



Restoration of the Hartford Stream for European Common Eel



Our Past, Our Future

Our Past, Our Future is a £4.4million landscape partnership scheme for the New Forest supported by the Heritage Lottery Fund. This 5-year initiative will deliver some 21 projects across four themes of work, which will better equip the New Forest to thrive through change and modern-day pressures:

- *Restoring lost landscapes*
- *Developing Forest skills*
- *Discovering Forest heritage and inspiring a new generation*
- *Monitoring and evaluation*

Freshwater Habitats Trust (acting on behalf of the New Forest Catchment Partnership) is the lead partner for the Living Waters OPOF project. The project, with match funding from the Environment Agency, will help to enhance and restore the New Forest's freshwater landscape, which includes numerous ponds, rivers, lakes and streams. These habitats are of national importance and support some of the UK's rarest plants and animals. However, due to historic modification, some elements of these landscapes have become disconnected or put under stress due to changes in land management and anthropogenic pressure.

The New Forest Catchment Partnership has been working with local landowners, stakeholders and communities on the Beaulieu River to identify issues which may be impacting on the water environment. Our aim is to find solutions which will bring significant benefits for freshwater wildlife, and in doing so put people in touch with their freshwater heritage.



European Eel

European Eel (Anguilla anguilla) have a remarkable life history; spending their adult lives in freshwaters (streams and ponds) in the UK, then migrating thousands of miles to the Sargasso Sea to reproduce.

The leaf-shaped larvae drift amongst the food rich plankton for up to 3 years, and on reaching coastal waters, they metamorphosis into "glass eels". The eels gain pigmentation, transform into elvers and, if no barriers exist, they move upstream into freshwaters. Typically these meter long adult eels feed and grow for several decades (males 6-12 years; females 9-20 years) in freshwaters before returning to the Sargasso.

The numbers of young eel returning to European coasts has declined dramatically (up to 95% at some catch sites in the last 25 years). As a result, the European Eel is now a Priority Species under the UK Post-2010 Biodiversity Framework, and are listed as Critically Endangered on the global IUCN Red List of Threatened Species.

The issues are not fully understood but may be a combination of climate change, overfishing, parasites, pollution and barriers to migration. Most of these issues are complex to resolve; they will take time and require global solutions. In the short term, we can at least tackle the historic modification of river and estuarine habitats, so that the young elver who make it this far have unobstructed passage to their freshwater homes.



Glass eels at the transition between salt sea and fresh water. Their skin at this stage is transparent, hence their name. © Uwe Kils bit.ly/2NaFStx.



Mature silver stage European eels migrate back to the ocean. © Felice Supino (1916) Pesci d'Acqua Dolce d'Italia, Milan bit.ly/2Wg5lGe.

The Hartford Stream

The Hartford Stream, is a small spring-fed stream, running from the open forest on Beaulieu Heath, through the ancient monastic grounds of the Beaulieu Abbey before draining directly into the Beaulieu estuary. Ecologically the Hartford Stream is in good condition, flowing through woodland habitats and mostly free from nutrient pollution, resulting in high invertebrate diversity. This is a window into the past when clean, wildlife rich freshwaters were commonplace for lowland streams, but which is now a diminishing resource because of widespread pollution in most of the wider countryside.

The stream and its eels are also a reminder of our eco-heritage; the dependence of communities past and present on the natural environment for food and resources. We can well imagine the monks of Abbey and the surrounding community, being grateful for the abundant rich fatty food supply provided by the spring elvers, as they gathered in the Beaulieu Estuary, waiting for the full moon to make the journey home.

There are a number of dammed ponds along the course of the Hartford stream. Often medieval in origin, they are thought to have been created by the monks of Beaulieu Abbey as fishing ponds. These ponds provide important wetland habitats in their own right including for protected species such as Great Crested Newts, Common Toad and a diverse plant and invertebrate communities.

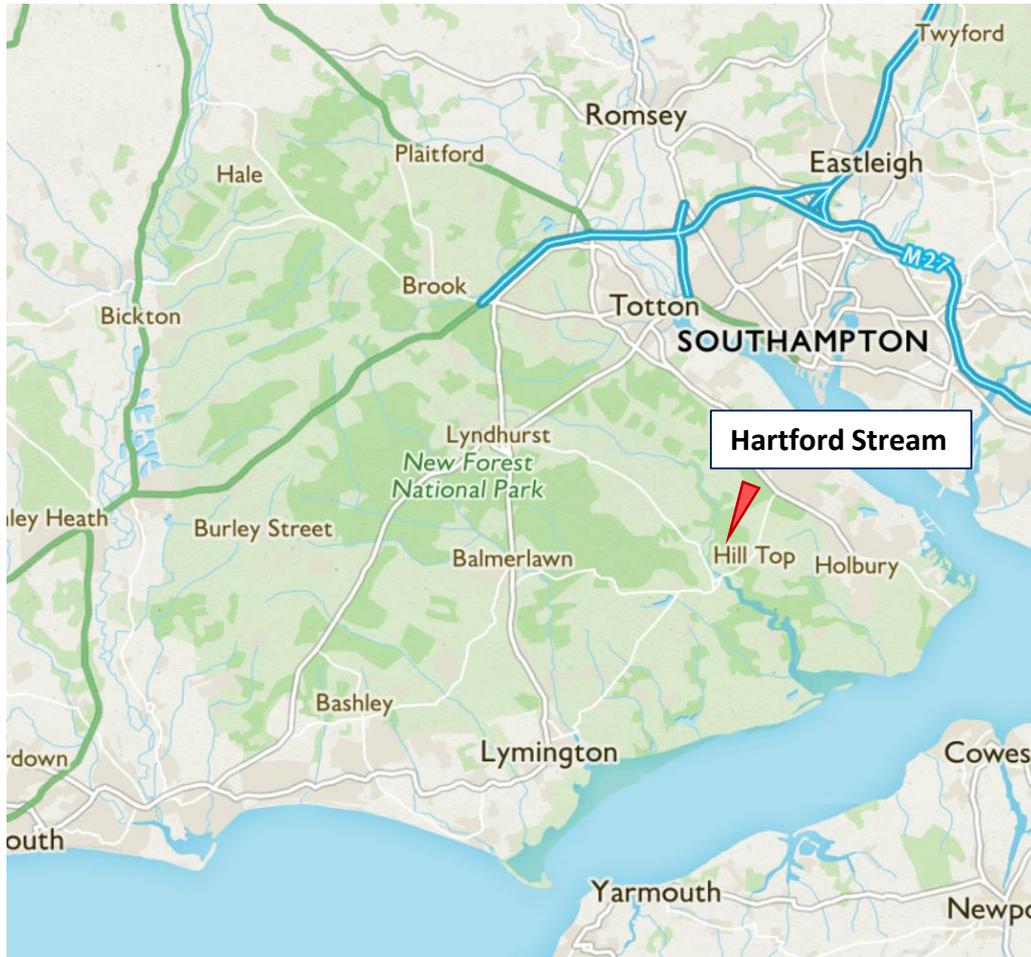


*Beaulieu Abbey was founded in 1204, when King John made a gift of land here to the Cistercian Monks. © Graham Horn
<http://bit.ly/2JCLAnl>.*



Medieval preparation of Eel Pie – we wonder if the monks of the Beaulieu Abbey were partial to a slice of this as well.

A stream of exceptional quality



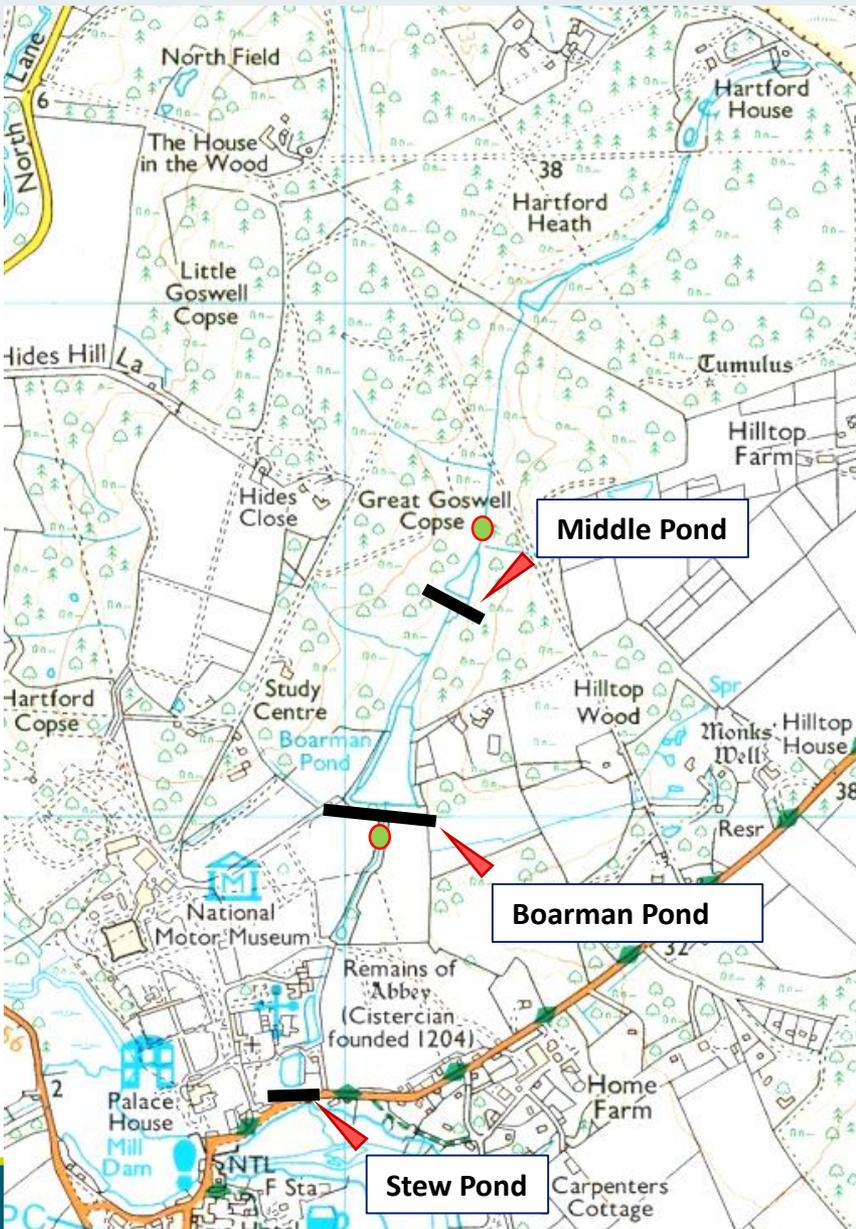
Map showing the location of the Hartford Stream, a 2.53km tributary of the Beaulieu River, New Forest.

Under Water Framework Directive definitions, the Hartford Stream (referred to as the Beaulieu Abbey Stream (GB107042011210)) is classified as heavily modified. A description given to waterbodies that have been historically modified (straightened or dammed).

For other assessed elements - physico-chemical and invertebrates - the stream achieves HIGH status. A sign that in spite of the modifications the stream is of exceptional quality.

The only failing element is the series of in-stream barriers, 'repairs' to the ponds in recent history, using modern materials. These are creating an insurmountable obstacle, limiting connectivity, particularly for migratory fish species and common eel.

Barriers to Common Eel migration



The most 'natural' option would be to remove the on-line ponds altogether. However, their ecological and archaeological value mean that the stream course cannot be restored by removing the dams, so our preferred option was to find solutions which would allow young eel to get over the barriers.

Specific works have been agreed with the landowners, the Beaulieu Estate, to modify or upgrade the in-stream structures where these are creating restrictions to eel passage, erosion due to obstructions in the river channel, and causing a lack of habitat connectivity from source to sea.

Three areas were prioritised; the outlets to the Stew Pond, Boarman Pond and Middle Pond.

Map of the Hartford Stream, showing the location of baseline surveys, and barriers identified at the pond outlets.

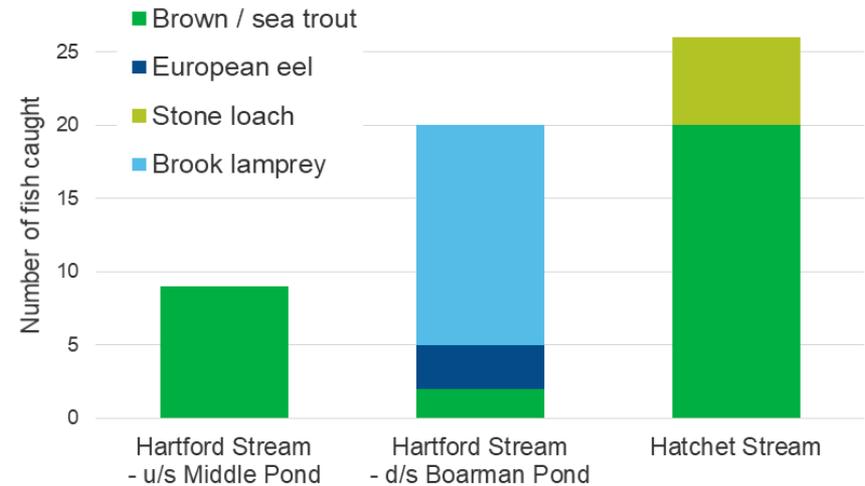
 *Baseline survey*

 *Barriers to eel passage*

Baseline surveys



Results of baseline fish surveys on the Hartford Stream (July 2017). Trout were present at all three sites, but they were most abundant on the Hatchet Stream. On the Hartford Stream, European eel and Brook lamprey were caught downstream from Boarman Pond, but not upstream of Middle Pond, indicating a barrier to their migration. This was further evidenced by the number of adult trout at Hartford Stream – in naturally migrating populations the adult trout migrate out to sea. Their presence here indicates that they may have been historically trapped, forcing a non-migratory population.



Options to aid eel migration



'Eel brush' options provide grip for young elvers to make their way up and over barriers. The eel pass must be installed in such a way to provide continuous slow water flow down the bristles board (left) or gutter brush (right). The base of the pass must sit below the water level of the river or below the average spring high tide level, to allow interception of migratory elver trying to move upstream.

Stew Pond



The Stew Pond: As the name suggests, these ponds were likely to have been built to provide fish for the Cistercian monks, who founded the Beaulieu Abbey in 1204.

Stew Pond – the issues



The outlet to Stew Pond (left): A sluice structure holds water in the pond, then the stream flows through a culvert (above) under the road and out into the estuary. An otter ramp has been installed at some point in the last c.30 years, but it is hard to see how eel could make easy passage from the stream into the pond.

Stew Pond – the solution



Eel passage solution: U-shaped UPVC gutter attached to the side of the existing brick culvert wall, with 100mm wide bristle mat secured inside (bristle clump spacing at 20mm to ensure passage of the smallest elvers moving in from the estuary). The gutter did not require a cover as there was no risk of elver predation or leaf fall into the culvert.

Stew Pond – the solution

A narrow slit was cut into the existing sluice wall, also with flexible matting (but see below), to allow low velocity gravity fed water to outflow from the pond (at approximately half a litre per second) during spring/summer flow conditions. Drop boards in the sluice will allow the flow of water to be adjusted if required.

The otter ramp, which had been removed to make way for the new eel pass, was reinstated in its original position (now sitting above the pass).

As expected, we had to do some fine tuning once we'd had a chance to assess the pass in action.

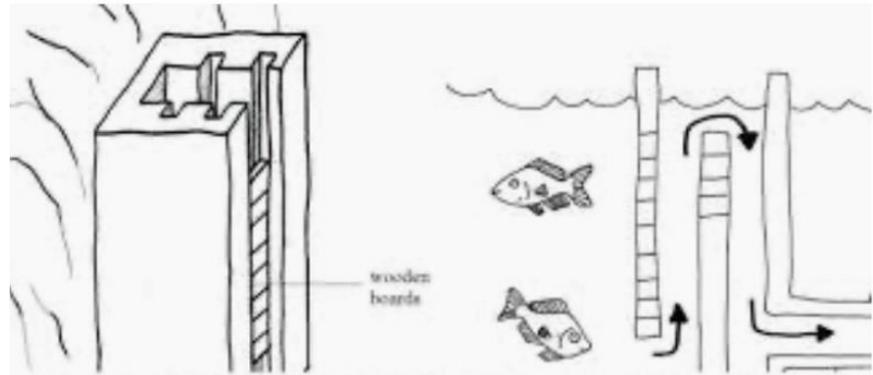
- 1. A small floating boom deflector will be installed around the inlet to the elver trap in order to deflect small floating debris away from the elver pass as this, in time, could clog up the bristle brush.*
- 2. We had to cut the fleximat away from the the brick wall inlet channel in order to install the elver trap for filming. This has been replaced with gutter brush down to a depth of approx. 1 metre below water level within the Stew Pond to ease passage of elver into the pond. The gutter brush is going to be detachable to allow for future trapping/filming, and so that they can be easily cleaned and replaced as necessary.*



Boarman Pond



Boarman Pond: Certainly one of the oldest and largest ponds on the Hartford Stream. Management of the pond is currently focussed on maintaining it as a fishing pond.



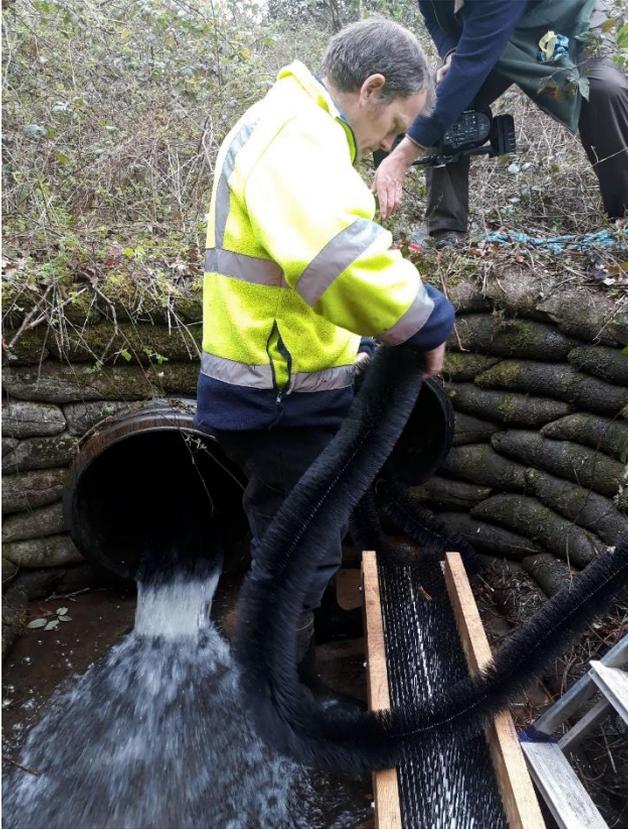
Monk structures are often found at the outlet of large ponds and lakes. They come in a variety of designs, but principally regulate pond temperature by creating a convection current drawing cold water from the depths, whilst ensuring that stocked fish remain in the pond. Unfortunately this also prevents native fish and eels swimming upstream.

Boarman Pond – the issues



The Monk on Boarman Pond works by drawing up water from a depth of 9 foot and directing it straight into the outlet pipe to discharge colder water and increase water temperatures. This pipe is approximately 30m in length with a high to variable flow year round. In addition, below the pipe, water flows over a concrete sill and drops into the stream creating an undercut. For the migratory eels this is an impossible set of obstacles.

Boarman Pond – the solution



Eel passage solution: Installation of a multi-core gutter-brush (several tied loosely together) running through the overflow pipe (to the right of the outflow pipe). These brushes hang down into the pond, below the low summer lake levels, and have been installed so that they can be easily removed for cleaning. A double width (200mm wide bristle-brush) ramp, with sides, now runs from the outlet of the overflow pipe at an angle of less than 45 degrees to the stream bed to by-pass the concrete sill.

Boarman Pond – the solution

To make the pass effective for common eel, a low velocity of water (approximately half a litre per second) must constantly flow over the brushes. The gap we need to bridge from mean water level within the pond and top of overflow pipe is approx. 30cm.

Two, 1 inch siphon pipes and nylon wicking material were used to draw water up from the pond and into the overflow pipe. This was time consuming to fit and has required some tweaks (see below).

Final modifications:

- 1. We have now placed metal strainer cages over the inlets to siphon pipes as both siphons blocked this summer!*
- 2. The nylon wicking rope hasn't been very effective at wicking! So, to bridge the gap between the top of the overflow pipe and the outlets of siphon pipes we have added non rotting capillary matting (self-wicking capillary rise of 10cm) underneath the gutter brushes. We will also trial cotton wicking rope, as this has a capillary rise of up to 50cm. Very effective but it will need to be replaced as it will naturally rot.*
- 3. Gutter brush is going to be tied (3 parallel lines) on top of the outlet ramp to prevent build up of leaf litter and prevent predation of elver.*



Middle Pond



Middle Pond was created in its current incarnation in c.1920, providing a head of water to drive a hydraulic ram to provide water to two local houses. However, investigations suggest that there may have been a medieval antecedent.

The pond is managed by the environmental education wing of the Beaulieu Estate, the Countryside Education Centre (CET).

The pond, together with the downstream section of stream below the dam, is regularly utilized as a field study area by CET school parties and CET volunteers.

Middle Pond – the issues

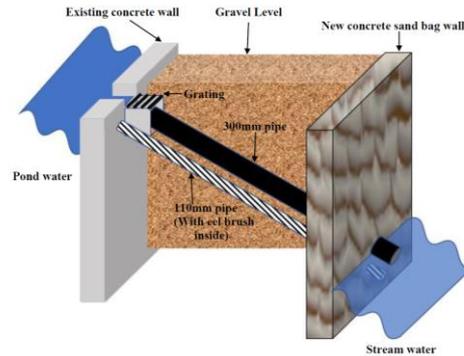


Middle Pond: A c.1920 dam made from concrete and topped with a line of bricks holds water back in middle pond. Initially water probably flowed uniformly over the lip of this dam, but over time water has nicked around the top edge of the concrete wall and eroded the bank.

In 1983, a reinforced concrete wall was constructed downstream of the original dam. Concrete hessian bags had been used as revetments either side of the wall and the middle section back filled with earth to provide an unstable path through to the woods.

The dam and footpath are in urgent need of repair to restore their integrity. However, the current design poses an obstacle to eel passage and therefore connectivity for eel must be provided at the same time as the repair.

Middle Pond – the solution



Step 1: Restoration of the dam. The original 1920s dam was retained in the new design for its archaeological value. The modern redundant downstream dam was removed and a new secondary retaining wall built from concrete sandbags. The space between the walls was backfilled with gravel to provide a safe passage over the pond outlet. A notch was created within the existing concrete sill, to formalise water levels in the pond and direct water into two 300mm outlet pipes.



Step 2: The elver pass. A 110mm pipe (5 - 6m long) was incorporated into the newly restored dam at a level below the minimum summer water level in the pond to create a constant gravity fed flow. The outlet of this pipe was sited at stream bed level downstream of the dam to allow access for elver in all conditions. A simple gutter brush was incorporated into the enclosed pipe which can periodically be removed and cleaned or replaced as required.

The eels return!



Capital works were completed by the end of April 2019, and although it was a bit of a long shot, Manny Hinge suggested we try to install an eel pass 'trap' to see if we could film elver using the newly installed passes.

We deployed one trap at the top of the new eel pass to the Stew Pond, and set it for a few days around the new moon for 3 consecutive months, during the eel migration window.

June: Trap set for 5 days, zero elvers caught.

July: Trap set for 6 days, 6 elvers caught!!

August: Trap set for 7 days, zero elvers caught

The eel had returned within just 3 months of completing the work. It shows, that with high quality freshwaters like the Hartford Stream, it only takes a small amount of work to make a big difference to the biodiversity of the catchment.

The eel did not remain contained in the traps for very long – very good escape artists – so the number caught is not representative of the number present. Manny Hinge attempted to film the elvers in-situ, by placing them on the pass, but they shot away, and we only have this photo to evidence our success. We will set traps again in spring/summer 2020 and investigate the potential for installation of cameras on some of the passes.

Living Waters Legacy

The key to these elver passes being sustainable in the longer term, is finding a volunteer who would be happy to check the build up to debris around the boom at the Stew Pond periodically and set up and check the siphons at Boarman Pond each season.

One of our Clean Water Quality volunteers has expressed an interest in helping out, and we will meet with him in the spring to show them how to set up the siphon. We've even purchased him his own plastic jug and graduated funnel!

Countryside Education Trust are happy to maintain the elver pass at Middle Pond, periodically detaching and clean the brush.



Acknowledgements: *With thanks to the Beaulieu Estate and Countryside Education Trust for their enthusiasm and engagement in the restoration work; Environment Agency staff for their support, technical advice and match funding without which we could not have undertaken the work; Richard Reeves who researched the history of the Beaulieu Abbey Stream; Niccolls Plant hire for undertaking the capital works; Manny Hinge for persevering with attempts to film the eels; and last but not least Jane Nordstrom (contractor) who went above and beyond, in her own time, to make this project a success.*

