary the protection of individual properties could be reviewed to enable a higher standard of protection. The flood outlines for the 1 in 100 year event and the 1 in 200 year events are shown overleaf.

[9] Fluvial Freeboard Guidance Note, R&D Technical Report W187, A M Kirby & J R V Ash, EA, 2000: Based on 'quick method' an uncertainty allowance of 0.5 x Flood Depth. For max depth flooding of 220mm, (the average depth will be less), a free board of 0.1m may be calculated. Other methods would be difficult to apply to this situation.

British Standard PAS 1188-1: Flood protection products. Specification. Building aperture products, BSI,2009: This has a requirement to test property level defences for waves of 0.1m

Figure 6-1: Pluvial Flooding outlines for proposed Gravity Outfall



6.2 Option 1b - Gravity Outfall Arbuthnott Place/High Street

This is essentially a variation of Option 1a, (See Drawings in Appendix A). To ensure efficient collection and disposal of surface water, water is collected at the lowest point and discharged along a new shallow drain installed directly out to sea. This essentially formalises existing overland flow routes, but could require potential underpinning of adjacent properties. The volume of flooding and return periods at which flooding would occur would be similar to Option 1.

Although potentially disruptive to a few residents, work should be carried out externally to the properties, and should not normally prevent access to them. The amount of work would be dependent on further site investigation work and surveys.

6.3 Option 2a - Pumping Station in Arbuthnott Court

In this option the gravity outfall is supplemented by a new pumped outfall, otherwise the drainage system is identical to Option 1a, (See Drawings in Appendix A). A variation on this option would be to install a pump in Arbuthnott Court car park , and pump water via a 'surge chamber' through the gravity outfall. This would mean that access for pump maintenance is improved and the pumping station is behind the coastal defences, however construction would cause considerable disturbance to residents, since large excavations would be required.

The results show that with a maximum pump rate of 833 l/s the number of properties at risk of flooding at the 200 year flood would be 0.

6.4 Option 2b - Pumping Station on Arbuthnott Place/High Street Outfall

In this option the pump station is moved to the lowest point to enable more efficient water collection, this also reduces the risk of clashes with services, although it is likely that some of these including a medium pressure gas main may need to be moved, or other precautions taken to protect plant. Precautions would also need to be taken to protect surrounding buildings from ground movement, for example back filling the chambers using concrete.

6.5 Option 3a and 3b - Gravity Drainage and Storage

One method of reducing the risk of flooding further would be to provide storage for the flood water. To avoid flooding entirely for the 1 in 200 year event would require the provision of a storage area of approximately 14.5 x14.5 x1.5 m. Storage may be provided by routing water to flood storage basins or shallow tanks incorporated below car parks etc.. Creating storage basins in car parks could hinder access for emergency services, so may not be appropriate in this situation. However, shallow storage tanks may be used.

The tanks may be subject to flotation during a flood event and would therefore need to be weighted down by ensuring an appropriate thickness of fill above, or surrounding with concrete. This may difficult to do without altering building thresholds, and carrying out service diversions. They would also need to be watertight to prevent infiltration from ground water. Rising sea levels would also reduce the effectiveness of such a system. So it is likely to be expensive and disruptive to provide extra storage when offset against the potential benefit. This option has therefore not been costed.

6.6 Model Sensitivity Check

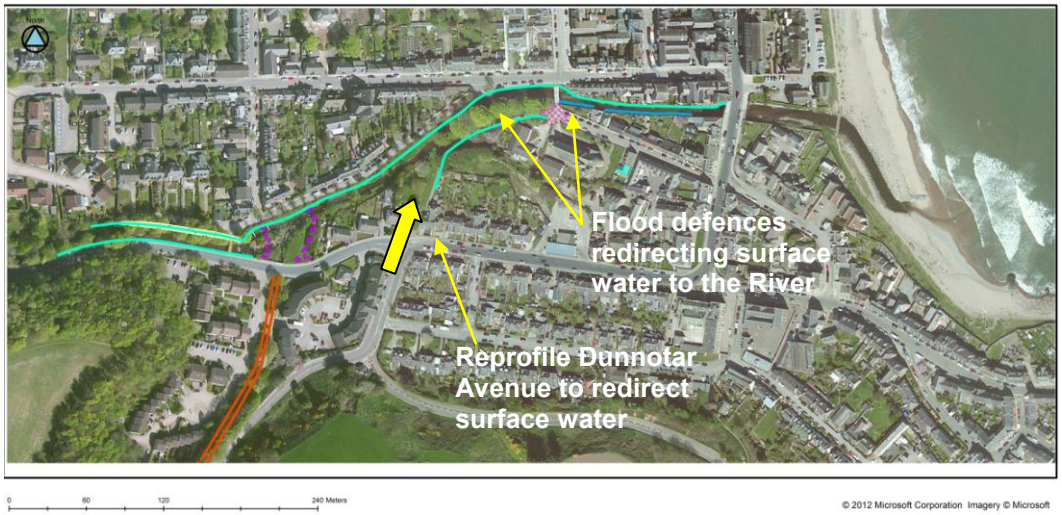
Two sensitivity checks were carried out.

1. Assuming that river and sea defences are in place and continuous. i.e. water that would otherwise flow off the edge of the DTM should be deflected back by the defences.
2. Assuming that no reduction was made for drainage i.e. all the rain that falls remains above ground.

6.6.1 River and Sea Defences in Place

The JFLOW+ model was rerun using a DTM with river and sea defences stamped onto it. This means that no water can escape from the model that would otherwise pond in the area of interest. The inclusion of river and coastal defences on the DTM did not increase flooding at Arbuthnott Place, this is possibly due to some of the defences redirecting some of the surface water back from Bervie Braes into the river, see Figure 6-2. It may also be possible to re-profile the street at the end of Dunnottar Avenue to ensure more of the surface water goes back into the River Carron, reducing pumping and drainage requirements. However this would need further study as part of taking the preferred option to the next stage.

Figure 6-2: Flood defences re-routing surface water



6.6.2 Urban Drainage Assumed to be Zero

Removing the drainage component from the rainfall model, means that it is assumed that all of the rainfall remains above ground and the effect of the existing urban drainage system is ignored. This therefore increases the volume and peak flow rate at Arbuthnott Place which is to be expected.

This increase in volume and peak flow rate was tested against the proposed options to assess what affect they would have.

For the gravity drainage options the maximum depth of flooding for the 200 year scenario is estimated to be about 270mm, with a level of 3.17mAOD, and an estimated 31 properties affected (with 100mm freeboard).

Table 6-4: Flow and Tidal Return periods giving a joint probability of 1 in 200 years

	Volume of flooding for (1in 200 year) Joint Probability **No Drainage** (m^3)		Volume of flooding for (1in 200 year) Joint Probability **With Drainage** (m^3)	
Pipe No.	F25ND-T16	F200ND-T2	F25-T16	F200-T2
1	251	163	165	103
1.001	212	85	151	47
2	0	0	0	0
1.002	0	0	0	0
1.003	0	0	0	0
Total Volume (m^3)	463	248	316	150

Table 6-5: Flow and Tidal Return periods giving a joint probability of 1 in 75 years

	Volume of flooding for (1in 75 year) Joint Probability **No Drainage** (m^3)
Pipe No.	F25ND-T2
1	69
1.001	12
2	OK
1.002	Surcharged
1.003	Surcharged
Total Volume (m^3)	81

The maximum depth of flooding for the 75 year scenario is estimated to be about 110mm, with a level of 3.01mAOD, and an estimated eight properties affected (with 100mm freeboard).

As can be seen for the gravity drainage options, the increase in volume and flow rate reduces the level of protection to below the 1 in 75 year event to somewhere between the 1 in 25 and 1 in 75year event.

For the existing pumped options (Options 3 and 4), the increase in volume and peak flow causes the proposed new drainage network to surcharge, but not to flood. Therefore both pumped options will still provide protection for the 1 in 200 year event.

Whilst it is unlikely that all of the rainfall will bypass the existing drainage network, it is nevertheless a factor that should be taken into consideration when making a decision on which option to proceed with.

7 Costing of Options

The construction costs for each scheme are shown in Appendix B and are summarised below. These costs exclude professional fees, statutory fees, site investigation costs, VAT, legal costs, land acquisition costs, compensation costs, and maintenance and operation costs.

Table 7-1: Estimate of Construction Costs

	Estimate of Construction Costs
Option 1a - Gravity Outfall Arbuthnott Drain	£291,152
Option 1b - Gravity Outfall Arbuthnott Place/High Street	£270,423
Option 2a - Pumping Station in Arbuthnott Ct	£994,007
Option 2b - Pumping Station on Arbuthnott Place/High Street Outfall	£935,062

7.1 Life Cycle Costs

Pumping stations have significant maintenance costs associated with them and should be appraised as part of the project costs. The following activities are associated with maintaining a pump station, of a similar size and complexity to that required on this project:

Table 7-2: Maintenance Costs for Pumping Station

Maintenance	Frequency	Cost Range (yearly)
Checking Flap Valves, inlets and outlets, clearing sediment	6 months	£500-£1,500
Pump Servicing, lubrication, testing, cleaning & adjustment	6 months	£250
Ultra-sonic switch/senor calibration and check	6 months	£100
Float switches, inspection	6 months	£100
Valves, general check	6 months	£500-£1,500
MCC (Motor Control Centre), electrical check	6 months	£250
Emergency Call Out	As required	£0-£2,000

Table 7-3: Replacement/Refurbishment Costs for Pumping Station

Replacement/Refurbishment	Frequency	Cost Range
MCC	15 years	£7,500-£10,000
Pumps & Motors	25 years	£15,000-£25,000
Mechanical Valves	15 years	£6,000-£15,000
Tidal Flap Valve	25 years	£5,000-£10,000
Replacement of Generator	15 years	£20,000-£25,000

7.2 Discussion

Options 1 and 2 may be considered broadly similar in terms of cost. Option 1 may be more difficult to construct due to the need to divert more services, however obtaining land owner permission to carry out option 2 may be more difficult. Other routes for gravity drainage may be possible although it is unlikely that they would significantly change costs. Since the costs of options 1 and 2 are substantially lower than options 3 & 4. It is likely that options 1 & 2 will prove the most cost beneficial, although they provide a lower standard of protection.

The final choice between these options will depend on landowner/resident consultation, and a full financial appraisal.

8 Conclusions

It is assumed that a flood defence scheme will be in place along the River Carron and Glaslaw Burn, to prevent out of bank flows reaching Arbuthnott Place.

The existing drainage is likely to be exceeded during a flood event, with overland flows collecting in Arbuthnott Place. Flooding will occur at return periods less than 1 in 25 years.

Gravity drainage reduces flood risk protecting properties for a return period between 1 in 75 and 1 in 100 years. This could take the form of a wide collection channel connecting to the existing Arbuthnott Drain, Option 1a, or a wide channel, connected to the sea by a culvert following the most direct route, Option 1b. The maximum depth of flooding for the 1 in 200 year joint probability is currently estimated to be 0.22m.

Option 1a seeks to avoid services by keeping as shallow as possible, although clashes with services are likely to be unavoidable. Although Option 1b is likely to have less service clashes, the properties along the route are likely to require underpinning, or other precautions taken to prevent settlement of properties.

Excluding all the existing drainage from the model as a sensitivity check reduces the gravity drains standard of protection to between 1 in 25 and 1 in 75 years, but still provides a considerable improvement on the existing situation.

Including flood defences within the study area may have the effect of reducing surface water flows by redirecting some of the flow back into the River Carron.

A pumping station would prevent flooding for a 1 in 200 year event. A pumping station may be positioned along the line of the proposed gravity drainage.

The construction costs of the options are estimated as follows:

Table 8-1: Construction Costs for Pumping Station

	Estimate of Construction Costs
Option 1a - Gravity Outfall Arbuthnott Drain	£291,151.51
Option 1b - Gravity Outfall Arbuthnott Place/High Street	£270,423.01
Option 2a - Pumping Station in Arbuthnott Ct	£994,006.91
Option 2b - Pumping Station on Arbuthnott Place/High Street Outfall	£935,062.31

Options 1a & 1b cost substantially less than Options 2a & 2b and are likely to prove the most cost beneficial.

The final choice between these options will depend on landowner/resident consultation, and a full financial appraisal. However it is considered that a gravity system supplemented by pumping would provide the most robust method of flood alleviation and a higher standard of protection. Depending on availability funding it may make sense to phase the works, by constructing a gravity system first.

It is likely that climate change will affect the frequency and severity of flooding, and that if a gravity system is adopted it may need to be retrofitted at some point in the future, depending on rate of sea level rise/climate change. This would probably need to be carried out in conjunction with improvements in sea defences.

9 Recommendations

To confirm the cost and benefits associated with each option it is recommended that a threshold survey together with formal cost benefit analysis is undertaken to confirm which option is most beneficial in risk reduction.

The following additional information is required before the chosen solution is taken to the detailed design stage:

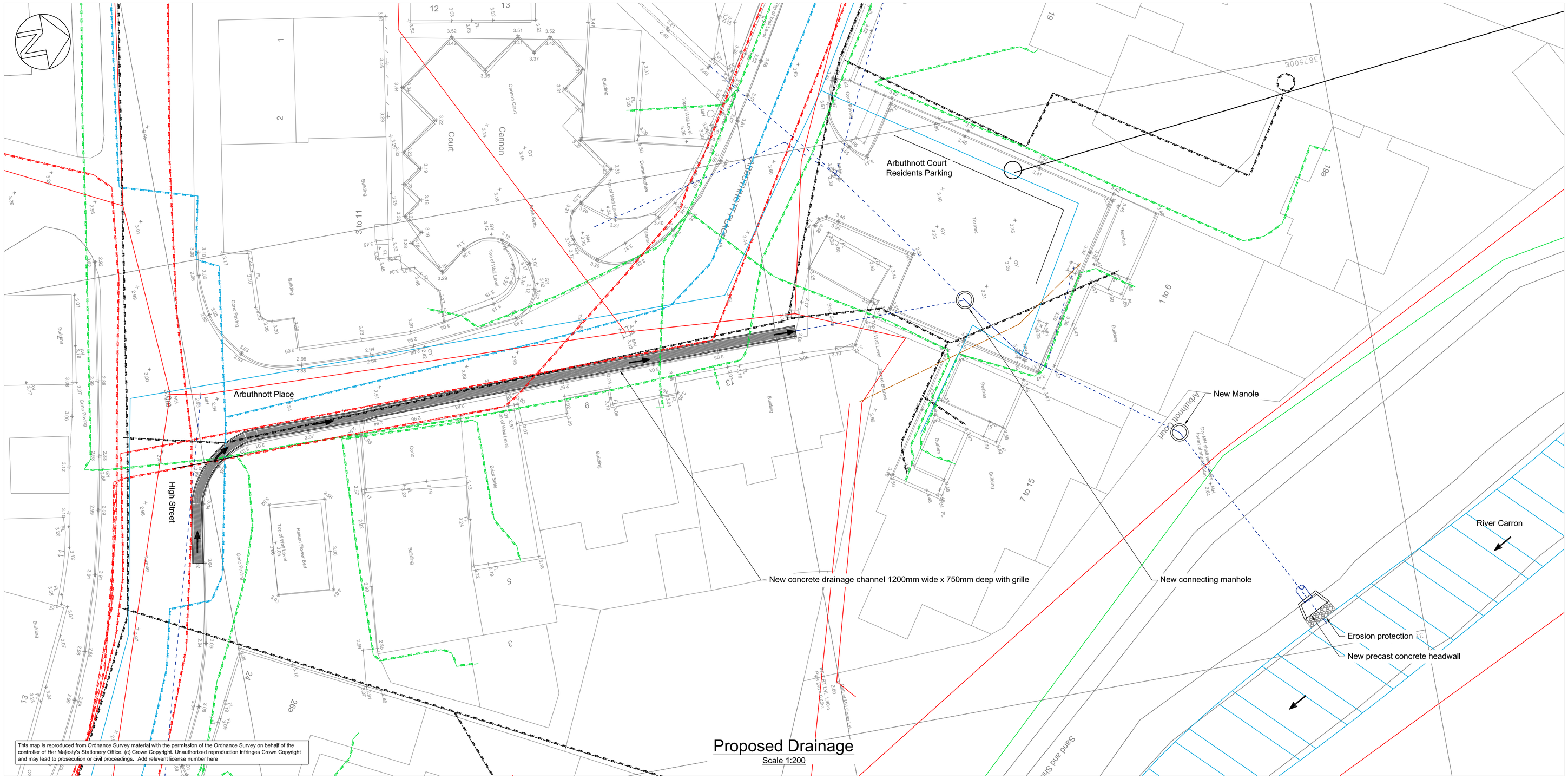
- Views from landowners and residents affected.
- Topographic Survey extending to incorporate full area of proposal.
- Site Investigation work to include ground permeability testing and seepage analysis.
- Utility Survey to locate precise route and depth of services, including trial pits.
- Trial pits to establish depth of foundations of adjacent buildings to determine if underpinning is required and the extent of works.

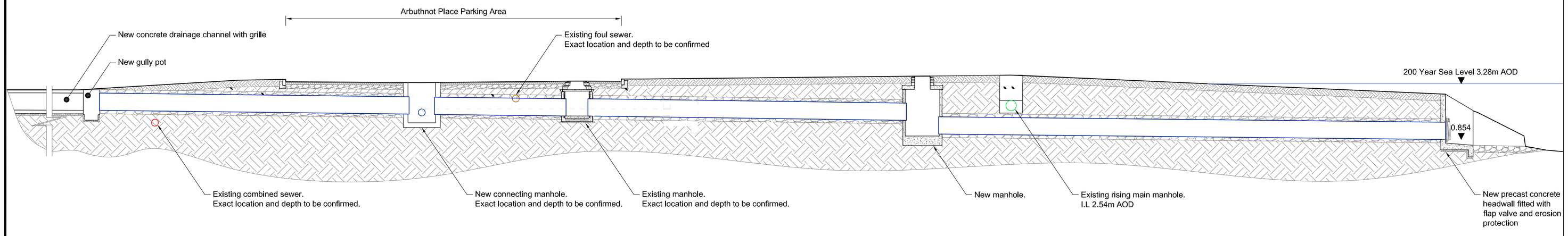
It is recommended that if a gravity solution is adopted, that this should be followed by a second phase in the short to medium term whereby additional pumping is added.

Further study to investigate the effects of re-landscaping at Dunnottar Avenue, may reduce pumping and drainage requirements, and should be looked at as part of the next stage, since this has the potential to provide some savings.

Appendices

A Appendix - Drawings





Long Section Through Proposed Drainage
Scale 1:100

General Notes

1. All dimensions shown are in metres unless otherwise stated and levels in metres to Ordnance Datum.
2. Do not scale from this drawing. All dimensions must be checked/verified on site - if in doubt ask.
3. Any discrepancies noted on site are to be reported to the Engineer immediately.
4. Survey undertaken by JBA Consulting on 15th & 16th August 2012
5. Service information supplied by Aberdeenshire Council 12th July 2012.
6. Service information shown is indicative only and not exhaustive. Service locations should be confirmed on site prior to the commencement of works.
7. Position of existing surface water outfall is indicative, as location could not be found by surveyor at time of survey.
8. Ground profile shown from building 1-6 Arbuthnott Place to watercourse is indicative only as it was not part of survey specification at time of survey.
9. Drawing to be read in conjunction with :-
   2012s6142-101 - Option 2 Gravity Outfall at Arbuthnott Place/ High Street
   2012s6142-102 - Option 3 Pumping Station at Arbuthnott Court
   2012s6142-103 - Option 4 Pumping Station at Arbuthnott Place/ High Street

Legend

- Existing Ground Profile
- New Drain
- New Concete Drainage Channel 1200(W)x750(D)

Services

- Surface Water Sewer
- Combined Sewer
- Foul Sewer
- Natural Water
- Rising Main
- BT Overhead
- BT Underground
- Gas
- Electricity 1kv Underground
- Electricity 11kv Underground

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Storage Removed, dwg relabelled	07/01/13	KM	MON	SF	SF

JBA consulting
Port Neuk
1 Longcraig Road
South Queensferry
EDINBURGH
EH30 9TD
United Kingdom
www.jbaconsulting.com
t +44 (0)131 3192940
f +44 (0)845 8627772
e info@jbaconsulting.com
Offices at Atherstone, Doncaster, Edinburgh, Haywards Heath, Limerick, Newcastle upon Tyne, Newport, Saltaire, Skipton, Tadcaster, Thirsk, Wallingford and Warrington

for

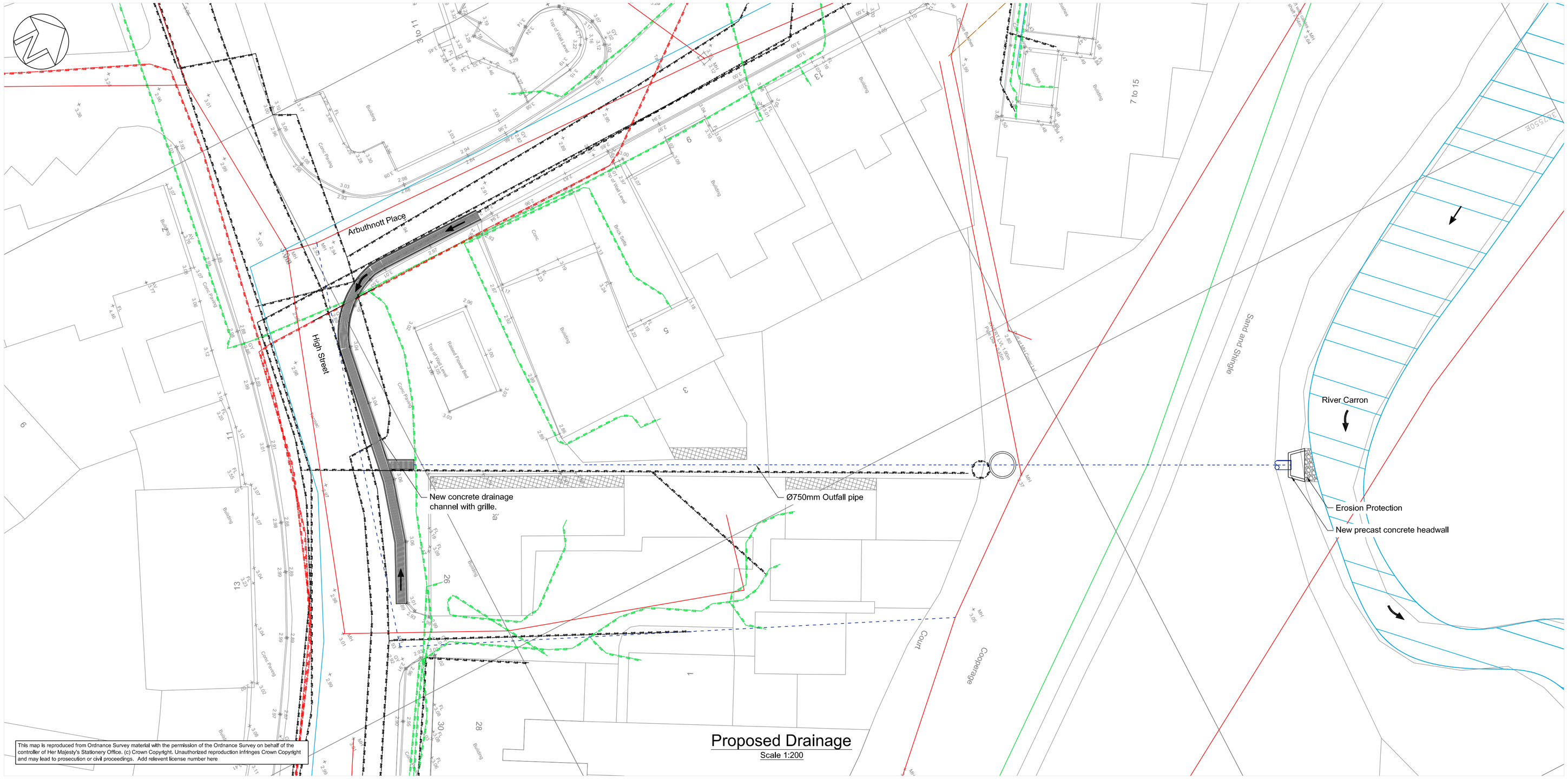
Aberdeenshire Council

Arbuthnott Drain Improvements
Stonehaven
Option 1a - Gravity Outfall at Arbuthnott Court

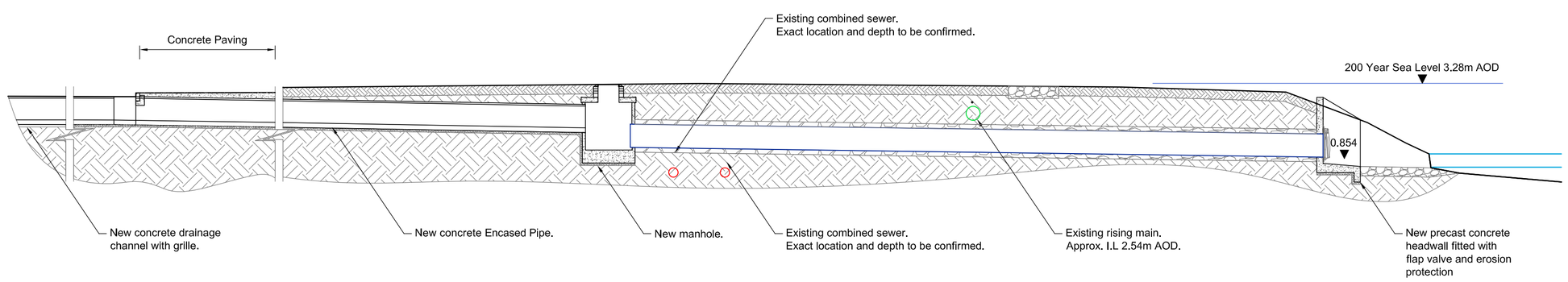
Scale: As Shown @ A1	Drawn:	K. Morris 26/10/12
	Designed:	M.O'Neil 25/10/12
	Checked:	S.Farrar 05/11/12
	Approved:	D. Bassett 09/01/13

Digital File Name: 2012s6142-100 - Option 1a Gravity Outfall Arbuthnott Court.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
2012s6142-100	A		Draft



Proposed Drainage
Scale 1:200



Long Section Through Proposed Drainage
Scale 1:100

General Notes

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8. Ground profile shown from building 1-6 Arbuthnott Place to watercourse is indicative only as it was not part of survey specification at time of survey.
9. Drawing to be read in conjunction with :-
   2012s6142-100 - Option 1 Gravity Outfall at Arbuthnott Court
   2012s6142-102 - Option 3 Pumping Station at Arbuthnott Court
   2012s6142-103 - Option 4 Pumping Station at Arbuthnott Place/ High Street

Legend

- Existing Ground Profile
- New Drain
- New Concete Drainage Channel 1200(W)x750(D)
- Areas potentially requiring underpinning

Services

- Surface Water Sewer
- Combined Sewer
- Foul Sewer
- Natural Water
- Rising Main
- BT Overhead
- BT Underground
- Gas
- Electricity 1kv Underground
- Electricity 11kv Underground

Rev.	Modifications	Date	Drawn	Desligned	Checked	Approved
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JBA consulting
Port Neuk
1 Longcraig Road
South Queensferry
EDINBURGH
EH30 9TD
United Kingdom
www.jbaconsulting.com
t +44 (0)131 3192940
f +44 (0)845 8627772
e info@jbaconsulting.com
Offices at Atherstone, Doncaster, Edinburgh, Haywards Heath, Limerick, Newcastle upon Tyne, Newport, Saltaire, Skipton, Tadcaster, Thirsk, Wallingford and Warrington

for

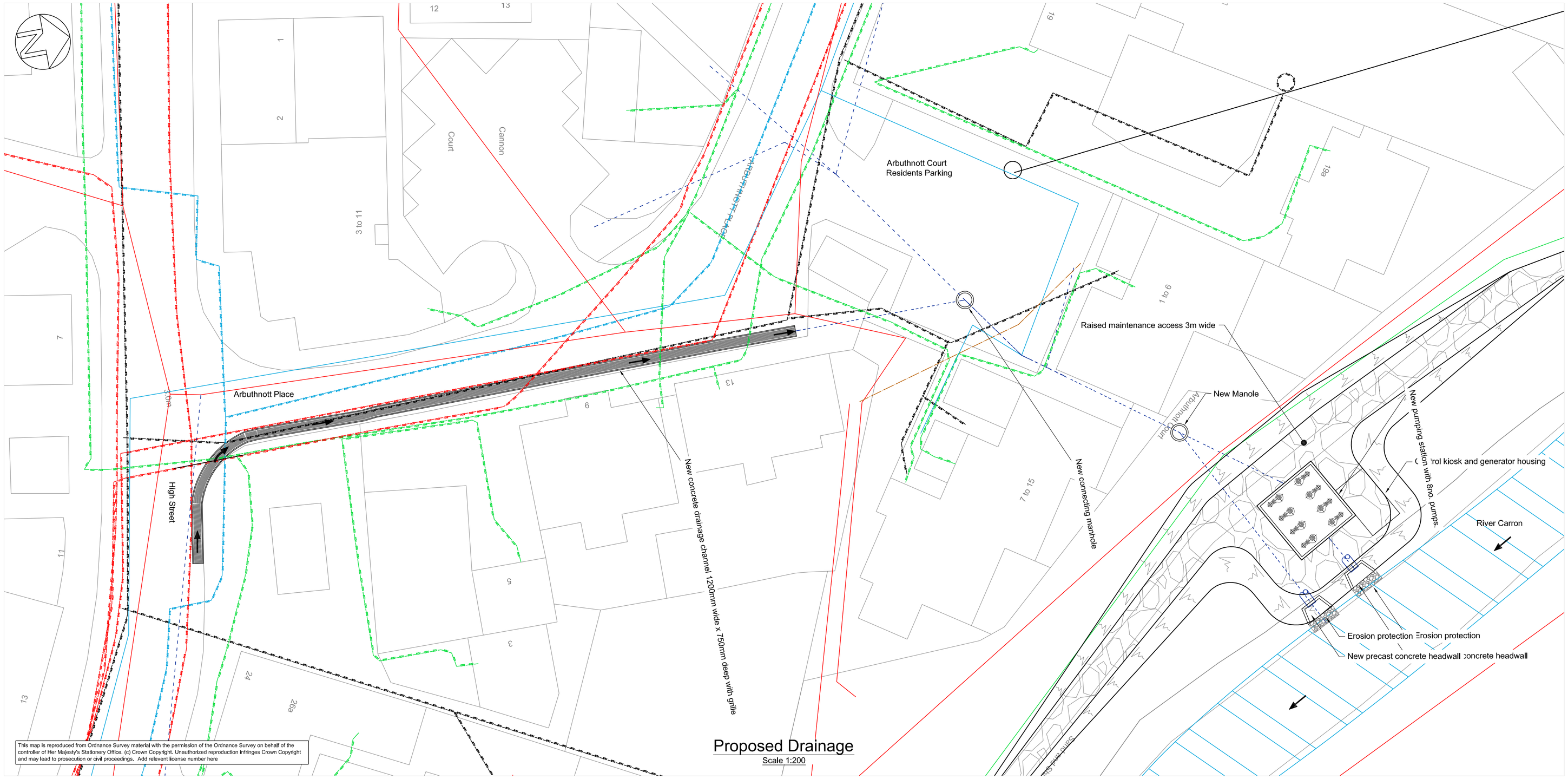
Aberdeenshire Council

Arbuthnott Drain Improvements
Stonehaven
Option 1b - Gravity Outfall at Arbuthnott Place/ High Street

Scale: As Shown @ A1	Drawn:	K. Morris	26/10/12
	Designed:	M.O'Neil	25/10/12
	Checked:	S.Farrar	05/11/12
	Approved:	D. Bassett	09/01/13

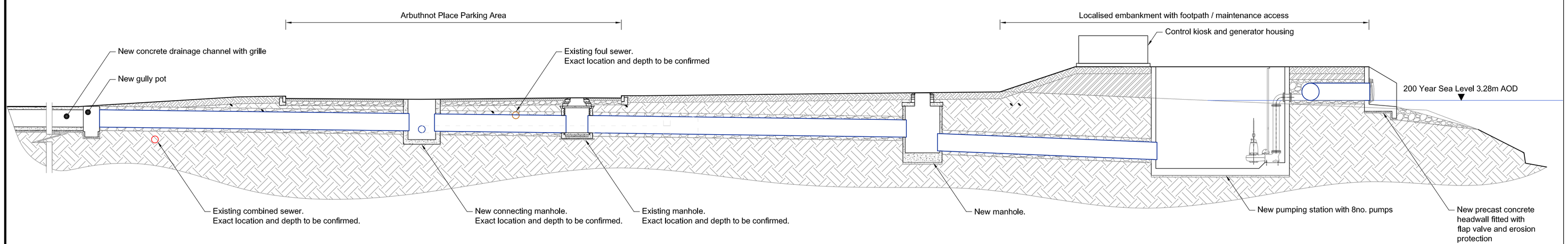
Digital File Name: 2012s6142-101- Option 1b Gravity Outfall Arbuthnott Place/ High Street

Drawing Number:	Rev.:	Sheet No.:	Status:
2012s6142-101	A		Draft



Proposed Drainage

Scale 1:200



Long Section Through Proposed Drainage

Scale 1:100

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   2012s6142-102 - Option 3 Pumping Station at Arbuthnott Court
   2012s6142-103 - Option 4 Pumping Station at Arbuthnott Place/ High Street

Legend

- Existing Ground Profile
- New Drain
- New Concete Drainage Channel 1200(W)x750(D)

Services

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- Combined Sewer
- Foul Sewer
- Natural Water
- Rising Main
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Rev.	Modifications	Date	Drawn	Designed	Checked	Approved

JBA consulting

Port Neuk
1 Longcraig Road
South Queensferry
EDINBURGH
EH30 9TD
United Kingdom

www.jbaconsulting.com

t +44 (0)131 3192940
f +44 (0)845 8627772
e info@jbaconsulting.com

Offices at Atherstone, Doncaster, Edinburgh, Haywards Heath, Limerick, Newcastle upon Tyne, Newport, Saltaire, Skipton, Tadcaster, Thirsk, Wallingford and Warrington

for

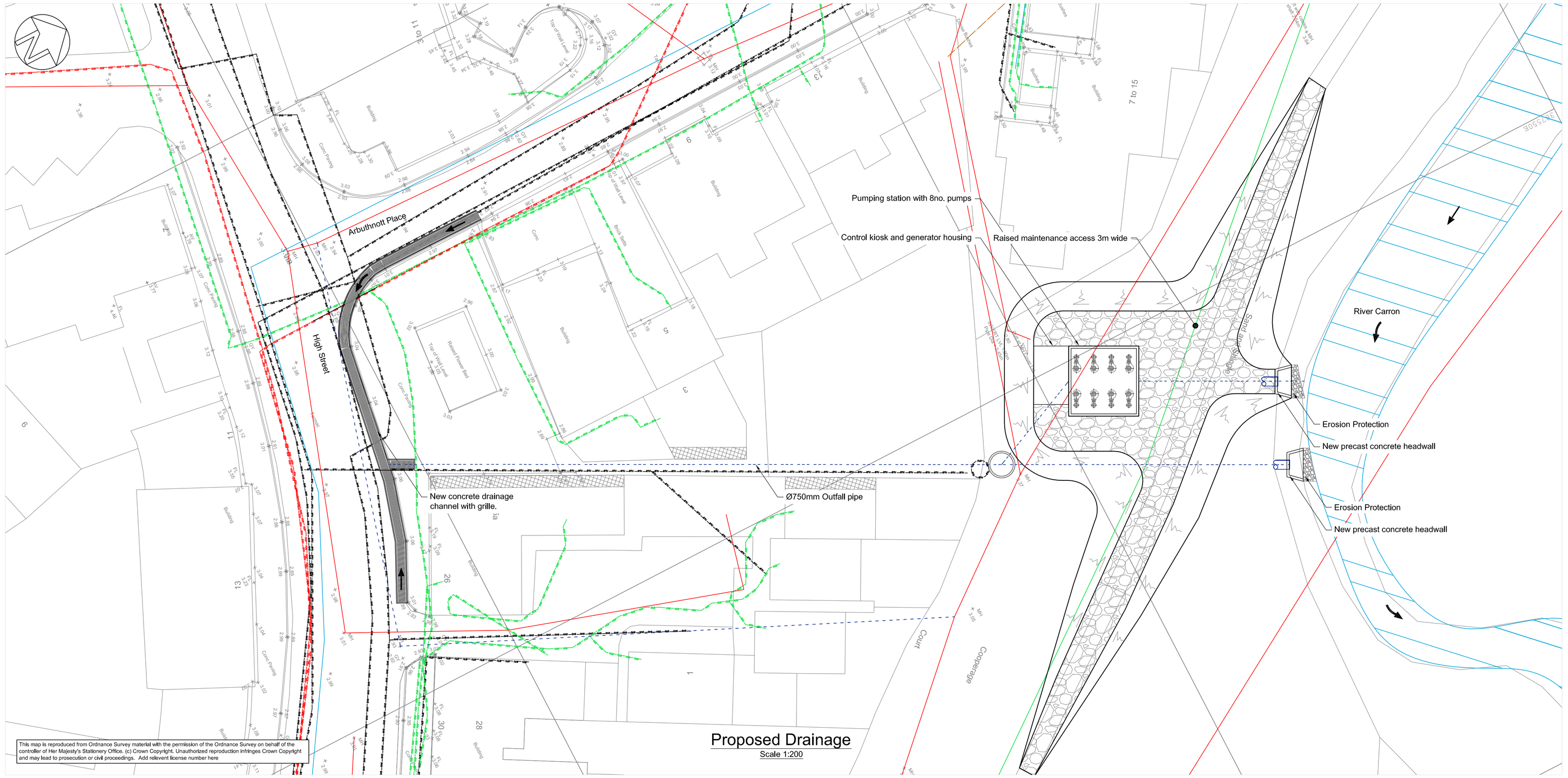
Aberdeenshire Council

Arbuthnott Drain Improvements
Stonehaven
Option 2a - Pumping Station at Arbuthnott Court

Scale: As Shown @ A1	Drawn:	K. Morris	07/01/13
	Designed:	M.O'Neill	07/01/13
	Checked:	S.Farrar	07/01/13
	Approved:	D. Bassett	09/01/13

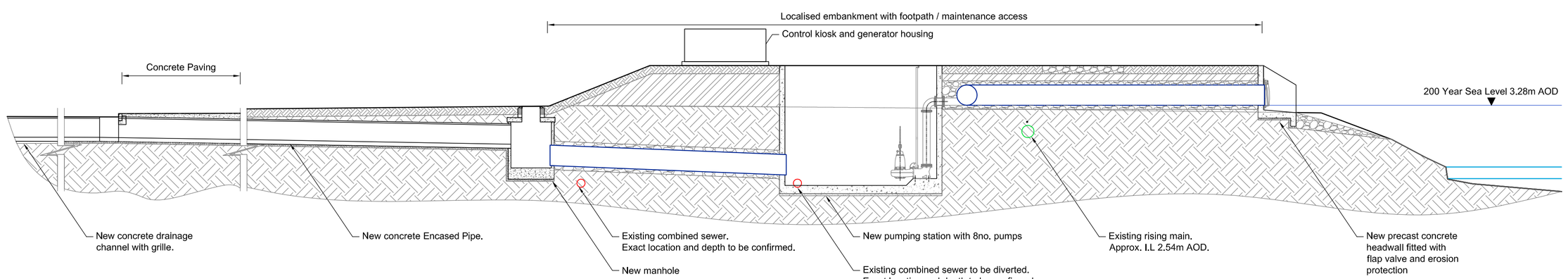
Digital File Name: 2012s6142-200 - Option 2a Pumping Station Arbuthnott Court.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
2012s6142-200			Draft



Proposed Drainage

Scale 1:200



Long Section Through Proposed Drainage

Scale 1:100

General Notes

1. All dimensions shown are in metres unless otherwise stated and levels in metres to Ordnance Datum.
2. Do not scale from this drawing. All dimensions must be checked/verified on site - if in doubt ask.
3. Any discrepancies noted on site are to be reported to the Engineer immediately.
4. Survey undertaken by JBA Consulting on 15th & 16th August 2012
5. Service information supplied by Aberdeenshire Council 12th July 2012.
6. Service information shown is indicative only and not exhaustive. Service locations should be confirmed on site prior to the commencement of works.
7. Position of existing surface water outfall is indicative, as location could not be found by surveyor at time of survey.
8. Ground profile shown from building 1-6 Arbuthnott Place to watercourse is indicative only as it was not part of survey specification at time of survey.
9. Drawing to be read in conjunction with :-
   2012s6142-100 - Option 1 Gravity Outfall at Arbuthnott Court
   2012s6142-102 - Option 3 Pumping Station at Arbuthnott Court
   2012s6142-103 - Option 4 Pumping Station at Arbuthnott Place/ High Street

Legend

- Existing Ground Profile
- New Drain
- New Concete Drainage Channel 1200(W)x750(D)
- Areas potentially requiring underpinning

Services

- Surface Water Sewer
- Combined Sewer
- Foul Sewer
- Natural Water
- Rising Main
- BT Overhead
- BT Underground
- Gas
- Electricity 1kv Underground
- Electricity 11kv Underground

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved

JBA consulting
Port Neuk
1 Longcraig Road
South Queensferry
EDINBURGH
EH30 9TD
United Kingdom
www.jbaconsulting.com
t +44 (0)131 3192940
f +44 (0)845 8627772
e info@jbaconsulting.com
Offices at Atherstone, Doncaster, Edinburgh, Haywards Heath, Limerick, Newcastle upon Tyne, Newport, Saltaire, Skipton, Tadcaster, Thirsk, Wallingford and Warrington

for

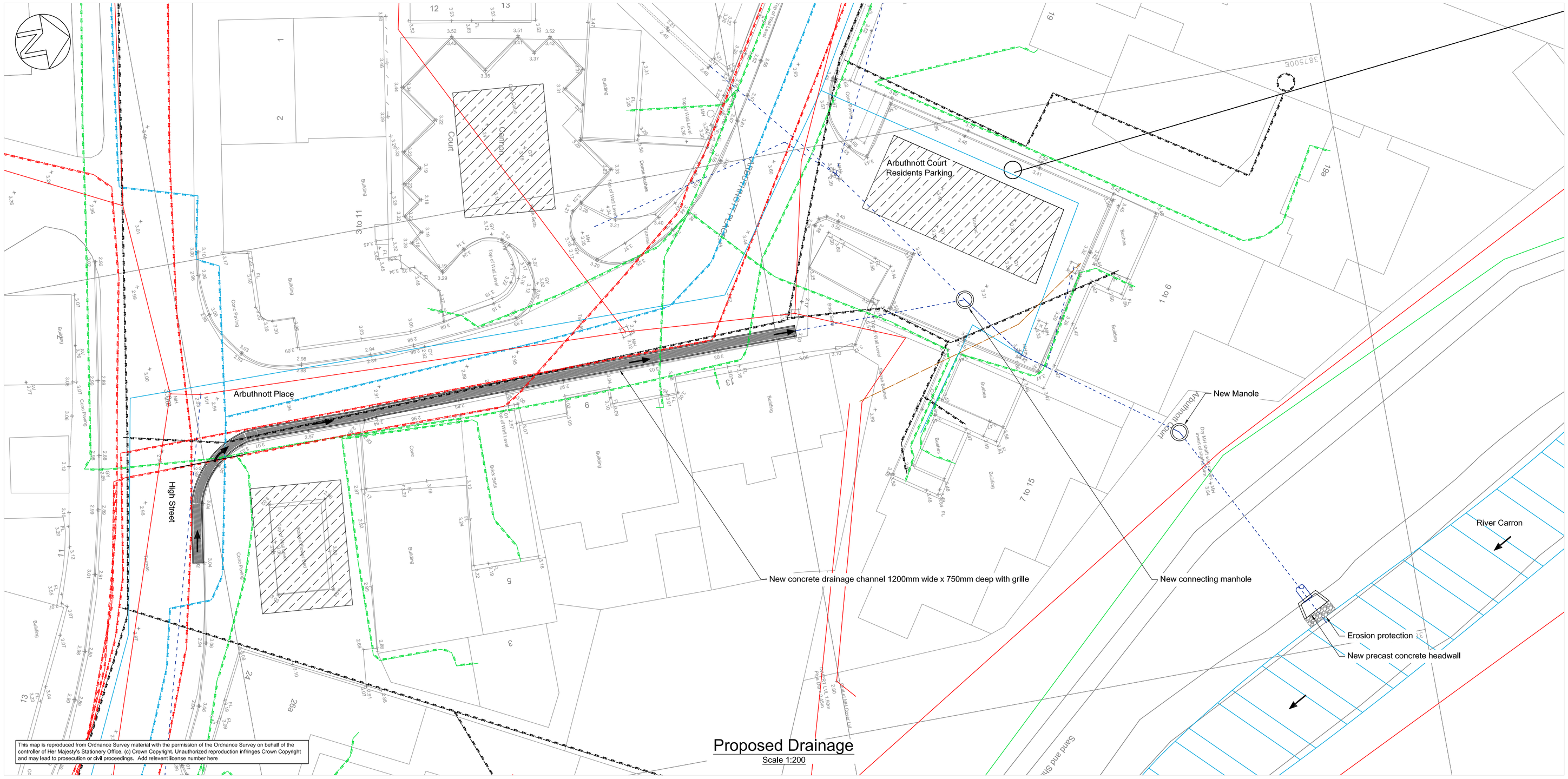
Aberdeenshire Council

Arbuthnott Drain Improvements
Stonehaven
Option 2b- Pumping Station at Arbuthnott Place/ High Street

Scale: As Shown @ A1	Drawn:	K. Morris	07/01/13
	Designed:	M.O'Neil	07/01/13
	Checked:	S.Farrar	07/01/13
	Approved:	D.Bassett	09/01/13

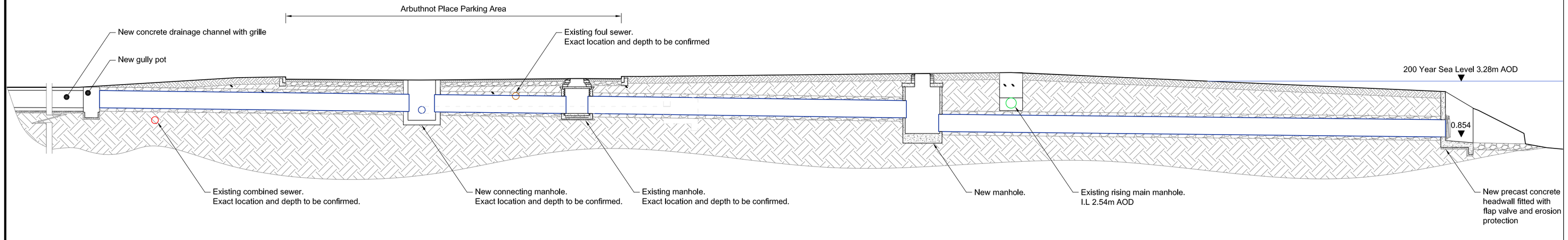
Digital File Name: 2012s6142-201- Option 2b Pumping Station Arbuthnott Place/ High Street

Drawing Number:	Rev.:	Sheet No.:	Status:
2012s6142-201			Draft



Proposed Drainage

Scale 1:200



Long Section Through Proposed Drainage

Scale 1:100

General Notes

1. All dimensions shown are in metres unless otherwise stated and levels in metres to Ordnance Datum.
2. Do not scale from this drawing. All dimensions must be checked/verified on site - if in doubt ask.
3. Any discrepancies noted on site are to be reported to the Engineer immediately.
4. Survey undertaken by JBA Consulting on 15th & 16th August 2012
5. Service information supplied by Aberdeenshire Council 12th July 2012.
6. Service information shown is indicative only and not exhaustive. Service locations should be confirmed on site prior to the commencement of works.
7. Position of existing surface water outfall is indicative, as location could not be found by surveyor at time of survey.
8. Ground profile shown from building 1-6 Arbuthnott Place to watercourse is indicative only as it was not part of survey specification at time of survey.
9. Drawing to be read in conjunction with :-
   2012s6142-101 - Option 2 Gravity Outfall at Arbuthnott Place/ High Street
   2012s6142-102 - Option 3 Pumping Station at Arbuthnott Court
   2012s6142-103 - Option 4 Pumping Station at Arbuthnott Place/ High Street

Legend

- Existing Ground Profile
- New Drain
- New Concete Drainage Channel 1200(W)x750(D)
- Potential Storage Areas / Sites for pumping station

Services

- Surface Water Sewer
- Combined Sewer
- Foul Sewer
- Natural Water
- Rising Main
- BT Overhead
- BT Underground
- Gas
- Electricity 1kv Underground
- Electricity 11kv Underground

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved

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Port Neuk
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South Queensferry
EDINBURGH
EH30 9TD
United Kingdom

www.jbaconsulting.com

t +44 (0)131 3192940
f +44 (0)845 8627772
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for

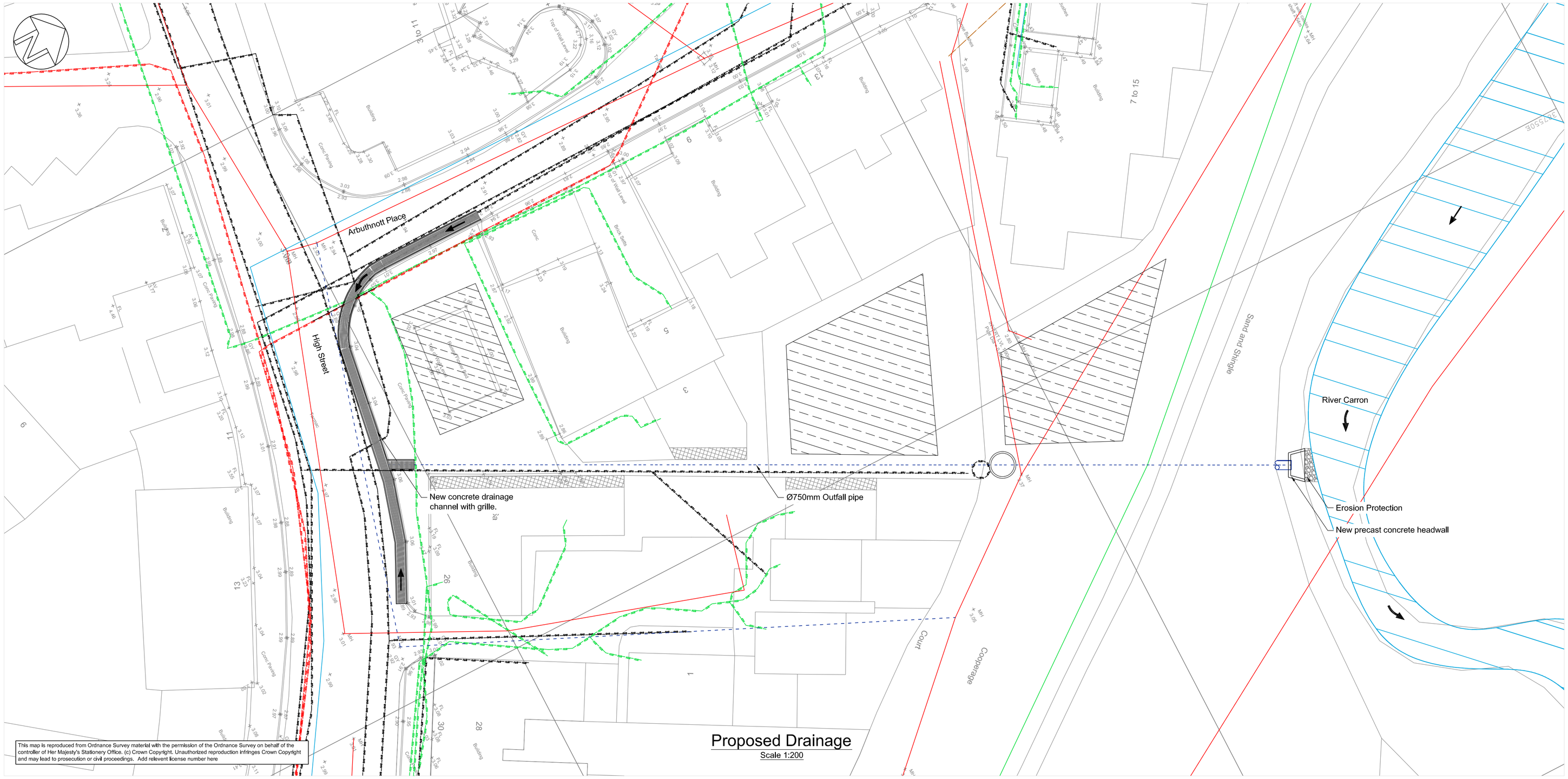
Aberdeenshire Council

Arbuthnott Drain Improvements
Stonehaven
Option 3a - Gravity Outfall with Storage at Arbuthnott Court

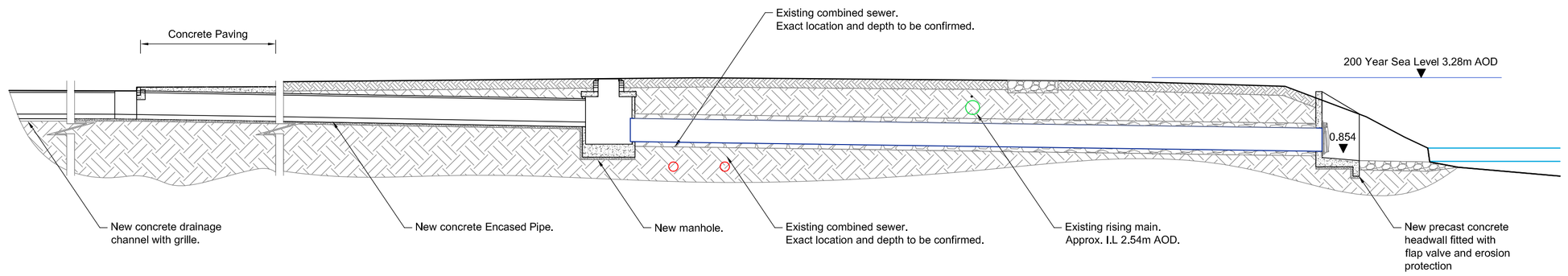
Scale: As Shown @ A1	Drawn:	K. Morris	07/01/13
	Designed:	M.O'Neil	07/01/13
	Checked:	S.Farrar	07/01/13
	Approved:	D. Bassett	09/01/13

Digital File Name: 2012s6142-300 - Option 3a Gravity Outfall Arbuthnott Court.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
2012s6142-300			Draft



Proposed Drainage
Scale 1:200



Long Section Through Proposed Drainage
Scale 1:100

General Notes

1. All dimensions shown are in metres unless otherwise stated and levels in metres to Ordnance Datum.
2. Do not scale from this drawing. All dimensions must be checked/verified on site - if in doubt ask.
3. Any discrepancies noted on site are to be reported to the Engineer immediately.
4. Survey undertaken by JBA Consulting on 15th & 16th August 2012
5. Service information supplied by Aberdeenshire Council 12th July 2012.
6. Service information shown is indicative only and not exhaustive. Service locations should be confirmed on site prior to the commencement of works.
7. Position of existing surface water outfall is indicative, as location could not be found by surveyor at time of survey.
8. Ground profile shown from building 1-6 Arbuthnott Place to watercourse is indicative only as it was not part of survey specification at time of survey.
9. Drawing to be read in conjunction with :-
   2012s6142-100 - Option 1 Gravity Outfall at Arbuthnott Court
   2012s6142-102 - Option 3 Pumping Station at Arbuthnott Court
   2012s6142-103 - Option 4 Pumping Station at Arbuthnott Place/ High Street

Legend

- Existing Ground Profile
- New Drain
- Potential Storage Areas / Pumping station site
- New Concete Drainage Channel 1200(W)x750(D)
- Areas potentially requiring underpinning

Services

- Surface Water Sewer
- Combined Sewer
- Foul Sewer
- Natural Water
- Rising Main
- BT Overhead
- BT Underground
- Gas
- Electricity 1kv Underground
- Electricity 11kv Underground

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved

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for

Aberdeenshire Council

Arbuthnott Drain Improvements
Stonehaven
Option 3b - Gravity Outfall with Storage Arbuthnott Place/ High St

Scale: As Shown @ A1	Drawn:	K. Morris	07/01/13
	Designed:	M.O'Neil	07/01/13
	Checked:	S.Farrar	07/01/13
	Approved:	D.Bassett	09/01/13

Digital File Name: 2012s6142-301- Option 3b Gravity Outfall Arbuthnott Place/ High St

Drawing Number:	Rev.:	Sheet No.:	Status:
2012s6142-301			Draft

B Appendix - Costs

Arbuthnott Drain Improvements
Option 1a - Gravity Outfall Arbuthnott Drain

Cost Plan

Author:	SJF	Date:	18/09/2012
Checked:		Date:	
Approved:		Date:	

Project No:	2012s6142
Status:	Outline
Rev:	0

Project Code	2012s6142					
Project Title	Gravity Outfall - Arbuthnott Drain					
Client	Aberdeenshire Council					

Ref	Extra	Description	Unit	Quantity	Rate	Amount
Class A		**GENERAL ITEMS**				
		Contractual Requirements				
A120		Insurance of the Works	sum	1.00	£750.00	£1,000.00
A130		Third Party Insurance	sum	1.00	£250.00	£500.00
		Testing of the Works				
A260		Water test of pump and discharge chambers to meet requirements of speification clause 7.5 for 1m head of water above crown.	sum	1.00	£500.00	£500.00
		Temporary Works				
A279		Closure and reopening of pavement & associated roadway	sum	1.00	£200.00	£200.00
A272.1		Establishment and removal of signage to identify footpath as closed (except for access).	sum	1.00	£200.00	£200.00
A272.2		Maintenance of signage to identify footpath as closed.	wk	4.00	£5.00	£20.00
A279.1		Establishment and removal of high visibility fencing around areas of construction.	m	400.00	£15.00	£6,000.00
A279.2		Maintenance of temporary fence in Item A279.1	wk	4.00	£10.00	£40.00
A2710.1		Erection and removal of scheme sign board	sum	1.00	£300.00	£300.00
A2710.1		Maintenance of scheme sign board	wk	4.00	£2.00	£8.00
		Method Related Charges				
		The tenderer may insert items of Method Related Charges to cover items of work relating to the intended methods of executing the works				
		Itemisation shall follow the order of classification and other requirements set out in CESMM, showing fixed or time related charges. Items may be inserted to cover works other than those set out in CESMM				

		Each item shall be fully described to define precisely the extent of work covered and to identify the resources to be used and the items of permanent or temporary works, if any, to which the item relates.				
		Temporary Accommodation and Buildings				
A314		Provision and maintenance of secure container for storage of plant and materials for duration of contract	wk	4.00	£100.00	£400.00
A315		Provision and maintenance of site office/messing area for duration of contract	wk	4.00	£350.00	£1,400.00
A327		Provision and maintenance of Health Safety & Welfare Equipment & Facilities for duration of contract	wk	4.00	£350.00	£1,400.00
		Services				
A322		Water supply for duration of contract	sum	1.00	£100.00	£100.00
A339		Provision of Road Cleaning equipment	hrs	60.00	£10.00	£600.00
		Plant				
A339		Provision of portable pump and hoses for dewatering excavations for duration of contract, to include setting up and dismantling	sum	1.00	£1,500.00	£1,500.00
		Supervision & Labour				
A371		Management & Supervision for duration of Contract: Time-related	sum	1.00	£7,500.00	£7,500.00
A372.1		Administration for the duration of the contract; Time-related	sum	1.00	£7,500.00	£7,500.00
A372.2		Carrying out condition survey of roads, services and adjoining properties prior to start on site and on completion of contract (contractor to make good damage caused by his actions); Fixed	sum	1.00	£1,500.00	£1,500.00
		Provisional Sums				
A42		Provisional Sum for Service Diversions	sum	1.00	£60,000.00	£60,000.00
		On-Site Survey				
A510.1		Contractor to complete post construction topographical survey of the works to confirm as-built levels.	sum	1.00	£600.00	£600.00
					Total for Class A	£91,268.00

Project Code	2012s6142					
Project Title	Gravity Outfall - Arbuthnott Drain					
Client	Aberdeenshire Council					
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class D		**DEMOLITION AND SITE CLEARANCE**				
		General Clearance				
D100		General clearance of site	ha	0.20	£400.00	£80.00
D531		Removal existing Soakaway Chamber	sum	1.00	£250.00	£250.00
					Total for Class D	£330.00

Project Code		2012s6142				
Project Title		Gravity Outfall - Arbuthnott Drain				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class E		**EARTHWORKS**				
E442		Excavation surface and base course of road max depth 450mm	m^3	73	£33.00	£2,409.00
		Excavation Ancillaries				
E531		Disposal of excavated topsoil	m^3	rate only		
E532		Disposal of excavated material other than topsoil rock or artificial Hard Material	m^3	rate only		
E534		Disposal of excavated road surfacing	m^3	73	£20.00	£1,460.00
						£3,869.00

Project Code		2012s6142				
Project Title		Gravity Outfall - Arbuthnott Drain				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class I		**PIPEWORK-PIPES**				
		Pipe from Linear Drainage				
I234		Concrete Pipe 600mm ID in supplied, installed & tested in accordance with 'Sewer's for Scotland' 2nd Ed.	m	14.5	£150.00	£2,175.00
		Outfall Pipe				
I237		Concrete Pipe 900mm ID supplied, installed & tested in accordance with 'Sewer's for Scotland' 2nd Ed.	m	26.9	£190.00	£5,111.00
					Total for Class I	£7,286.00

Project Code	2012s6142					
Project Title	Gravity Outfall - Arbuthnott Drain					
Client	Aberdeenshire Council					
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class J		**PIPEWORK-Fitting And Valves**				
		Outfall Pipe				
J835		Fitting 900mm dia plastic flap valve	nr	1.0	£500.00	£500.00
					Total for Class I	£500.00

Project Code		2012s6142				
Project Title		Gravity Outfall - Arbuthnott Drain				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class K		**PIPEWORK - MANHOLES AND PIPEWORK ANCILLARIES**				
		Connection of Inlet Pipe to Mill Lade				
K152.1		1800mm dia x 2000mm deep Type B manhole to 'Sewers for Scotland' 2nd Ed	nr	1	£3,200.00	£3,200.00
		Connection of outlet Pipe to Mill Lade				
K152.2		1800mm dia x 2000mm deep Type B manhole to 'Sewers for Scotland' 2nd Ed	nr	1	£3,500.00	£3,500.00
		Other Stated Chambers				
K231		Reinforced concrete channel approx 1200mmx900mm, 200mm thick RC walls, 40N/mm^2 concrete with open grating PAM C250 RE70 H3GD or similar approved	m	61.0	£1,400.00	£85,400.00
		Reinstatement				
K742		Breaking up & reinstatement of roads for installation of channels and associated pipework (includes reinstatement of kerbs and strip between road channel)	m	76	£100.00	£7,600.00
		Other Pipework Ancillaries				
		Outlet Haedwall				
K874		Installation precast concrete headwall for 900mm dia pipe and erosion protection	nr	1	£3,500.00	£3,500.00
					Total for Class K	£103,200.00

Project Code		2012s6142				
Project Title		Gravity Outfall - Arbuthnott Drain				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class L		**PIPEWORK - SUPPORT AND PROTECTION, ANCILLARIES TO LAYING AND EXCAVATION**				
		Beds				
L324		150mm deep imported granular material, bore 600-900mm	m	26.9	£3.00	£80.70
L344		150mm thck concrete bed, bore 600-900mm	m	14.5	£10.00	£145.00
		Surrounds				
L524		150mm thick imported granular material, bore 600-900mm	m	26.9	£10.00	£269.00
L544		150mm thck concrete surround, bore 600-900mm	m	14.5	£30.00	£435.00
					Total for Class L	£929.70

Project Code		2012s6142				
Project Title		Gravity Outfall - Arbuthnott Drain				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class R		**Roads & Pavings**				
		Reprofiling road to slope towards drain				
		150mm deep Road Base	m^2	137.0	£50.00	£6,850.00
		100mm deep Base Course	m^2	137.0	£35.00	£4,795.00
		50mm deep wearing course	m^2	137.0	£25.00	£3,425.00
					Total for Class R	£15,070.00

Project Code		2012s6142				
Project Title		Gravity Outfall - Arbuthnott Drain				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
		Survey Prior to Work on Site existing culvert and other pipes affected by the works				
Y13.1		CCTV survey and report as per specification.	m	61	£10.00	£610.00
		Survey after completion of Work on Site on existing culvert and other pipes affected by the works & new pipes				
Y13.2		CCTV survey and report as per specification.	m	90	£10.00	£900.00
					Total for Class	£1,510.00

SECTION		
Class A	General Items	£91,268.00
Class D	Demolition and Site Clearance	£330.00
Class E	Earthworks	£3,869.00
Class I	Pipework-Pipes	£7,286.00
Class J	Pipework-Fittings & Valves	£500.00
Class K	Pipework-Manholes and Pipework Ancillaries	£103,200.00
Class L	Pipework-Supports and protection, ancillaries to laying and excavation	£929.70
Class R	Roads and Pavings	£15,070.00
Class Y	CCTV Survey	£1,510.00
	Total Price of Works	£223,962.70
	Optimism bias at 30%	£67,188.81
	Grand Total	£291,151.51

Note: Costs exclude all professional, statutory fees, project management and site supervision. VAT, legal costs, land aquisition, and compensation costs are also excluded.

Arbuthnott Drain Improvements
Option 1b - Gravity Outfall HighStreet/Arbuthnott Place

Cost Plan

Author:	SJF	Date:	18/09/2012
Checked:		Date:	
Approved:		Date:	

Project No:	2012s6142
Status:	Outline
Rev:	0

Project Code	2012s6142					
Project Title	Gravity Outfall - High Street/ Arbuthnott Place					
Client	Aberdeenshire Council					
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class A		**GENERAL ITEMS**				
		Contractual Requirements				
A120		Insurance of the Works	sum	1.00	£750.00	£1,000.00
A130		Third Party Insurance	sum	1.00	£250.00	£500.00
		Testing of the Works				
A260		Water test of pump and discharge chambers to meet requirements of speification clause 7.5 for 1m head of water above crown.	sum	1.00	£500.00	£500.00
		Temporary Works				
A279		Closure and reopening of pavement & associated roadway	sum	1.00	£200.00	£200.00
A272.1		Establishment and removal of signage to identify footpath as closed (except for access).	sum	1.00	£200.00	£200.00
A272.2		Maintenance of signage to identify footpath as closed.	wk	4.00	£5.00	£20.00
A279.1		Establishment and removal of high visibility fencing around areas of construction.	m	400.00	£15.00	£6,000.00
A279.2		Maintenance of temporary fence in Item A279.1	wk	4.00	£10.00	£40.00
A2710.1		Erection and removal of scheme sign board	sum	1.00	£300.00	£300.00
A2710.1		Maintenance of scheme sign board	wk	4.00	£2.00	£8.00
		Method Related Charges				
		The tenderer may insert items of Method Related Charges to cover items of work relating to the intended methods of executing the works				
		Itemisation shall follow the order of classification and other requirements set out in CESMM, showing fixed or time related charges. Items may be inserted to cover works other than those set out in CESMM				

		Each item shall be fully described to define precisely the extent of work covered and to identify the resources to be used and the items of permanent or temporary works, if any, to which the item relates.				
		Temporary Accommodation and Buildings				
A314		Provision and maintenance of secure container for storage of plant and materials for duration of contract	wk	4.00	£100.00	£400.00
A315		Provision and maintenance of site office/messing area for duration of contract	wk	4.00	£350.00	£1,400.00
A327		Provision and maintenance of Health Safety & Welfare Equipment & Facilities for duration of contract	wk	4.00	£350.00	£1,400.00
		Services				
A322		Water supply for duration of contract	sum	1.00	£100.00	£100.00
A339		Provision of Road Cleaning equipment	hrs	60.00	£10.00	£600.00
		Plant				
A339		Provision of portable pump and hoses for dewatering excavations for duration of contract, to include setting up and dismantling	sum	1.00	£1,500.00	£1,500.00
		Supervision & Labour				
A371		Management & Supervision for duration of Contract: Time-related	sum	1.00	£7,500.00	£7,500.00
A372.1		Administration for the duration of the contract; Time-related	sum	1.00	£7,500.00	£7,500.00
A372.2		Carrying out condition survey of roads, services and adjoining properties prior to start on site and on completion of contract (contractor to make good damage caused by his actions); Fixed	sum	1.00	£1,500.00	£1,500.00
		Provisional Sums				
A42		Provisional Sum for Service Diversions	sum	1.00	£45,000.00	£45,000.00
		On-Site Survey				
A510.1		Contractor to complete post construction topographical survey of the works to confirm as-built levels.	sum	1.00	£600.00	£600.00
					Total for Class A	£76,268.00

Project Code	2012s6142
Project Title	Gravity Outfall - High Street/ Arbuthnott Place
Client	Aberdeenshire Council

Ref	Extra	Description	Unit	Quantity	Rate	Amount
Class D		**DEMOLITION AND SITE CLEARANCE**				
		General Clearance				
D100		General clearance of site	ha	0.20	£3,000.00	£600.00
					Total for Class D	£600.00

Project Code	2012s6142					
Project Title	Gravity Outfall - High Street/ Arbuthnott Place					
Client	Aberdeenshire Council					
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class E		**EXCAVATION**				
		Excavation for Underpinning				
E324		Excavation Below Footings	m3	30.00	£500.00	£15,000.00
					Total for Class D	£15,000.00

Project Code	2012s6142					
Project Title	Gravity Outfall - High Street/ Arbuthnott Place					
Client	Aberdeenshire Council					
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class F		**IN SITU CONCRETE**				
		Provision of Concrete				
F243		Provision C20 Concrete	m^3	30.00	£100.00	£3,000.00
		Placing of Concrete				
F58		Mass concrete underpinning	m^3	30.00	£900.00	£27,000.00
					Total for Class D	£30,000.00

Project Code		2012s6142				
Project Title		Gravity Outfall - High Street/ Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class I		**PIPEWORK-PIPES**				
		Pipe from Linear Drainage				
		Outfall Pipe				
I237		Concrete Pipe 900mm ID supplied, installed & tested in accordance with 'Sewer's for Scotland' 2nd Ed.	m	79.0	£190.00	£15,010.00
					Total for Class I	£15,010.00

Project Code		2012s6142				
Project Title		Gravity Outfall - High Street/ Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class J		**PIPEWORK-Fitting And Valves**				
		Outfall Pipe				
J835		Fitting 900mm dia plastic flap valve	nr	1.0	£500.00	£500.00
					Total for Class I	£500.00

Project Code		2012s6142				
Project Title		Gravity Outfall - High Street/ Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class K		**PIPEWORK - MANHOLES AND PIPEWORK ANCILLARIES**				
		Connection of Inlet Pipe to Mill Lade				
K152.1		1800mm dia x 2000mm deep Type B manhole to 'Sewers for Scotland' 2nd Ed	nr	1	£3,200.00	£3,200.00
		Other Stated Chambers				
K231		Reinforced concrete channel approx 1200mmx900mm, 200mm thick RC walls, 40N/mm^2 concrete with open grating PAM C250 RE70 H3GD or similar approved	m	41.0	£1,400.00	£57,400.00
		Reinstatement				
K742		Breaking up & reinstatement of roads for installation of channels and associated pipework (includes reinstatement of kerbs and strip between road channel)	m	41	£100.00	£4,100.00
		Other Pipework Ancillaries				
		Outlet Haedwall				
K874		Installation precast concrete headwall for 900mm dia pipe and erosion protection	nr	1	£3,500.00	£3,500.00
					Total for Class K	£68,200.00

Project Code		2012s6142				
Project Title		Gravity Outfall - High Street/ Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class L		**PIPEWORK - SUPPORT AND PROTECTION, ANCILLARIES TO LAYING AND EXCAVATION**				
		Beds				
L324		150mm deep imported granular material, bore 600-900mm	m	26.9	£3.00	£80.70
L344		150mm thck concrete bed, bore 600-900mm	m	14.5	£10.00	£145.00
		Surrounds				
L524		150mm thick imported granular material, bore 600-900mm	m	26.9	£10.00	£269.00
L544		150mm thck concrete surround, bore 600-900mm	m	14.5	£30.00	£435.00
					Total for Class L	£929.70

Project Code		2012s6142				
Project Title		Gravity Outfall - High Street/ Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
		Survey Prior to Work on Site existing culvert and other pipes affected by the works				
Y13.1		CCTV survey and report as per specification.	m	61	£10.00	£610.00
		Survey after completion of Work on Site on existing culvert and other pipes affected by the works & new pipes				
Y13.2		CCTV survey and report as per specification.	m	90	£10.00	£900.00
					Total for Class	£1,510.00

SECTION		
Class A	General Items	£76,268.00
Class D	Demolition and Site Clearance	£600.00
Class E	Excavation	£15,000.00
Class F	In-situ Concrete	£30,000.00
Class I	Pipework-Pipes	£15,010.00
Class J	Pipework-Fittings & Valves	£500.00
Class K	Pipework-Manholes and Pipework Ancillaries	£68,200.00
Class L	Pipework-Supports and protection, ancillaries to laying and excavation	£929.70
Class Y	CCTV Survey	£1,510.00
	Total Price of Works	£208,017.70
	Optimism bias at 30%	£62,405.31
	Grand Total	£270,423.01

Note: Costs exclude all professional, statutory fees, project management and site supervision. VAT, legal costs, land aquisition, and compensation costs are also excluded.

Arbuthnott Drain Improvements
Option 2a - Pumping Station Arbuthnott Court

Cost Plan

Author:	SJF	Date:	18/09/2012
Checked:		Date:	
Approved:		Date:	

Project No:	2012s6142
Status:	Outline
Rev:	0

Project Code	2012s6142					
Project Title	Pumping Station - Arbuthnott Court					
Client	Aberdeenshire Council					
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class A		**GENERAL ITEMS**				
		Contractual Requirements				
A120		Insurance of the Works	sum	1.00	£1,500.00	£1,000.00
A130		Third Party Insurance	sum	1.00	£500.00	£500.00
		Testing of the Works				
A260		Water test of pump and discharge chambers to meet requirements of speification clause 7.5 for 1m head of water above crown.	sum	1.00	£3,000.00	£3,000.00
		Temporary Works				
A279		Closure and reopening of pavement & associated roadway	sum	1.00	£200.00	£200.00
A272.1		Establishment and removal of signage to identify footpath as closed (except for access).	sum	1.00	£200.00	£200.00
A272.2		Maintenance of signage to identify footpath as closed.	wk	12.00	£5.00	£60.00
A279.1		Establishment and removal of high visibility fencing around areas of construction.	m	400.00	£15.00	£6,000.00
A279.2		Maintenance of temporary fence in Item A279.1	wk	12.00	£10.00	£120.00
A2710.1		Erection and removal of scheme sign board	sum	1.00	£300.00	£300.00
A2710.1		Maintenance of scheme sign board	wk	12.00	£2.00	£24.00
		Method Related Charges				
		The tenderer may insert items of Method Related Charges to cover items of work relating to the intended methods of executing the works				
		Itemisation shall follow the order of classification and other requirements set out in CESMM, showing fixed or time related charges. Items may be inserted to cover works other than those set out in CESMM				

		Each item shall be fully described to define precisely the extent of work covered and to identify the resources to be used and the items of permanent or temporary works, if any, to which the item relates.				
		Temporary Accommodation and Buildings				
A314		Provision and maintenance of secure container for storage of plant and materials for duration of contract	wk	12.00	£200.00	£2,400.00
A315		Provision and maintenance of site office/messing area for duration of contract	wk	12.00	£700.00	£8,400.00
A327		Provision and maintenance of Health Safety & Welfare Equipment & Facilities for duration of contract	wk	12.00	£700.00	£8,400.00
		Services				
A322		Water supply for duration of contract	sum	1.00	£100.00	£100.00
A339		Provision of Road Cleaning equipment	hrs	440.00	£10.00	£4,400.00
		Plant				
A339		Provision of portable pump and hoses for dewatering excavations for duration of contract, to include setting up and dismantling	sum	1.00	£1,500.00	£1,500.00
		Supervision & Labour				
A371		Management & Supervision for duration of Contract: Time-related	sum	1.00	£25,000.00	£25,000.00
A372.1		Administration for the duration of the contract; Time-related	sum	1.00	£25,000.00	£25,000.00
A372.2		Carrying out condition survey of roads, services and adjoining properties prior to start on site and on completion of contract (contractor to make good damage caused by his actions); Fixed	sum	1.00	£2,500.00	£2,500.00
		Provisional Sums				
A42		Provisional Sum for Service Diversions	sum	1.00	£70,000.00	£70,000.00
		On-Site Survey				
A510.1		Contractor to complete post construction topographical survey of the works to confirm as-built levels.	sum	1.00	£800.00	£800.00
					Total for Class A	£159,904.00

Project Code	2012s6142					
Project Title	Pumping Station - Arbuthnott Court					
Client	Aberdeenshire Council					
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class D		**DEMOLITION AND SITE CLEARANCE**				
		General Clearance				
D100		General clearance of site	ha	0.20	£400.00	£80.00
D531		Removal existing Soakaway Chamber	sum	1.00	£250.00	£250.00
					Total for Class D	£330.00

Project Code		2012s6142				
Project Title		Pumping Station - Arbuthnott Court				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class E		**EARTHWORKS**				
E442		Excavation surface and base course of road max depth 450mm	m^3	73	£66.00	£4,818.00
		Excavation Ancillaries				
E531		Disposal of excavated topsoil	m^3	rate only		
E532		Disposal of excavated material other than topsoil rock or artificial Hard Material	m^3	rate only		
E534		Disposal of excavated road surfacing	m^3	73	£40.00	£2,920.00
		Filling				
E625		Filling to pumping Station to create raised area with imported granular fill	m^3	215	£35.00	£7,525.00
E627		Riprap protection against wave acition with geotextile under layer	m^3	20	£200.00	£4,000.00
						£19,263.00

Project Code		2012s6142				
Project Title		Pumping Station - Arbuthnott Court				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class I		**PIPEWORK-PIPES**				
		Rising Main				
		750mm HDPE Rising Main	m	6.00	£350.00	£2,100.00
		Pipe from Linear Drainage				
I234		Concrete Pipe 600mm ID in supplied, installed & tested in accordance with 'Sewer's for Scotland' 2nd Ed.	m	14.5	£150.00	£2,175.00
		Outfall Pipe				
I237		Concrete Pipe 900mm ID supplied, installed & tested in accordance with 'Sewer's for Scotland' 2nd Ed.	m	26.9	£190.00	£5,111.00
					Total for Class I	£9,386.00

Project Code		2012s6142				
Project Title		Pumping Station - Arbuthnott Court				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class J		**PIPEWORK-Fitting And Valves**				
		Outfall Pipe				
J835		Fitting 900mm dia plastic flap valve	nr	1.0	£500.00	£500.00
		Fittings for pipework				
J322		350mm dia. Double Flanged 90 degree bend	Nr	10	£225.00	£2,250.00
J382		350mm dia. Double Flanged Pipe - 1650mm long	Nr	8	£350.00	£2,800.00
J382		350mm dia.Double Flanged Pipe - 250mm long	Nr	8	£300.00	£2,400.00
J382		350mm dia.Double Flanged Pipe - 544mm long	Nr	8	£300.00	£2,400.00
J323		350mm dia All Flanged radial Tee	Nr	6	£2,000.00	£12,000.00
J383		350mm dia.Double Flanged Pipe -1500mm long	Nr	8	£350.00	£2,800.00
		350-750mm concentric taper	Nr	1	£250.00	£250.00
J323		750 dia. Double Flanged T	Nr	1	£2,500.00	£2,500.00
J383		750mm dia.Double Flanged Pipe - 3000mm long	Nr	4	£450.00	£1,800.00
J383		750mm dia 45 degree bend	Nr	2	£350.00	£700.00
J373		750mm adapter	Nr	1	£1,000.00	£1,000.00
		Valves & Penstocks				
J830		350mm dia. Eurocheck Non-Return Valve	Nr	8	£1,200.00	£9,600.00
J810		350mm dia. Gate Valve	Nr	8	£500.00	£4,000.00
					Total for Class J	£45,000.00

Project Code		2012s6142				
Project Title		Pumping Station - Arbuthnott Court				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class K		**PIPEWORK - MANHOLES AND PIPEWORK ANCILLARIES**				
		Connection of Inlet Pipe to Mill Lade				
K152.1		1800mm dia x 2000mm deep Type B manhole to 'Sewers for Scotland' 2nd Ed	nr	1	£3,200.00	£3,200.00
		Connection of outlet Pipe to Mill Lade				
K152.2		1800mm dia x 2000mm deep Type B manhole to 'Sewers for Scotland' 2nd Ed	nr	1	£3,500.00	£3,500.00
		Other Stated Chambers				
		Collection Chamber				
K231		Reinforced concrete channel approx 1200mmx900mm, 200mm thick RC walls, 40N/mm^2 concrete with open grating PAM C250 RE70 H3GD or similar approved	m	61.0	£1,400.00	£85,400.00
		Pump Chamber				
K235		Reinforced Concrete Chamber approx. 6m x 6m x 3.5m deep	nr	1.0	£90,000.00	£90,000.00
		Reinstatement				
K742		Breaking up & reinstatement of roads for installation of channels and associated pipework (includes reinstatement of kerbs and strip between road channel)	m	76	£100.00	£7,600.00
		Other Pipework Ancillaries				
		Outlet Haedwall				
K874		Installation precast concrete headwall for 900mm dia pipe and erosion protection	nr	2	£3,500.00	£7,000.00
					Total for Class K	£196,700.00

Project Code		2012s6142				
Project Title		Pumping Station - Arbuthnott Court				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class L		**PIPEWORK - SUPPORT AND PROTECTION, ANCILLARIES TO LAYING AND EXCAVATION**				
		Beds				
L324		150mm deep imported granular material, bore 600-900mm	m	26.9	£3.00	£80.70
L344		150mm thck concrete bed, bore 600-900mm	m	14.5	£10.00	£145.00
		Surrounds				
L524		150mm thick imported granular material, bore 600-900mm	m	26.9	£10.00	£269.00
L544		150mm thck concrete surround, bore 600-900mm	m	14.5	£30.00	£435.00
					Total for Class L	£929.70

Project Code		2012s6142				
Project Title		Pumping Station - Arbuthnott Court				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class R		**Roads & Pavings**				
		Reprofiling road to slope towards drain				
		150mm deep Road Base	m^2	137.0	£60.00	£8,220.00
		100mm deep Base Course	m^2	137.0	£50.00	£6,850.00
		50mm deep wearing course	m^2	137.0	£44.00	£6,028.00
		Upgrading Track				
		3m wide track to provide access for maintenance vehicles	m	250.0	£600.00	£150,000.00
					Total for Class R	£171,098.00

Project Code		2012s6142				
Project Title		Pumping Station - Arbuthnott Court				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
		Survey Prior to Work on Site existing culvert and other pipes affected by the works				
Y13.1		CCTV survey and report as per specification.	m	61	£10.00	£610.00
		Survey after completion of Work on Site on existing culvert and other pipes affected by the works & new pipes				
Y13.2		CCTV survey and report as per specification.	m	90	£10.00	£900.00
					Total for Class	£1,510.00

Project Code		2011s5146				
Project Title		Tillicoultry Flood Studies Report				
Client		Clackmannanshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
		Mechanical & Electrical Works				
ME1		Supply of Pumps	sum	1	£70,000.00	£70,000.00
ME2		Witness Tests	sum	1	£2,000.00	£2,000.00
ME3		Supply of Electric Motors (Shaft Driven Pumps Only)	sum	1		
ME4		Pipework and Valves (except the ones shown on the drawings)	sum	1		
ME5		Any Additional Steelwork, Seating Frames etc.	sum	1	£4,000.00	£4,000.00
ME6		Control Cabinet and all Equipment Therein	sum	1	£30,000.00	£30,000.00
ME7		Generator socket/connection box and associated equipment	sum	1	£2,000.00	£2,000.00
ME8		Level Control Equipment	sum	1	£2,500.00	£2,500.00
ME9		Telemetry (Signal, Monitor and Alarm: Level Control, Pumps Operation, Intruder, Flows & Mains Supply, Back Up Battery Switchover)	sum	1	£2,500.00	£2,500.00
ME10		Electric Cabling, Lamps, Lamp Standards etc. (All as shown on the drawings)	sum	1	£12,000.00	£12,000.00
ME11		Lightning Protection	sum	1		
ME12		Spares	sum	1		
ME13		Installation and Commissioning	sum	1		
ME14		Training of Client's staff to operate pumps and systems installed	sum	1	£2,000.00	£2,000.00
ME15		Manuals	sum	1		
ME16		Provision of Service Agreement up to end of defects correction period	sum	1	£3,500.00	£3,500.00
		Other Items				
ME17		Provision 120kVa generator & housing	sum	1	£30,000.00	£30,000.00
					Total for Class	£160,500.00

SECTION		
Class A	General Items	£159,904.00
Class D	Demolition and Site Clearance	£330.00
Class E	Earthworks	£19,263.00
Class I	Pipework-Pipes	£9,386.00
Class J	Pipework-Fittings & Valves	£45,000.00
Class K	Pipework-Manholes and Pipework Ancillaries	£196,700.00
Class L	Pipework-Supports and protection, ancillaries to laying and excavation	£929.70
Class R	Roads and Pavings	£171,098.00
Class Y	CCTV Survey	£1,510.00
Class M&E	Mechanical & Electrical Works	£160,500.00
	Total Price of Works	£764,620.70
	Optimism bias at 30%	£229,386.21
	Grand Total	£994,006.91

Note: Costs exclude all professional, statutory fees, project management and site supervision. Provision of electricity supply, VAT, legal costs, land aquisition, and compensation costs are also excluded.

Arbuthnott Drain Improvements
Option 2b - Pumping Station High Street / Arbuthnott Place

Cost Plan

Author:	SJF	Date:	18/09/2012
Checked:		Date:	
Approved:		Date:	

Project No:	2012s6142
Status:	Outline
Rev:	0

Project Code	2012s6142					
Project Title	Pumping Station - High Street / Arbuthnott Place					
Client	Aberdeenshire Council					

Ref	Extra	Description	Unit	Quantity	Rate	Amount
Class A		**GENERAL ITEMS**				
		Contractual Requirements				
A120		Insurance of the Works	sum	1.00	£1,500.00	£1,000.00
A130		Third Party Insurance	sum	1.00	£500.00	£500.00
		Testing of the Works				
A260		Water test of pump and discharge chambers to meet requirements of speification clause 7.5 for 1m head of water above crown.	sum	1.00	£3,000.00	£3,000.00
		Temporary Works				
A279		Closure and reopening of pavement & associated roadway	sum	1.00	£200.00	£200.00
A272.1		Establishment and removal of signage to identify footpath as closed (except for access).	sum	1.00	£200.00	£200.00
A272.2		Maintenance of signage to identify footpath as closed.	wk	12.00	£5.00	£60.00
A279.1		Establishment and removal of high visibility fencing around areas of construction.	m	400.00	£15.00	£6,000.00
A279.2		Maintenance of temporary fence in Item A279.1	wk	12.00	£10.00	£120.00
A2710.1		Erection and removal of scheme sign board	sum	1.00	£300.00	£300.00
A2710.1		Maintenance of scheme sign board	wk	12.00	£2.00	£24.00
		Method Related Charges				
		The tenderer may insert items of Method Related Charges to cover items of work relating to the intended methods of executing the works				
		Itemisation shall follow the order of classification and other requirements set out in CESMM, showing fixed or time related charges. Items may be inserted to cover works other than those set out in CESMM				

		Each item shall be fully described to define precisely the extent of work covered and to identify the resources to be used and the items of permanent or temporary works, if any, to which the item relates.				
		Temporary Accommodation and Buildings				
A314		Provision and maintenance of secure container for storage of plant and materials for duration of contract	wk	12.00	£200.00	£2,400.00
A315		Provision and maintenance of site office/messing area for duration of contract	wk	12.00	£700.00	£8,400.00
A327		Provision and maintenance of Health Safety & Welfare Equipment & Facilities for duration of contract	wk	12.00	£700.00	£8,400.00
		Services				
A322		Water supply for duration of contract	sum	1.00	£100.00	£100.00
A339		Provision of Road Cleaning equipment	hrs	440.00	£10.00	£4,400.00
		Plant				
A339		Provision of portable pump and hoses for dewatering excavations for duration of contract, to include setting up and dismantling	sum	1.00	£1,500.00	£1,500.00
		Supervision & Labour				
A371		Management & Supervision for duration of Contract: Time-related	sum	1.00	£25,000.00	£25,000.00
A372.1		Administration for the duration of the contract; Time-related	sum	1.00	£25,000.00	£25,000.00
A372.2		Carrying out condition survey of roads, services and adjoining properties prior to start on site and on completion of contract (contractor to make good damage caused by his actions); Fixed	sum	1.00	£2,500.00	£2,500.00
		Provisional Sums				
A42		Provisional Sum for Service Diversions	sum	1.00	£50,000.00	£50,000.00
		On-Site Survey				
A510.1		Contractor to complete post construction topographical survey of the works to confirm as-built levels.	sum	1.00	£800.00	£800.00
					Total for Class A	£139,904.00

Project Code	2012s6142
Project Title	Pumping Station - High Street / Arbuthnott Place
Client	Aberdeenshire Council

Ref	Extra	Description	Unit	Quantity	Rate	Amount
Class D		**DEMOLITION AND SITE CLEARANCE**				
		General Clearance				
D100		General clearance of site	ha	0.20	£3,000.00	£600.00
					Total for Class D	£600.00

Project Code	2012s6142					
Project Title	Pumping Station - High Street / Arbuthnott Place					
Client	Aberdeenshire Council					
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class E		**EXCAVATION**				
		Excavation for Underpinning				
E324		Excavation Below Footings	m3	30.00	£500.00	£15,000.00
		Filling				
E625		Filling to pumping Station to create raised area with imported granular fill	m^3	215	£35.00	£7,525.00
E627		Riprap protection against wave acition with geotextile under layer	m^3	20	£200.00	£4,000.00
					Total for Class D	£26,525.00

Project Code	2012s6142
Project Title	Pumping Station - High Street / Arbuthnott Place
Client	Aberdeenshire Council

Ref	Extra	Description	Unit	Quantity	Rate	Amount
Class F		**IN SITU CONCRETE**				
		Provision of Concrete				
F243		Provision C20 Concrete	m^3	30.00	£100.00	£3,000.00
		Placing of Concrete				
F58		Mass concrete underpinning	m^3	30.00	£900.00	£27,000.00
					Total for Class D	£30,000.00

Project Code		2012s6142				
Project Title		Pumping Station - High Street / Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class I		**PIPEWORK-PIPES**				
		Pipe from Linear Drainage				
		Rising Main				
		750mm HDPE Rising Main	m	16.00	£350.00	£5,600.00
		Outfall Pipe				
I237		Concrete Pipe 900mm ID supplied, installed & tested in accordance with 'Sewer's for Scotland' 2nd Ed.	m	79.0	£190.00	£15,010.00
					Total for Class I	£20,610.00

Project Code	2012s6142					
Project Title	Pumping Station - High Street / Arbuthnott Place					
Client	Aberdeenshire Council					
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class J		**PIPEWORK-Fitting And Valves**				
		Outfall Pipe				
J835		Fitting 900mm dia plastic flap valve	nr	1.0	£500.00	£500.00
		Fittings for pipework				
J322		350mm dia. Double Flanged 90 degree bend	Nr	10	£225.00	£2,250.00
J382		350mm dia. Double Flanged Pipe - 1650mm long	Nr	8	£350.00	£2,800.00
J382		350mm dia.Double Flanged Pipe - 250mm long	Nr	8	£300.00	£2,400.00
J382		350mm dia.Double Flanged Pipe - 544mm long	Nr	8	£300.00	£2,400.00
J323		350mm dia All Flanged radial Tee	Nr	6	£2,000.00	£12,000.00
J383		350mm dia.Double Flanged Pipe -1500mm long	Nr	8	£350.00	£2,800.00
		350-750mm concentric taper	Nr	1	£250.00	£250.00
J323		750 dia. Double Flanged T	Nr	1	£2,500.00	£2,500.00
J383		750mm dia.Double Flanged Pipe - 3000mm long	Nr	4	£450.00	£1,800.00
J383		750mm dia 45 degree bend	Nr	2	£350.00	£700.00
J373		750mm adapter	Nr	1	£1,000.00	£1,000.00
		Valves & Penstocks				
J830		350mm dia. Eurocheck Non-Return Valve	Nr	8	£1,200.00	£9,600.00
J810		350mm dia. Gate Valve	Nr	8	£500.00	£4,000.00
					Total for Class I	£45,000.00

Project Code		2012s6142				
Project Title		Pumping Station - High Street / Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class K		**PIPEWORK - MANHOLES AND PIPEWORK ANCILLARIES**				
		Connection of Inlet Pipe to Pumping Station				
K152.1		1800mm dia x 2000mm deep Type B manhole to 'Sewers for Scotland' 2nd Ed	nr	1	£3,200.00	£3,200.00
		Other Stated Chambers				
K231		Reinforced concrete channel approx 1200mmx900mm, 200mm thick RC walls, 40N/mm^2 concrete with open grating PAM C250 RE70 H3GD or similar approved	m	41.0	£1,400.00	£57,400.00
		Pump Chamber				
K235		Reinforced Concrete Chamber approx. 6m x 6m x 3.5m deep	nr	1.0	£90,000.00	£90,000.00
		Reinstatement				
K742		Breaking up & reinstatement of roads for installation of channels and associated pipework (includes reinstatement of kerbs and strip between road channel)	m	41	£100.00	£4,100.00
		Other Pipework Ancillaries				
		Outlet Haedwall				
K874		Installation precast concrete headwall for 900mm dia pipe and erosion protection	nr	2	£3,500.00	£7,000.00
					Total for Class K	£161,700.00

Project Code		2012s6142				
Project Title		Pumping Station - High Street / Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class L		**PIPEWORK - SUPPORT AND PROTECTION, ANCILLARIES TO LAYING AND EXCAVATION**				
		Beds				
L324		150mm deep imported granular material, bore 600-900mm	m	26.9	£3.00	£80.70
L344		150mm thck concrete bed, bore 600-900mm	m	14.5	£10.00	£145.00
		Surrounds				
L524		150mm thick imported granular material, bore 600-900mm	m	26.9	£10.00	£269.00
L544		150mm thck concrete surround, bore 600-900mm	m	14.5	£30.00	£435.00
					Total for Class L	£929.70

Project Code		2012s6142				
Project Title		Pumping Station - Arbuthnott Court				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
Class R		**Roads & Pavings**				
		Upgrading Track				
		3m wide track to provide access for maintenance vehicles	m	220.0	£600.00	£132,000.00
					Total for Class R	£132,000.00

Project Code		2012s6142				
Project Title		Pumping Station - High Street / Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
		Survey Prior to Work on Site existing culvert and other pipes affected by the works				
Y13.1		CCTV survey and report as per specification.	m	61	£10.00	£610.00
		Survey after completion of Work on Site on existing culvert and other pipes affected by the works & new pipes				
Y13.2		CCTV survey and report as per specification.	m	90	£10.00	£900.00
					Total for Class	£1,510.00

Project Code		2012s6142				
Project Title		Pumping Station - High Street / Arbuthnott Place				
Client		Aberdeenshire Council				
Ref	**Extra**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
		Mechanical & Electrical Works				
ME1		Supply of Pumps	sum	1	£70,000.00	£70,000.00
ME2		Witness Tests	sum	1	£2,000.00	£2,000.00
ME3		Supply of Electric Motors (Shaft Driven Pumps Only)	sum	1		
ME4		Pipework and Valves (except the ones shown on	sum	1		
ME5		Any Additional Steelwork, Seating Frames etc.	sum	1	£4,000.00	£4,000.00
ME6		Control Cabinet and all Equipment Therein	sum	1	£30,000.00	£30,000.00
ME7		Generator socket/connection box and associated equipment	sum	1	£2,000.00	£2,000.00
ME8		Level Control Equipment	sum	1	£2,500.00	£2,500.00
ME9		Telemetry (Signal, Monitor and Alarm: Level Control, Pumps Operation, Intruder, Flows & Mains Supply, Back Up Battery Switchover)	sum	1	£2,500.00	£2,500.00
ME10		Electric Cabling, Lamps, Lamp Standards etc. (All as shown on the drawings)	sum	1	£12,000.00	£12,000.00
ME11		Lightning Protection	sum	1		
ME12		Spares	sum	1		
ME13		Installation and Commissioning	sum	1		
ME14		Training of Client's staff to operate pumps and systems installed	sum	1	£2,000.00	£2,000.00
ME15		Manuals	sum	1		
ME16		Provision of Service Agreement up to end of defects correction period	sum	1	£3,500.00	£3,500.00
		Other Items				
ME17		Provision 120kVa generator & housing	sum	1	£30,000.00	£30,000.00
					Total for Class	£160,500.00

SECTION		
Class A	General Items	£139,904.00
Class D	Demolition and Site Clearance	£600.00
Class E	Excavation	£26,525.00
Class F	In-situ Concrete	£30,000.00
Class I	Pipework-Pipes	£20,610.00
Class J	Pipework-Fittings & Valves	£45,000.00
Class K	Pipework-Manholes and Pipework Ancillaries	£161,700.00
Class L	Pipework-Supports and protection, ancillaries to laying and excavation	£929.70
Class R	Roads and pavings	£132,000.00
Class Y	CCTV Survey	£1,510.00
Class M&E	Mechanical & Electrical Works	£160,500.00
	Total Price of Works	£719,278.70
	Optimism bias at 30%	£215,783.61
	Grand Total	£935,062.31

Note: Costs exclude all professional, statutory fees, project management and site supervision. VAT, legal costs, land aquisition, and compensation costs are also excluded.

C Appendix - Calculations

Existing Network Details for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	57.220	0.100	572.2	0.000	1.00	0.0	0.600	|_|	-3
1.001	14.500	0.130	111.5	0.000	0.00	0.0	0.600	o	500
2.000	35.000	0.409	85.6	0.000	5.00	0.0	0.600	[]	-4
1.002	6.960	0.160	43.5	0.000	0.00	0.0	0.600	[]	-4
1.003	26.900	0.865	31.1	0.000	0.00	0.0	0.600	[]	-4

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
1.000	2.250	0.000	0.0	1.30	624.1
1.001	2.150	0.000	0.0	2.06	403.8
2.000	2.430	0.000	0.0	3.36	2690.0
1.002	2.020	0.000	0.0	4.72	3777.2
1.003	1.865	0.000	0.0	5.59	4469.3

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003		3.640	1.000	1.000	0	0

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm) 200.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status OFF
Inertia Status OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.969	-0.031	69.039	0.11	0.0	128.2	FLOOD
1.001	2	2.952	0.052	52.284	0.11	0.0	135.5	FLOOD
2.000	5	2.955	-0.275	0.000	0.00	0.0	0.2	OK
1.002	3	2.955	0.135	0.000	0.12	0.0	137.5	SURCHARGED
1.003	4	2.976	0.311	0.000	0.05	0.0	137.2	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm)	200.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.884	-0.116	0.000	0.55	0.0	624.0	FLOOD RISK
1.001	2	2.812	-0.088	0.000	0.51	0.0	628.3	FLOOD RISK
2.000	5	2.781	-0.449	0.000	0.00	0.0	0.2	OK
1.002	3	2.781	-0.039	0.000	0.56	0.0	631.5	OK
1.003	4	2.766	0.101	0.000	0.24	0.0	631.8	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm) 200.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status OFF
Inertia Status OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.929	-0.071	29.118	0.20	0.0	234.3	FLOOD
1.001	2	2.914	0.014	14.476	0.19	0.0	229.3	FLOOD
2.000	5	2.903	-0.327	0.000	0.00	0.0	0.3	OK
1.002	3	2.903	0.083	0.000	0.20	0.0	228.9	SURCHARGED
1.003	4	2.895	0.230	0.000	0.09	0.0	228.6	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm)	200.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.901	-0.099	1.110	0.47	0.0	538.2	FLOOD
1.001	2	2.850	-0.050	0.000	0.44	0.0	538.3	FLOOD RISK
2.000	5	2.823	-0.407	0.000	0.00	0.0	0.2	OK
1.002	3	2.823	0.003	0.000	0.47	0.0	538.4	SURCHARGED
1.003	4	2.805	0.140	0.000	0.20	0.0	538.4	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm) 200.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status OFF
Inertia Status OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	3.000	0.000	100.000	0.15	0.0	170.2	FLOOD
1.001	2	2.989	0.089	88.511	0.17	0.0	210.9	FLOOD
2.000	5	2.992	-0.238	0.000	0.00	0.0	0.3	OK
1.002	3	2.991	0.171	0.000	0.19	0.0	217.6	SURCHARGED
1.003	4	3.068	0.403	0.000	0.08	0.0	218.6	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm) 200.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status OFF
Inertia Status OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.984	-0.016	83.649	0.55	0.0	625.8	FLOOD
1.001	2	2.937	0.037	37.311	0.55	0.0	678.5	FLOOD
2.000	5	2.914	-0.316	0.000	0.00	0.0	0.2	OK
1.002	3	2.914	0.094	0.000	0.60	0.0	681.7	SURCHARGED
1.003	4	2.902	0.237	0.000	0.26	0.0	682.4	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm)	200.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	3.003	0.003	103.485	0.76	0.0	874.0	FLOOD
1.001	2	2.947	0.047	46.726	0.72	0.0	893.2	FLOOD
2.000	5	2.905	-0.325	0.000	0.00	0.0	0.3	OK
1.002	3	2.905	0.085	0.000	0.79	0.0	893.6	SURCHARGED
1.003	4	2.869	0.204	0.000	0.34	0.0	892.5	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm) 200.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status OFF
Inertia Status OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	3.064	0.064	164.475	0.21	0.0	244.1	FLOOD
1.001	2	3.051	0.151	151.262	0.24	0.0	294.7	FLOOD
2.000	5	3.041	-0.189	0.000	0.00	0.0	0.3	OK
1.002	3	3.041	0.221	0.000	0.26	0.0	298.5	SURCHARGED
1.003	4	3.034	0.369	0.000	0.11	0.0	298.1	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm)	200.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	3.017	0.017	117.227	0.43	0.0	493.6	FLOOD
1.001	2	2.987	0.087	87.253	0.45	0.0	555.3	FLOOD
2.000	5	2.964	-0.266	0.000	0.00	0.0	0.3	OK
1.002	3	2.965	0.145	0.000	0.49	0.0	558.8	SURCHARGED
1.003	4	2.949	0.284	0.000	0.21	0.0	559.7	SURCHARGED

Time Area Diagram for Storm

Time (mins)	Area (ha)
0-4	0.000

Total Area Contributing (ha) = 0.000

Total Pipe Volume (m^3) = 119.636

Existing Network Details for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	57.220	0.100	572.2	0.000	1.00	0.0	0.600	|_|	-11
1.001	14.500	0.130	111.5	0.000	0.00	0.0	0.600	[]	-12
2.000	35.000	0.409	85.6	0.000	5.00	0.0	0.600	[]	-4
1.002	6.960	0.160	43.5	0.000	0.00	0.0	0.600	[]	-4
1.003	26.900	0.865	31.1	0.000	0.00	0.0	0.600	[]	-4

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
1.000	2.250	0.000	0.0	1.66	1495.1
1.001	2.150	0.000	0.0	3.01	2711.9
2.000	2.430	0.000	0.0	3.36	2690.0
1.002	2.020	0.000	0.0	4.72	3777.2
1.003	1.865	0.000	0.0	5.59	4469.3

Conduit Sections for Storm

NOTE: Diameters less than 66 refer to section numbers of hydraulic conduits. These conduits are marked by the symbols:- [] box culvert, \/ open channel, oo dual pipe, ooo triple pipe, O egg.

Section numbers < 0 are taken from user conduit table

Section Number	Conduit Type	Major Dimn. (mm)	Minor Dimn. (mm)	Side Slope (Deg)	Corner Splay (mm)	4*Hyd Radius (m)	XSect Area (m^2)
-4	[]	1000	800	90.0		0.889	0.800
-11	|_|	1200	750	90.0		1.333	0.900
-12	[]	1200	750	90.0		0.923	0.900

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	2.900	0.650	Open Manhole	1200	1.000	2.250	-11				
2	2.900	0.750	Open Manhole	1200	1.001	2.150	-12	1.000	2.150	-11	
5	3.760	1.330	Open Manhole	1200	2.000	2.430	-4				
3	3.310	1.290	Open Manhole	1200	1.002	2.020	-4	1.001	2.020	-12	
								2.000	2.021	-4	1
4	3.380	1.520	Open Manhole	1200	1.003	1.865	-4	1.002	1.860	-4	
	3.640	2.640	Open Manhole	0		OUTFALL		1.003	1.000	-4	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	|_|	-11	1	2.900	2.250	-0.100	Open Manhole	1200
1.001	[]	-12	2	2.900	2.150	0.000	Open Manhole	1200
2.000	[]	-4	5	3.760	2.430	0.530	Open Manhole	1200
1.002	[]	-4	3	3.310	2.020	0.490	Open Manhole	1200
1.003	[]	-4	4	3.380	1.865	0.715	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	57.220	572.2	2	2.900	2.150	0.000	Open Manhole	1200
1.001	14.500	111.5	3	3.310	2.020	0.540	Open Manhole	1200
2.000	35.000	85.6	3	3.310	2.021	0.489	Open Manhole	1200
1.002	6.960	43.5	4	3.380	1.860	0.720	Open Manhole	1200
1.003	26.900	31.1		3.640	1.000	1.840	Open Manhole	0

Setting Out Information - True Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Layout (North)
1.000	1	1200				
1.001	2	1200				
2.000	5	1200				
1.002	3	1200				
1.003	4	1200				

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
1.003		0				

Setting Out Information - Site Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Layout (North)
1.000	1	1200				
1.001	2	1200				
2.000	5	1200				
1.002	3	1200				
1.003	4	1200				

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
1.003		0				

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003		3.640	1.000	1.000	0	0

Datum (m) 0.000 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
15	-0.590	195	-1.460	375	1.500	555	2.560	735	-0.380	915	-1.970
30	-0.870	210	-1.280	390	1.710	570	2.420	750	-0.730	930	-1.860
45	-1.080	225	-1.080	405	1.910	585	2.270	765	-0.990	945	-1.670
60	-1.280	240	-0.870	420	2.080	600	2.100	780	-1.220	960	-1.470
75	-1.460	255	-0.620	435	2.280	615	1.890	795	-1.490	975	-1.240
90	-1.580	270	-0.390	450	2.410	630	1.680	810	-1.690	990	-1.010
105	-1.670	285	-0.080	465	2.530	645	1.400	825	-1.850	1005	-0.750
120	-1.690	300	0.220	480	2.640	660	1.140	840	-1.960	1020	-0.440
135	-1.770	315	0.520	495	2.700	675	0.890	855	-2.070	1035	-0.140
150	-1.720	330	0.780	510	2.700	690	0.590	870	-2.130		
165	-1.670	345	1.010	525	2.700	705	0.280	885	-2.130		
180	-1.580	360	1.280	540	2.640	720	0.010	900	-2.070		

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	2000
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	5

Number of Input Hydrographs	1	Number of Storage Structures	0
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	200
Site Location	GB 387050 785550 NO 87050 85550
C (1km)	-0.013
D1 (1km)	0.494
D2 (1km)	0.426
D3 (1km)	0.205
E (1km)	0.239
F (1km)	2.178
Summer Storms	Yes
Winter Storms	No
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

Online Controls for Storm

Non Return Valve Manhole: 4, DS/PN: 1.003, Volume (m³): 6.3

Manhole Headloss for Storm

PN	US/MH Name	US/MH Headloss
1.000	1	0.500
1.001	2	0.500
2.000	5	0.500
1.002	3	0.500
1.003	4	0.500

Model Audit of Storm

If the data displayed are due to errors in the DSD file then corrections should be made.

	Pipe Number	USMH Name	Possible surveying or human error !? ?'s	Error Number
1	1.000	1	DS/CL = US/CL	6
2	1.003	4	Negative backdrop in manhole < 100mm	7

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm) 200.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.517	-0.483	0.000	0.08	0.0	88.3	OK
1.001	2	2.504	-0.396	0.000	0.07	0.0	90.4	OK
2.000	5	2.547	-0.683	0.000	0.00	0.0	1.2	OK
1.002	3	2.546	-0.274	0.000	0.08	0.0	93.2	OK
1.003	4	2.724	0.059	0.000	0.04	0.0	117.9	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm) 200.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.691	-0.309	0.000	0.21	0.0	244.4	OK
1.001	2	2.669	-0.231	0.000	0.20	0.0	246.3	OK
2.000	5	2.665	-0.565	0.000	0.00	0.0	0.3	OK
1.002	3	2.665	-0.155	0.000	0.22	0.0	248.5	OK
1.003	4	2.657	-0.008	0.000	0.09	0.0	242.0	OK

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm)	200.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.898	-0.102	0.000	0.08	0.0	88.9	FLOOD RISK
1.001	2	2.895	-0.005	0.000	0.07	0.0	86.7	FLOOD RISK
2.000	5	2.888	-0.342	0.000	0.00	0.0	0.2	OK
1.002	3	2.888	0.068	0.000	0.08	0.0	85.4	SURCHARGED
1.003	4	2.920	0.255	0.000	0.03	0.0	85.0	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm)	200.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.872	-0.128	0.000	0.21	0.0	244.4	FLOOD RISK
1.001	2	2.856	-0.044	0.000	0.20	0.0	243.4	FLOOD RISK
2.000	5	2.844	-0.386	0.000	0.00	0.0	0.2	OK
1.002	3	2.844	0.024	0.000	0.21	0.0	242.8	SURCHARGED
1.003	4	2.836	0.171	0.000	0.09	0.0	242.3	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm)	200.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.861	-0.139	0.000	0.47	0.0	537.0	FLOOD RISK
1.001	2	2.801	-0.099	0.000	0.44	0.0	537.6	FLOOD RISK
2.000	5	2.774	-0.456	0.000	0.00	0.0	0.2	OK
1.002	3	2.774	-0.046	0.000	0.47	0.0	538.0	OK
1.003	4	2.755	0.090	0.000	0.20	0.0	538.3	SURCHARGED

Summary of Results for 30 minute 200 year Summer (Storm)

Margin for Flood Risk Warning (mm) 200.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	2.734	-0.266	0.000	0.59	0.0	882.8	FLOOD RISK
1.001	2	2.476	-0.424	0.000	0.57	0.0	882.8	OK
2.000	5	2.430	-0.800	0.000	0.00	0.0	0.0	OK
1.002	3	2.419	-0.401	0.000	0.78	0.0	882.8	OK
1.003	4	1.709	0.909	0.000	38.25	0.0	873.5	SURCHARGED

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Registered Office
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Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE

t:+44(0)1756 799919
e:info@jbaconsulting.com

Jeremy Benn Associates Ltd
Registered in England 3246693

Visit our website
www.jbaconsulting.com