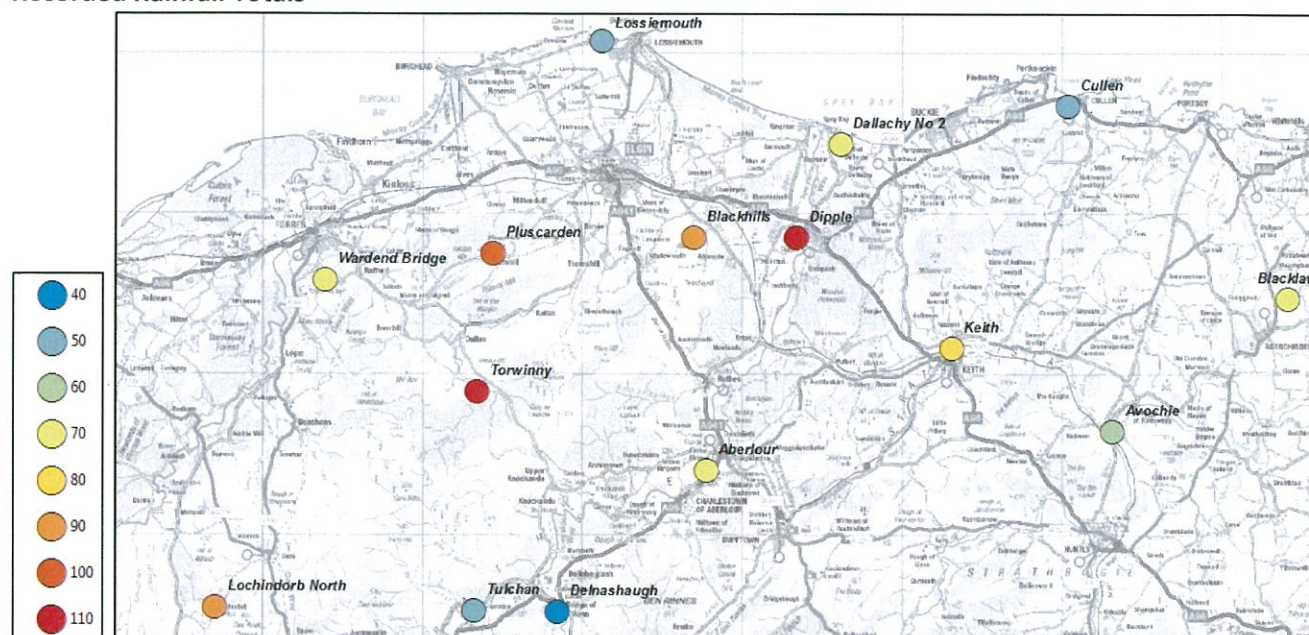


7th June 2017: Flooding in Moray and North Aberdeenshire

A heavy rainfall event on 6th and 7th of June resulted in notable flood flows in catchments across Moray and parts of Aberdeenshire, despite following a prolonged period of dry weather giving extremely dry antecedent conditions.

A significant rainfall event was fairly well forecast in the days leading up to the event. By the morning of 6th June rainfall totals in the order of 50-80mm over 24 hours were forecast for the wider area by the Met Office. The nature of the weather system was similar to many previous summer flood events which have affected the Moray area and so flooding to some extent was expected.

Recorded Rainfall Totals



SEPA Telemetry Raingauge Locations with event totals shown in 10mm bands

The rainfall event lasted between 24 and 36 hours across the area and the event totals are shown in the table below along with an estimate of the return period of the 24 hours totals.

Station	Catchment	Height (mAOD)	Total Event Rainfall (mm)	Return period for 24h total ~
Dipple	Spey	27	119.2	200
Torwinny	Lossie	199	115.8	190
Pluscarden	Lossie	36	115.2	190
Blackhills	Coastal	100	94.8	45
Lochindorb North	Findhorn	305	90.4	15
Keith	Deveron	111	86	25
Wardend Bridge	Findhorn	42	79	15
Dallachy No 2	Coastal	14	77.2	25
Blacklaw	Coastal	183	74.5	20
Avochie	Deveron	82	69.8	10
Lossiemouth	Coastal	5	56	5
Cullen	Coastal	7	52.6	5

Return periods have been estimated from the Flood Estimation Handbook web service using the 2013 rainfall model. Caution should be attached to the estimates, particularly those over 100 years as we have observed a number of similar and more severe rainfall events in this area over the past 10 years. Although it was hoped that the 2013 updated rainfall model for FEH would improve rarity estimates, it appears that durations of less than 12 hours are better, but longer duration events of the type that frequently cause flooding in this region, are less realistic in the new model possibly due to a lack of local calibration data being included.

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lower than QMED and so in the order we would expect to see most years. A summary of the station records are shown in the table below.

Station	Catchment	Catchment Area (km ²)	Record since	Peak Stage (m)	Peak Flow (m ³ s)	Amax Rank	Return Period ~
Cullen	Burn of Deskford	47	1991	1.712	61.2	2	30
Ballachraggan	Lossie	20	2015	1.936	36.3	1	25
Forres	Findhorn	782	1957	3.059	785.1	3	25
Sheriffmills	Lossie	216	1989	2.995	100.7	5	25
Grange	Isa	176	1989	3.627	110.7	2	20
Dunphail	Findhorn	165	1982	2.416	125.1	3	15
Pluscarden	Lossie	36	2012	2.556	14.5	2	10
Brodie	Muckle Burn	78	2004	1.491	35.0	3	10
Feshie Bridge	Spey	232	1993	2.086	149.8	8	5
Balnatoich	Nairn	128	1993	1.572	36.7	10	5
Firhall	Nairn	313	1978	1.969	116.1	13	5
Wardend Bridge	Findhorn	28	1998	0.978	24.1	4	-
Abertour	Spey	2655	1991	2.977	level only	6	-
Huntly GS	Deveron	256	2009	2.23	70.9	7	<QMED
Avochie	Deveron	442	1959	1.532	86.6	<QMED	<QMED
Shenachie	Findhorn	416	1959	1.831	228.0	<QMED	<QMED

Peak flows are calculated using current station rating equations and most of the stations are calibrated at least to QMED. Return periods are an initial estimate made using the Flood Estimation Handbook statistical method. Most are based on single site analysis, sometimes improved with predecessor station records. More detailed analysis of each station is required using a range of methods and taking account of uncertainties in station ratings, but generally in the most affected areas, flows in the order of a 4% annual probability were observed (1 in 25 years). Given that on these catchments, all of the top 5 floods have occurred within the past 20 years regardless of length of station record, caution is required as ever with flood probability estimation.

Generally speaking, the event was in the top 5 floods recorded in the area. It was a notable event, but less severe than the flooding which affected the area in August 2014 and September 2009.

Impacts of Flooding

Across Moray, a number of flood prevention schemes have been built over the past 10 years. The most recent is in Dallas which was nearing completion at the time of the flood, but was sufficiently advanced to successfully prevent flooding to the village. During the event it was evident that all of the major Moray schemes were operational and flooding of properties would have been inevitable during the event in the communities of Lhanbryde, Forbes, Elgin and Dallas were it not for the 5 schemes which collectively protect over 1000 properties across those communities.

Outwith those schemes, there was widespread flooding of roads and farmland; individual properties were also affected in particular along the lower Spey and in Portsoy. The main Inverness to Aberdeen railway line was flooded near Keith from the River Isla, and though flooding of properties was prevented in Dallas, the village was cut off due to surrounding roads flooding to depth and resulting in extensive damage. In Milntown the distillery and road were affected but there are so far no reports of properties flooding. Most of the roads downstream of Elgin towards Lossiemouth were flooded and impassable. On the lower Spey flooding of properties and roads occurred at Garmouth, and the village hall was flooded resulting in a new location being sought for use as a polling station for the General Election the following day.

Possibly the most significant impacts in the area arose from small ungauged watercourses in Portsoy where the Burn of Durn flooded properties and washed away a section of road. The smaller Soy Burn also caused flooding of properties which have been flooded in the past and this highlights the long term problems associated with culverted watercourses. Given the ungauged nature of these small catchments, it is difficult to estimate peak flows and return periods, both for observed floods and for assessing flood risk.

A selection of photos of flood impacts is included at the end of this document.

Data Collection

During the flood SEPA Hydrometry Staff managed to collect high flow measurements at many of the affected stations. High flow gauging is problematic in that stations are often difficult to access, peaks can occur outwith normal office hours and conditions can be hazardous with high velocities and large debris in the rivers. With improved technology, high flow gauging has been extended beyond stations with winch and cableway equipment and can now be undertaken using boats at a wider range of locations.

High flow measurements were taken at a number of stations including Forbes, Pluscarden, Brodie, Ballachraggan and Dunphail. The gaugings at Forbes, Brodie, Ballachraggan and Dunphail were new high measurements for those sites, most by a considerable margin. As a result, rating equations at all these sites can now be extended to higher flows and uncertainties in the flow records will be substantially reduced. This has benefits for all aspects of SEPA's flood work including flood warning, flood risk, flood mapping and flood risk management planning.

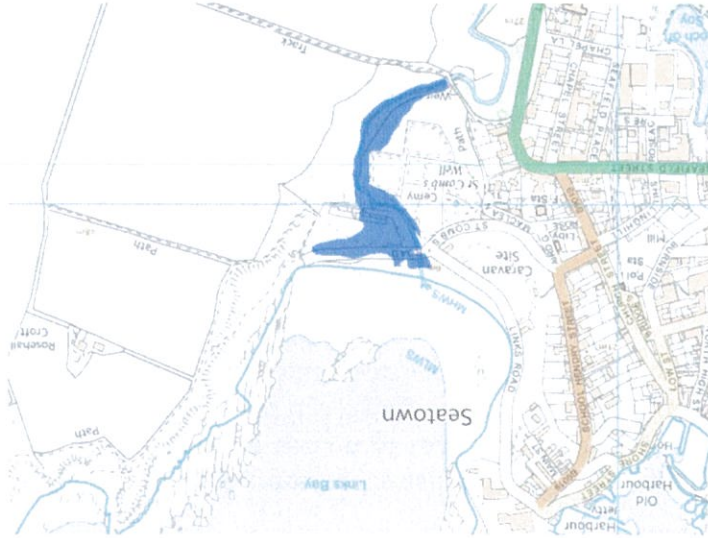
During the river gauging at Forbes large changes to the channel geometry were detected. The channel has proved extremely mobile at Forbes during larger floods, particularly since the Findhorn Flood Scheme was constructed which involved significant changes to the channel through that reach. A bathymetric survey of the whole pool will be undertaken to assess the change in volume.

Initial post-flood visits have been undertaken in Portsoy, Milntown, Dallas and areas downstream of Elgin. Some photos and trashline surveys have been collected using the FEDCAP system currently being developed. A more detailed survey will be undertaken over the next few weeks to survey maximum flood levels at key locations and collect some channel cross-sections, both on the Burn of Durn at Portsoy and at some Gauging Station locations where further work to assess peak flows is required.

Flood damaged properties with access road washed out, Burn of Durn at Portsoy



Observed flood extent: Burn of Durn, Portsoy



Locations of post-flood data collection – 8th June 2017



Flood Warning

As noted above, the rainfall event was reasonably well forecast. Forecast totals were possibly underestimated given that we recorded in excess of 100mm for the event across a number of our raingauges. This is not unusual for flooding in the Moray area. In our experience Moray flood events usually yield more rainfall than was forecast.

In the 24 hours prior to the flooding, some very useful Grid to Grid modelling output was provided to the FWDO by the duty flood forecaster. For the Lossie and Findhorn catchments the G2G made some reasonable predictions of observed flows. The big anomaly seems to be the predictions for the River Nairn catchment and this has also been evident during past events. The Nairn would therefore benefit from some further assessment of why flows are overestimated significantly. The G2G predicted peak at Balnafoich was $>100\text{m}^3\text{s}^{-1}$ which is nearly twice the largest flow ever recorded there (1997). The recorded flow from the event was $36.7\text{m}^3\text{s}^{-1}$ which is ranked 10th in the station AMAX record which has 24 years of data. The annual probability is between 20 and 30%.

The issuing of flood warnings for the event was efficient with all the appropriate warnings being issued. In consultation with Moray Council, no warnings were issued for the areas of Elgin and Forres which are now protected by schemes. Warnings for the surrounding areas which are undefended were issued, and for target areas on the Lower Spey and upper Lossie. Flooding was observed in all of the Lossie and Spey target areas issued, with properties either being inundated or close to inundation thresholds.

No reports of flooding were received from the areas immediately up- and downstream of Forres. The August 2014 event along with the construction of the Forres FPS completely changed the stage-discharge relationship at Forres gauging station and since then the flood forecasting model state updating has been switched off. This means that there is no suitable model information for the duty officer to base issue of warnings on. A new rating was established for the Forres station in 2015 and the model will be updated as part of a regional re-calibration later this year.. During this particular event, Shenachie in the upper catchment lost communication so only the observed stage and flow for Forres were available. Some further information gathering is required upstream of Forres at Mundole to re-establish a suitable flood warning threshold for the area. Downstream of Forres, the flood mechanism is controlled by informal embankments which are prone to breach. There are high uncertainties with when and where a breach would be likely, and once a breach occurs flooding is rapid and hazardous as was observed in August 2014 so a precautionary threshold should be maintained for the area.

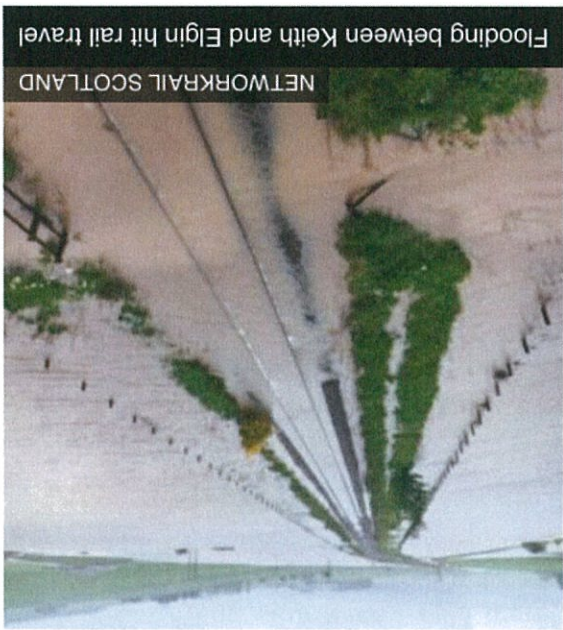
An updated version of this note should be produced once the station ratings have been revised using the new high flow measurements and further post-flood survey work has been undertaken.

Claire Wheeler
12 June 2017

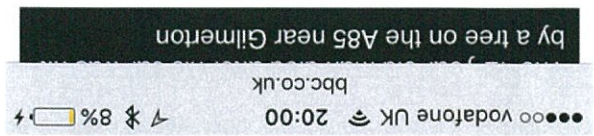
The River Lossie contained by the FPS through Elgin



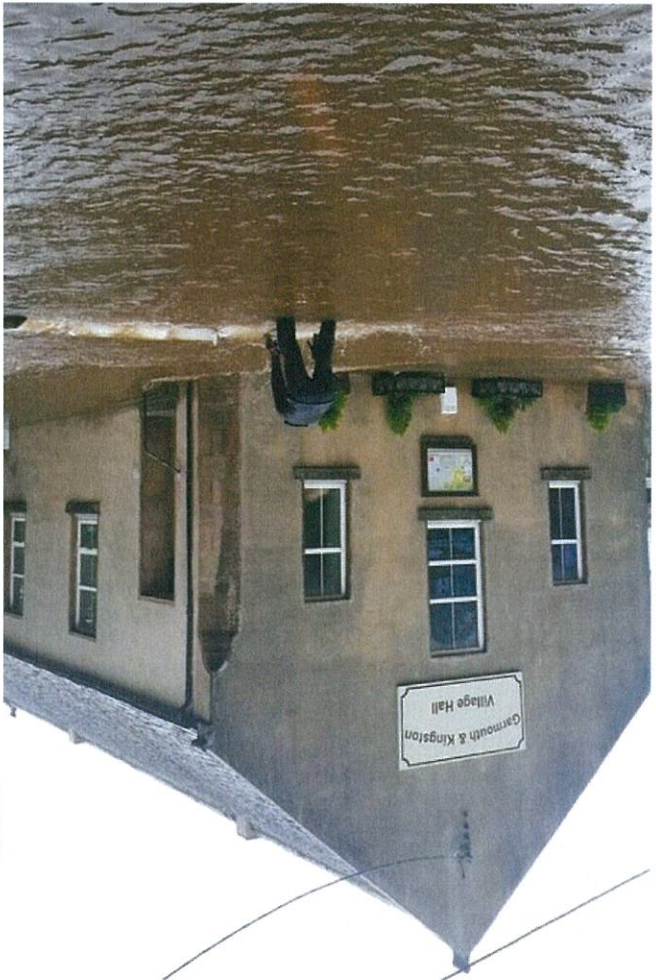
Inverness to Aberdeen Railway Line



NETWORKRAIL SCOTLAND
Flooding between Keith and Elgin hit rail travel



Garmouth Village Hall





Water rushes over the road out of Dallas in Moray

The main access road to Dallas



Water contained in-bank on the Mosset Burn downstream of the Flood Reservoir, Forres



Homes have been evacuated at Portsoy in Aberdeenshire

Bunkhouse and holiday accommodation at Portsoy

