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CERTIFICATE

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A STUDY

OF

WATER POWERED INDUSTRIES

IN ESSEX

INDEX

OBJECTIVES

The objective of this study is to examine the role wind and water power played in developing and mechanising industry in Essex. The geographic distribution of industries is also examined. The history of Flour milling has not been included in this study, since from the twelfth century wind and water powered corn mills existed in every Essex parish.

This study is based on original material in the Essex Record Office (ERO) and Greater London Record Office (GLRO) and the Public Record Office (PRO). I have also drawn on the transcriptions of Essex Feet of Fines published by the Essex Archaeological Society and Inquisitions post Mortum published by the PRO.

[Key map number 1]

Brick and tile making was practised extensively in Essex. The main requirement for power was driving the pug mill which prepared the clay for moulding into bricks. Before the twentieth century Essex Brick works seem to have been totally reliant on horses although there was some use of wind pumps to drain the clay pits. Several Essex millers were involved in brick making, at Beach's brick works in Chelmsford the pug mill stood near Beach's watermill where an early photograph shows a "pug horse" harnessed to the pug mill [*ERO Spalding collection*].

ARTIFICIAL SLATE WORKS were set up by Sir James Wright, who lived at Ray House Woodford, the exact date is not known but the works were in existence by May 1782 when Sir James paid £2 10 0d in parish rates on 'the manufactory' [*E.R.O D/DP 167/11/1*]. In 1780 John Smeaton was commissioned to produce drawings for utilising the waters of the Roding to power the works, but it is not clear if Smeaton actually carried out the work since one of his drawings is inscribed "delivered but not executed" [*Smeaton's drawings*]. A contemporary view of the works, published in the Universal Magazine for August 1798, shows a two story building standing by the Roding but gives no clue as to the power used. This view of the works shows a sluice in the river but the general arrangement cannot be reconciled with that proposed by John Smeaton.

In 1796 the site was described as a patent manufactory of artificial slate, although no reference is made as to which patent was used. The slates were said to have measured 24 inches by 15 inches and cost 1/- each. The slate works may have been out of use by 1803 when Ray House was put up for sale, as the sale particulars make no mention of it [*E.R.O B1574*]. Sand and gravel pits are recorded at Woodford bridge which may have originally been associated with the slate works [*E.R.O D/DCy P3*]

A patent was granted to Henry Cook, of Stoke Holy Cross, Norfolk, in 1778 for "An entire New Composition, to be used as a Substitute for, and will in every respect be Preferable to, either Lead, Slates, or Tiles, in covering of Churches, Houses, and other buildings" [*English patent No. 1185 dated June 1778*]. Although there is no evidence for this patent being used at Woodford it is interesting in its use of water power. The substitute material was to be made of :

Litharge, red lead, white lead, chalk, stone, black flint, brick dust, fine sand prepared by washing, caput mortuum, and ground glass. The above reduced to a fine powder and all mixed together. To every hundred weight of the above materials is added twenty-eight pounds of old junk, rope, or hemp, reduced to a pulp, and all worked together in water by a water-mill; the composition thus mixed is put into moulds, and formed like slates, then pressed as dry as may be by large iron presses, afterwards dried in a stove by fire, and when quite dry pressed by iron cylinders: then each sheet is steeped in a liquor prepared with linseed oil, litharge, red lead, white copperas, and sugar of lead, again dried in a stove, pressed by the cylinders, and painted.

SAW MILLS. At Abbey Mill, Waltham Abbey there was a small saw mill in 1821. This was using a water wheel previously used to power a pin factory which moved out in 1821. [*ERO D/DHf P11*]. The saw mill was still in existence in 1849 when the lease for Abbey mills was advertised but may have gone out of use when the mill was taken over by new tenants [*The London Gazette, 1849*].

[key map number 2]

FULLING MILLS. Outside of agriculture the main source of employment in Essex was the woollen trade which specialised in bays and says. The industry was centered on hand looms with Spain and Portugal the main destination for Essex cloth. Essex specialised in the production of bays and says, forms of half worsted cloth brought to Britain by Dutch Protestants during the reign of Elizabeth I. War with Spain between 1624 and 1630 bought about a period of depression in the weaving industry, by denying access to its traditional markets. By 1700 the weaving was becoming centered upon north Essex the cloth industry finally collapsed around 1800. A detailed report, commissioned into the woollen trade in the Hinckford Hundred in 1629, shows the depth of the depression occasioned by the loss of the Spanish trade. The principle clothing towns were given as Colchester, Coggeshall, Witham, Bocking, Braintree and Dedham [*Essex Review vol 17, 1908*]. Minor centers of the weaving trade were Chelmsford, Maldon, Dunmow, Harlow and Waltham Abbey.

After the weaving process the cloth was fulled to scour or cleanse the cloth. Fulling involved the beating of wet folded cloth originally a hand process which mechanised by the use of hanging-stokes driven by a water wheel. When the water powered fulling mill first appeared in Essex is unclear. However in 1240 documents relating to the manor of Dedham mention a Robert the Fuller. As there is no mention of a miller he may have been working at Dedham water mill in which the manor had a half share [*Feet of Fine*s]. A fulling mill is recorded in Dedham in 1382 and around 1410 half a fulling mill was given to the prioress and convent of St Mary's church Champesse [*Inq Rich II; Inq 11 Hen IV*]. In 1775 Dedham mill was a corn and fulling mill and probably had always operated as such [*Andre & Chapman*]. Weaving in Dedham declined after 1730 and ended around 1791, the water mill continued on milling flour.

On the river Chelmer, Dunmow was once a busy cloth centre may not have had mechanised fulling. Deeds of Langley Farm record land called Fulling Mead and in 1700 there were sufficient numbers of fullers to form their own company [*ERO D/DU881: A F J Brown, Essex at Work, Chelmsford 1969*]. Lower down the Chelmer were fulling mills serving the weavers of Chelmsford and Maldon; these mills do not seem to have survived the depression of the seventeenth century, none are shown on Andre & Chapman's survey. In 1405 a John Friday "fuller" is mentioned in documents concerning the rebuilding and lease of a fulling mill called Pacchingmelle [*D/DP M209*]. John Friday was one of the keepers of the torch light of Writtle church [*D/DP M223*]. A fulling mill existed in Lt Waltham in 1419 [*D/DU 514/29-31*] was still at work in 1740 [*D/DU 738/2*] but by the 1760's was used only for milling. In 1445 a John Aleyn "ffuller" sold a house and land in Chelmsford [*Feet of Fines*]. In 1408 the Abbot of Coggeshall was granted yearly rent of a fulling mill and land in Springfield [*Morant, History of Essex*]. Barnes mill, Springfield, was a fulling mill in 1436 when it was leased by Thos Phillips of Springfield to John Danel "fuller" of Gt Badow for a term of 11 years at £3 10s per annum [*ERO. D/DAy T2/178-179*]. It was still a fulling mill in 1441 and 1582 [*ERO. D/DAy T2/178: D/DU 480/1: Feet of Fines*] but was a corn mill by l648 when it was leased to Richard Adams, miller [*ERO. D/DAc 213*]. Little Badow mill was also once used for fulling and milling, an apprenticeship indenture dated 1624, between Jeffrey Melbourne of Lt Badow miller and Phillip Somes, son of Edw Somes was for instruction in "millinge and fullinge of cloth" [*D/DU 54/4*]. Below Lt Badow was Huscardes mill which in 1539 was a fulling mill belonging to the manor of Mugdon Hall, Hatfield Peveral, [*Feet of Fines*]. In 1589 it was both a corn and fulling mill [*Essex Review vol 42*]. Fulling had ceased by 1679 and the mill continued as corn and paper mill. In 1545 there was in Woodham Walter one water mill and one fulling mill, ie a mill with one pair of stones and one set of fulling stocks [*Feet of Fines*]. On the manor of Langford there was in

1575-1559 one fulling mill [*Feet of Fines*] which was probably a corn mill by 1659. The last mill on the Chelmer was Beligh Mills which between 1656-1697 was being used for both milling and fulling, with two sets of stones and two fulling stokes, driven by separate water wheels [*D/DHn T22*]. Fulling had probably ceased by 1753 when the site was purchased by John Strutt for a flour mill.

The river Blackwater flows through the former bay making towns of Bocking, Braintree, Coggeshall and Witham. The largest center of production was Bocking, where before 1626 four hundred pieces of cloth were being made. Braintree and Coggeshall were producing one hundred pieces with Witham some forty or fifty a week [*Essex Review vol 17, 1908*]. To the north of Bocking, at Ashwell Hall in Finchingfield, there was a water mill in 1295 which was a fulling mill in 1300. However there are no further references to these mills which like a number of other small mills which once existed on the upper Blackwater are now lost with out trace [*Feet of Fines: Inq post Mort*]. The parish of Bocking had three or possible four mills which were involved at various times in fulling cloth. Deeds and rentals for Bocking make reference to fulling mills from the middle of the sixteenth century although it is difficult to identify then with specific sites. [*ERO D/DBm 180: D/Dg T6*], Chapman and Andre's survey published in 1777 show only Straits mill as a fulling mill. Bocking Church Street mill was acquired by Thomas Nottridge, a Bocking clothier, around 1760. Nottridge sent his bays by carrier to London but by the 1780's his business was dwindling and the mill was leased to John Hayes, a fuller and miller. Nottridge was also a tenant at Bulford mill, Cressing, which was a corn and fulling mill in 1650 [*D/DAc 94-98*]. In 1804 Bulford mill was acquired by Joseph Savill who according to his diary "set up my fulling stocks to work there" [*D/Cd A1-3,A5-6, Z7*]. The Savills were one of Bockings largest cloth firms who in an effort to overcome the effects of war with France had diversified in to new types of cloth, Bulford was probable needed because the blankets and horse cloths being made needed fulling. In 1812 Joseph Savill extended his business by purchasing Church Street mill for £3,450 and installing spinning machines. Although initially profitable these new enterprises were not a long term success. Bulford mill was sold in 1813 to Richard Dixon who converted it too corn milling, and Church Street mill was sold in 1819 to Samuel Courtauld for £2,500 [*D/DQc/1*]. William Daniell, clothier of Braintree, mentions in his will a fulling mill: Bradford mill in Bocking. This could be Bradford Street mill, Bocking, or nearby Straits mill [*D/DU 203/29*]. Andre and Chapman mark a fulling mill which in 1781 was an overshot mill owned by Robert Strait [*Royal Exchange fire insurance*]. Strait still owned the mill in 1829 when it was said to be a fulling and grinding mill [*D/F 21/1*]. With the demise of the cloth trade the mill was refitted, in 1830, as a flour mill with three pairs of french stones [*Chelmsford Chronicle Aug 1832*]. Down river, from Bocking, Stisted Mill was said to have one water mill and one fulling mill in 1569 [*Feet of Fine*s]. The fulling stocks may have survived until the mid eighteenth century when the mill was completely rebuilt [*Chelmsford Chronicle 1781*]. The collapse of the cloth industry around Coggeshall brought an end to the local fulling mills. Ferring Mill a fulling mill in 1699 and 1775 was converted to a water corn mill around 1791 [*D/DHt T107/2: Sun Fire Insurance*] Abbey mill went back to corn milling before being converted to silk mill. Several smaller mills situated on small streams in the Coggeshall area disappeared during the eighteenth century being to small to be converted to uses other than fulling [*D/DOp P1*]. The cloth trade lingered longest at Coggeshall West Mill, a corn and fulling mill. In 1787 it was described as a "fulling and roving baize water mill" [*Sun Fire Insurance*]. A survey taken in 1838 said it was a woollen mill with a 4hp wheel employing ten people of which six were under eighteen [*Parliamentary return 1838*]. In 1848 the partnership described as "staplers and worsted manufacturers" went bankrupt and the business put up for sale [*London Gazette 1848*]. West mill was said to be a combined corn mill and "woollen manufactory"

the site was then only used for corn milling until around 1910.

Colchester was well served by fulling mills from the middle of the thirteenth century [*V.H.E Eseex*]. Of these mills seven were still working solely as fulling mills in 1777 [*Andre & Chapman*]. Some of these mills were small affairs which worked only as fulling mills and disappeared at the end of the cloth trade. On the river Coln Cookes Mill, in West Burgholt, was a fulling mill 1445 and was still at work in 1766 when a Mr Hills, a Colchester baymaker, was confident enough to commission John Smeaton to make improvements to the water wheel and build a horse mill [*Smeaton's drawings held at The Royal Society*]. However this plan was not carried out and with a declining wool trade the fulling mill was put up for sale in 1781 and converted to corn milling [*Ipswich Journal*]. Further down the Coln, in Colchester, there was a water powered fulling mill at Lexden in 1496, it was still working in the late eighteenth century in the ownership of Isaac Boggis a Colchester clothier, but was converted to corn milling in the 1820's [*Cal of Pat Rolls: Isaac Boggis letter book*]. On the Coln below Lexden several fulling mills were recorded in the thirteenth and fourteenth centuries but had disappeared by 1600 [*ERO D/B 5 Cr27*]. The disappearance of these smaller mills was probably due to the owners of Colchester Middle Mill and East Mill raising their river banks in order to obtain greater power. During the seventeenth and eighteenth centuries Middle Mill was both a fulling and corn mill and East Mill a fulling mill [*Feet of Fines: ERO D/B 5 R7*].

The problems of water shortage were not so great for Colchester bakers whose needs could be in part meet by numerous windmills that stood in and around the town. Colchester cloth-makers had to look to several small streams to the south and east of the town, either building new fulling mills or converting existing corn mills. The mills on the Bourne Brook from the early seventeenth century were being used for both fulling and milling. By the eighteenth century Bourne mill was used solely for weaving, fulling and finishing bays, the business closed in the 1840's being the last to do so in Colchester [*Sun Fire Insurance*]. By the early 1600's fulling stocks had been installed in all the mills along the Salary Brook which were operated as fulling mills until the collapse of the cloth trade [*Chapman & Andre, map of Essex, 1777*]. At Birch and Stanway, on Roman river, fulling mills existed in the early seventeenth century and were still at work in 1777 but out of use by 1800 [*D/DBe T29: D/DB T1594*]. On the Birch Brook, a small stream in Rowhenge, stood a fulling mill which in 1671 was described as "new fulling mill of Mr Cristopher Sills" the fulling mill was still at work in 1777 but in 1837 was described as two cottages formally a Bay Mill [*ERO D/DEl T77*]. At the mouth of the Coln on St Osyth Creek stood St Osyth tide mill which during the seventeenth century worked as both a corn and fulling mill. Two water wheels drove two mills stones and three fulling stokes, fulling had ceased by the early 1700's [*ERO D/B T1 163/4: Morant, History of Essex*]

LOGWOOD MILLS. A Logwood Mill was recorded as belonging to Temple mills in 1706-7, this mill seems to have been erected about 1690 to meet the demand for dyes from a growing dying industry in the Bow area. The partnership which built the logwood mill, apparently to exploit a patent for an invention for rasping wood, got into financial trouble and the venture failed. When William Savage the owner of the Temple Mill site endeavoured to find new tenants, the logwood mill was said to have two water wheels, with two pairs of stones for the grinding of logwood and an engine for rasping wood. Logwood was imported from Central America as logs about three feet in length. These logs were reduced to small chips or raspings in a logwood mill so that the colouring matter could more readily be extracted. [*ERO D/SH 1*]

POWDER BLUE MILLS. Powder Blue was used in laundering linen. In 1627 Abraham Baker had mills at Temple Mills which he employed in the grinding of rape seed and of smalt. It would seem that Baker had been manufacturing smalt for

a number of years. In 1618, together with Sir George Hay, Abraham Baker was granted letters patent (No.7) giving a thirty one year monopoly on the manufacture of SMAULT. Interestingly this patent was exempted from a statute of monopolies passed in 1621, (21 Jas i C.3 S.14) which placed a limit of 14 years on monopolies. Smalt is a blue glass made by melting cobalt ore with flint and potash. After cooling the glass is finely pulverised for use as a pigment or colouring matter. When smalt is mixed with starch it is known as Powder Blue [*ERO T/P 48/1*].

In 1767 there was a Powder Blue mill at Sewardston which was described as the only Blue mills in England. The mills were said to have been erected at great expense by the tenant. The mill an **L** shaped building was divided up into a smalting house, stove room and three further rooms used for warehouse and workshops. The Blue mill existed in 1777 but had gone by 1801 [*Andre & Chapman, map of Essex: ERO D/P 75/11/4,7/8,14-16*].

SILK MILLS. One of the earliest references to the silk trade in Essex is in Plaistow in 1645 where a Paul Fox was engaged in "weaving of fine lace and ribbaning" being assisted by his son and two workers [*Strange and Fearful News from Plaistow. London 1645*]. There was a considerable expansion in the trade following the introduction of silk throwing machinery in the early eighteenth century which took over the work of hand-throwsters. The Essex silk industry prospered until 1860 when the duty on silk was abolished, after which the industry gradually waned. The first silk throwing mills were erected on the rivers Stort and Lea.

In 1693 Charterhouse leased Little Hallingbury corn mill, on the river Stort, to London merchants who completely rebuilt it as a silk mill. The Silk Mill gave work to a great number of women and girls from the neighbourhood who were employed in twisting and winding silk on a method invented by William Alderly, an apprentice silk-thrower in London, for which the proprietors had a patent, and was built upon the model of the famous engine at Derby. [*Morant, History of Essex*].

In 1702 Thomas Crochett erected a water powered silk throwing mill, using Dutch machinery, in Derby on the river Derwent. Crochett's venture failed, a second mill was built nearby by Thomas Lombe, who imported silk from Italy, to a design based on Italian silk throwing machines, powered by a 23 foot diameter undershot water wheel. Thomas Lombe was granted a patent in 1718 (No. 422) for "A New Invention of Three Sorts of Engine never before made or used in Great Britain, One to Wind the Finest Raw Silk, Another to Spin, and the Other to Twist the Finest Italian Raw Silk into Organzine in great Perfection which was never before done in this Kingdom". The patent describes the machinery to be used and concludes with the comment "The cogg wheels, shafts, and original motions afore mentioned suppose these engines to worked by water,....." Lombe's factory was in Derbyshire and he described himself as a merchant of the City of London in the patent. No details of the machinery fitted at Little Hallingbury have survived. Eighteenth century maps mark the site as Silk Mills or the Silk Mill. Silk throwing was still being carried out in 1775, [*Chapman and Andre survey of Essex*], but ceased a few years afterwards when the mill was converted into a corn mill, operated by George Pavitt [*Sun Fire insurance policy, 1792*].

At Waltham Abbey Chapman & Andre's map of Essex in 1777 show a silk and corn mill. Waltham Abbey Mill had two water wheels one of which presumably drove the silk mill which may have been a short lived affair since a report on the river drawn up by John Smeaton in 1779 mentions only "the Waltham Abbey corn mills". The silk mill became a pin manufactury shortly afterwards.

Also in Waltham Abbey, Sewardstone mills were used for several unsuccessful ventures connected with the silk trade. In 1801 the partnership between Thomas Hargrave and John Morley, who had operated at Sewardstone as silk throwsters, was disolved. [*London Gazett, 21 July 1801*]. John Morley then went in to partnership with William Wood under the name of Morley and Wood, millers, but this parnership was disolved in 1804 and John

Morley, was declared bankrupt in 1806. [*London Gazett, 3 Januarry 1804*]. A valuation on the mills taken in 1812 gave: Corn mill worth £250 per year at 20 years purchase, £5000. Silk mill however was only worth £30 per year at 20 year purchase, £600 [*ERO D/DHf B22*]. By 1825 the site was a silk manufactory leased by Messers Carr & Co, of London, at £300 per annum. William Cowling Buttres then leased the mills for silk throwing but was declared bankrupt in 1844, although this was later annulled. William Burch was tenent in 1842, as a cotton dryer and dresser and was also declared bankrupt in 1856. [*ERO D/CT 381/2: London Gazette*].

In 1738 an article of agreement was drawn up between Conrad de Smith, George Heathcote, merchant of London, Theodor Jacobson and Adrian van Bommenaer, of Low Leyton, manufacturer, who had invented a new machine for twisting and manufacturing yarn to thread for the making of superfine lace and cambrick lace [*ERO D/DC 27/1051: UK patent no. 563, 1738*]. The machine was designed to be worked by a water wheel, the article of agreement stipulated that the manufacture was to take place in a building belonging to Conrad de Smith situated in Low leyton. From the Court of Sewers books it would seem that this building was on the site of an old leather mill at Temple Mills. In 1740 the court ordered the occupiers of Temple mills to draw their gates and Conrad de Smith to draw his sluices. [*ERO D/SH 2 ff23*]. In 1741 the leather mill site was occupied by Jacob Nostle & Co. [*ERO D/SH 2 ff50*]. By 1776 the mill site was being used as a lead mill [*ERO D/SH 3, ff 237*]

In 1798 Pebmarsh mills which consisted of a water powered corn mill and a wind mill was put up for sale [*County Chronicle, London*). The mill was acquired by a London silk firm, Witts & Co. The conversion to a water powered silk throwing mill was carried out by George Courtauld who also built a dwelling house into which he moved his family in 1801. By 1838 in addition to the water wheel a 5 horse power steam engine was being used [*Parliamentary returns*]. The silk mill continued in use until 1883. Courtauld's engagement with Witt's did not stipulate any term of years and as he was unable to secure a more definite arrangement he was attracted by other offers. In 1806 Courtauld meet with Joseph Wilson who had a business as a silk manufacturer [*ERO D/F 3/2/94*]. In 1809 Wilson purchased Braintree water corn mill [*Ipswich Journal*]. George Courtauld demolished the old mill and erected a larger building together with a mill house, the river was deepened and a larger water wheel, of 10 h.p, installed. Silk throwing started in 1810 and weaving shortly after. The partnership between Wilson and George Courtauld ended in 1818 and Courtauld left Braintree [*Courtaulds an economic and social history, D C Coleman, 1969*]. In 1836 the silk mill was working solely by water power employing 106 people, 77 of whom were under 18 [*Parliamentary returns*].

In 1816 George Courtauld's son Samuel, who had worked at the Braintree works, set up as a silk thrower on his own account with a horse mill in Panfield Lane, Bocking. In the summer of 1817 Samuel persuaded his cousin Peter Alfred Taylor to join him in the silk business. After an unsuccessful search for a suitable water mill they purchased a piece of land in Braintree on which to build a horse powered mill. The search for water power was kept up and they were able to secure a lease on a fulling mill in Church Street, Bocking, with an option to purchase from Joseph Savill [*ERO D/DQc 1*]. This was converted to silk throwing. Around 1825 a small steam engine was installed in the Bocking mill, the need for this had been brought about by a hard winter of 1822-3 when ice and frost was followed by severe floods.

In 1825 Stephen Beuzeville, a Spitalfields silk manufacturer, purchased Town Mill, Halstead. Samuel Courtauld was to convert the corn mill to silk throwing and take a share of the profits. Beuzeville went bankrupt two years later and Courtauld was able to buy him out. By 1826 soft-silk winding machinery had been installed. As at Bocking Courtauld installed a larger water wheel, this however brought litigation from the owners of Box mill which lay upstream [*ERO D/F 3/2/97*].

The owners of Box mill had long complained that the owners of Town mill by raising the water level back-watered their water wheel. Courtauld's by raising their banks by eighteen inches for the new wheel made matters worse. After a lengthy hearing at the Essex Assizes, in 1827, a jury found the owners of Town mill had no right to pen up more than eight inches on the apron at Box mill. As a result Courtauld was forced to install steam engine, in 1828, to supplement the power from the water wheel.

Although Samuel Courtauld founded his business on water power it was the introduction of steam power which allowed him to expand it. At Bocking the 8 h.p of water and 4 h.p of steam used in 1826 had become some 40 h.p of steam by 1850. At Halstead there was 8 h.p of water and 6 h.p of steam in 1828, and by 1850 45 h.p of steam was driving the power-loom factory. Braintree mills however remained wholly water powered during this period [*ERO D/F 3/2/30; 43-90: D/F 3/1/88-89*].

In 1814 George Courtauld was granted a patent for an improved spindle for the manufacture of silk. When John Hall came to Coggeshall to set up a branch of his ribbon-making business he went to Samuel Courtauld to get ideas for the interior design of Abbey mill, on which he had acquired a twenty years lease [*ERO D/DBw T19*]. Abbey mill was converted to silk throwing in 1820, and in 1838 was working with an 8 h.p water wheel and a 10 h.p steam engine [*Parliamentary Returns*]. In 1838 Hall, built a new steam powered silk manufactory in West St, Coggeshall, the lease on Abbey Mill was not renewed. During the following year it was converted to a flour mill.

Hatfield Peveral mill was briefly used for silk Throwing. A five storied building three floors of which were set up for the throwing of organzine and tram some time after 1815 by South Morse [*Chelmsford Chronicle, 1815*]. The venture was a failure and the mill put up for sale in 1828, by 1832 it had been converted back to a corn mill [*The Times, 1828; Chelmsford Chronicle, 1832*].

Morse like all the other Essex silk throwers relied on the cheap services of children and young girls. The sale particulars of 1828, for Hatfield Mill, state that the lodging house contained 6 bedrooms with ample accommodation for 40 - 50 children. In 1825 fifty girls absconded form Morse's mill. When brought before the magistrates one girl explained that she worked six days a week, 6 a.m to 7 p.m for which she received 3/6d in the first year and 4/- in the second, paying 1/- for lodging and 2/6d for food and had little to eat but bread. The magistrates however showed little sympathy or compassion and sentenced her to seven days' hard labour. John Hall, when setting up in Coggeshall, found local families unwilling to supply him with labour and had to import 35 girls, aged from 11 to 16 to work as winders. The girls were lodged in a hostel under the supervision of a domestic superintendent. Courtaulds in the course of the nineteenth century became the largest industrial employer in Essex, employing, in the early years, predominantly women and children who in the early 1830's worked double shifts of 12 hours by day 101w by night [*ERO D/F 3: Parliamentary Papers*].

[key map number 3]

The design of maltings was such that most work could be done by hand although a malting at Goldhanger was fitted with a windmill [*ERO D/F 21/4, pp65*]. In breweries the method of handling the raw materials was similar to that of the corn mill, the aim being to hoist the grain, water etc to the top of the building and then allow as much of the progression to be achieved by gravity. Until the introduction of steam engines, possibly as late as the 1830's, Essex brewers seem to have used only horses to drive the liquor engines and other machinery. However the two main centres for distilling, at Westham and Colchester, were developed on the sites of water powered corn mills.

Daniel Defoe said of distilling "A new trade in England is increased to a prodigious degree by an accident in our commerce which is the Prohibition of Brandy from France" [*The Complete English Tradesman, 4th ed. 1727*]. Increased consumption lead to the 1736 Gin Bill which attempted to restrain the evils caused by the popularity of this spirit.

Distilleries were set up on the tidal section of the river Lea at Four mills, in Bromley St Leonard Middlesex, and Three Mills, Westham. From the fourteenth century the owners of Three Mill and Four Mills were in almost constant litigation with each other and other mill owners in Westham over water rights. There was also a conflict of interest between the millers and barge owners since the mill head of Four Mills was used to carry the Lea navigation down from Old Ford Lock to tidal gates at the mill.

In 1727 Peter Lefebure purchased Three Mills from Lord Bathurst and set up a distilling business on the site [*ERO T/P 48/3*]. Three mills in 1745 consisted of two buildings containing six water wheels, granaries and a near by windmill. In 1734 a partnership was formed between Peter Lefebure, mealman, John Grace, mealman, John Debonnaire, distiller, Samual Bisson, malt distiller and Cristopher Barton, distiller, £31000 was put into the business at the Three Mills and St Thomas Mill. Three mills was then used for flour milling and a malt distillery. Distilling probably ceased during the Napoleonic wars. The business later came in to the ownership of Phillip Muir, who leased the mill in 1815, milling then ceased and the site was used solely for distilling [*ERO D/DHt T121/9*]. Muir went bankrupt in 1872 and the property acquired by William Nicholson, with whom Muir had incurred heavy debts. Nicholsons also purchased the freehold from the Lord of the manor in the following year for £1550 [*The History of the Three Mills. E M Gardener*]. The property became an important part of the business of J & W Nicholson who used the water driven stones to grind some 600 quarters of maize, barley, or oats each week which in turn was used in the preparation of 30-40,000 gallons of raw spirit. This spirit was rectified at the Clerkenwell distillery which was the centre of the Nicholson's Gin business [*GLRO E/TMD/6/14; E/TMD/10/1*]. The operation of the Three Mills distillery was totally dependant on the river Lea, not only for driving the water wheels but also for supplying some 150,00 gallons of water a day for cooling and condensing purposes. All raw materials, grain and coal were brought in by water in barges [*GLRO E/TMD/8/3*]. In 1932 a flood relief scheme was completed filling in the Three Mills back river, the mills went out of use during the 1940's.

In 1789 Four Mills was being used by Messrs Hatch & Co supplying a nearby distillery they owned [*Sun Fire Insurance policy*]. In 1805 the mills were totally destroyed by fire [*The Gentleman's Magazine, April 1805*]. The mills were rebuilt and by 1827 there was in addition to the water wheels a 30h.p steam engine [*London Borough of Tower Hamlets, local history collection*]. The lease on the mill was acquired by Messrs Currie, malt distillers who remained until 1845 [*ERO D/DLo L2/2*]. In 1847 the mills were purchased by the Trustees of the River Lee who repaired the water wheels and machinery however the River Lee Navigation Act, of 1850, provided for the building of a tidal pound lock at the mills and Four mills ceased to be water

powered and continued under steam, in 1894 the site was occupied by the Sun Mills and Four Mills Distillery [*25 inch OS map*].

Hull mill, Colchester, a water corn-mill and oil-mill was purchased in 1811 by Samuel Bawtree and George Savill who pulled down the mill and erected a malt distillery and water corn mill. Unlike the distillery at Westham the water supply was limited and the power of the water wheel was soon "assisted by the powerful agency of the steam engine". The business expanded to an extent that in 1825 it was said some two to three thousand pounds a week was being paid to the government in excise duty [*T Cromwell, A History of Colchester. 1825*]. Distilling came to an end in 1841 when the partnership was dissolved owing to "great losses" [*Essex Review vol 59, 1950*]. Colchester Distillery then was worked as a steam and water corn-mill with four pairs of stones driven by steam and three by water but although occupied by several tenants it could not be made to pay and was demolished in 1897 [*The Miller*].

Writing in 1856 George Dodd commented that "the metropolitan distilleries, of which the number is small, are establishments of considerable magnitude, necessitating a large supply of capital; indeed the capital required is one of the reasons why they are few in number. The revenue raised by the excise duty in British made spirits is very large; and as the money must be paid before the spirit leaves the distilleries, there is always a large amount of capital thus locked up" [*The Food of London. G Dodd. London 1856*].

The rivers and streams of Essex do not carry sufficient volume of water to permit the commercial exploitation of hydro-electric schemes. The arrival of R. E. Crompton & Co., electrical engineers in Chelmsford in 1878 did however stimulate the private generation of electricity. Crompton pioneered the use of the d.c system of dynamos and accumulators. A pioneer installation was a Berechurch Hall, near Colchester, where a Crompton dynamo driven by a steam engine built by the Colchester firm Messrs Davey-Paxman lit up some 200 incandescent lamps. Crompton & Co were also responsible for lighting the streets of Chelmsford by electricity in 1890 [*R E Crompton, Reminiscences. 1928*]. Christy's the Chelmsford millwrights and iron founders who also operated as electrical light engineers from about 1886 were probably responsible for installing electric lighting using Crompton dynamos in local water mills. Christy's were at a later date to become involved with the construction and ownership of hydro-electric power stations outside of Essex.

In 1898 Bluemills, Witham, a former water corn-mill was being used as an amateurs work shop with the water wheel driving a dynamo which was used to charge accumulators for supplying 16 electric lights for the mill house [*ERO D/F 21/25 pp 55*0]. This basic arrangement was to be found in many country mills before rural electrification, although where there was also a steam engine it was usual for it to also drive the dynamo, as at East Mills in Colchester where 75 lamps of 16 candle power were fitted in 1889, this was increased to 125 lamps in the following year [*The Annals of One Hundred Years of Flour Milling, Colchester 1940*]. The installation of electric lighting in flour mills, which were predominantly of wooden construction, was a valuable precaution against fire, since the destruction of mills by careless use of candles or oil lamps was all to common.

There was talk in 1902 of using Walton tidemill to generate electricity but nothing came of the scheme and the mill was demolished in 1921.

In the 1920's a turbine-driven dynamo was installed at the site of Lt Waltham watermill, which had been demolished at the turn if the century. The output from the dynamo was used to power and light a nearby greyhound track [H. *Benham, Some Essex Water Mills*].

POWDER MILLS. The manufacture of gun powder in Essex was confined to the river Lea between Waltham Abbey and Westham.

In Westham during the sixteenth century gunpowder mills operated at Saint Thomas mills and at Three Mills [*ERO T/P 48/2*]. The powder mill at Three mills was said to "standeth more than it goeth" and the tenant of St Thomas mill had problems working due to Three mills penning the water up too high, so back-watering the water wheel of St Thomas Mill. During this period there was also a water powered powder mill near temple mills which apparently blew up and was not rebuilt [*ERO T/P 48/1*]. Powder making recommenced in 1642 when John Berisford took over the lease to Temple Mills. Berisford gave up the lease in 1650, the site was then used for boring guns and making shells. By 1687 gunpowder was again being produced, interestingly by Huguenot refugees. However disaster again struck in 1690 when the powder mills blew up killing some seven people. This was the end of powder making in Westham.

Powder making was carried out in Walthamstow for a greater part of the seventeenth century, although possibly not all of the mills were water powered. In 1659 John Samyne, who was one of England's leading powder producers with another mill at East Molsey in Surrey, purchased Walthamstow mill. Samyne had originally started production in Walthamstow in the 1640's to meet the demands of the civil war. In 1687 Samyne was said to be capable of producing four barrels of powder a day. After several business set backs including explosions at East Mosely and Walthamstow the powder business failed, Walthamstow mills were sold in 1690 and the mills given over to paper making.

John Berisford, who was formally making gunpowder at Temple mills, took over water powered gunpowder mills at Sewardstone, in the parish of Waltham Abbey. Berisford emerged as a major supplier of powder to parliamentary supporters at the beginning of the civil war but seems to have given up his interest in powder making at the end of the war. By 1651 the mills were in the hands of John Freeman a London merchant closely identified with the parliamentary side during the Civil war. At the height of the First Dutch War (1652-54) Freeman was supplying 75 barrels of powder a week, but seems to have given up his interests in gun-powder after the restoration. In 1709 Sewardstone mills were sold to George Wharton who also owned a powder mill which stood on a branch of the Lea in Enfield, and others in Chilworth, Surrey. The Enfield powder mills had closed by 1726 and became derelict. John Smeaton in a survey of the Lea, taken in 1766, marks the site simple as "frame lock formally old mill" [*ERO T/M 436*]. Powder making ceased at Sewardstone around 1715, this was probably due to a reduced demand for powder following the Treaty of Utrecht in 1713 which brought about a period of peace.

In 1879 the Schultze Gunpowder Co expressed interest in obtaining a lease on Sewardstone mills. Schulze had been operating in Hampshire for ten years but wanted to get nearer to London and also obtain a better water supply. Schultze were however unable to obtain a licence to manufacture gunpowder. [*GLRO Acc 2558/Nr13*]

The largest centre for powder making, in Essex, was sited to the north of the town of Waltham Abbey. Sometime around 1665 Samauel Hudson, who was miller at Waltham Abbey mill took over the lease of a nearby fulling mill and converted it to powder making, he also erected powder mills to the north of the town at Hooks Marsh. This impetus in powder making was brought about by a shortage of powder due to the Second Dutch War (1664-67). The operation of the Hooks Marsh mills was the subject of many complaints concerning penning up the river water which in turn caused flooding. Although the manor court ordered that they should be dismantled, it would them that Hudson only complied following

a downturn in the demand for powder at the end of the Third Dutch War (1672-64).

The powder mills were acquired by John Walton who died in 1702. The business paing to his widow Philippa who with other members of the family greatly expanded production by building water powered corning engines and stamping mills with a number of horse mills [*John Farmer, The History of Waltham Abbey, 1735: Essex Journal vol 20, 1985*]. This was achieved despite the long period of peace that followed 1713.

In order to control the production of powder the British Government had in 1759 purchased the gunpowder mills at Faversham, Kent. This act did not find favour with the private merchants who lobbied parliament claiming that they could supply better and cheaper powder. During 1783 the then Prime Minister Pitt was persuaded to recommend the sale of the Faversham mills. This lead to Major William Congreve, Deputy Comptroller of the Royal Laboratory at Woolwich, to make representations through the Duke of Richmond, Master General of Ordnance, that Government manufacture did in fact yield a profit and if this profit were properly expended in improving the mills then it would be possible to make powder more powerful and durable than previously manufactured. So successful was Congreve in his representations that not only were the Faversham mills reprieved but negotiations were opened with John Walton for the purchase of the Waltham Abbey powder mills. The Board of Ordinance purchased the powder mills in 1787. New water driven powder mills were built to the north and south of the town. So important was the water supply that the Board found it necessary to purchase Cheshunt mill in 1805 and Waltham Abbey corn mill in 1809 in order to gain total control of the river flow.

The production of powder was great enough to still require the use of horses. John Rennie who in 1806 was commissioned to survey and report on what improvements might be made to the government mills made the following comments regarding the use of horses :

> In respect to the first of all the powers that can be applied to the working of machinery (except men) horses are the most expensive and whenever any other powers can be obtained to work regularly horses should not be used. I have no hesitation therefore in advising that no more horse mills should be erected and that those are now at work should be laid aside as soon as other mills can be erected to perform their work. It appears from an account furnished by the officers of the Royal Gunpowder Mills that the expense attending the grinding of a given quantity of cake, by horses, is fourteen times as much as by water [*John Rennie Reports vol 4 pp122*].

New water powered mills, built with improved iron machinery replaced the old horse mills, however the flow of the river Lea was the limiting factor on expansion until steam engines were introduced. Most of the water powered mills were phased out after the first world war although some water power incorporating mills were still at work in 1940.

[Key map number 6]

By the seventeenth century both wind and water powered oil mills were recorded in Essex. Oil production in Essex seems to have been predominantly centered on rape seed with some linseed. The history of seed crushing in Essex is closely linked to the development of the leather trades.

LEATHER and OIL MILLS. The major centre for water powered oil and leather mills was in west Essex along the river Lea. A water powered leather mill existed in the 16th century at Temple Mills, Westham, but had gone by 1593. In 1627 a rape seed oil mill was erected on site of an old leather mill by Abraham Baker; however production discontinued on Bakers death in 1642 [*ERO D/DU 194/23,24*]. At Waltham Abbey a water powered fulling mill was converted to an oil mill some time after 1643, seed crushing continued until 1669 when the site became a gunpowder mill. A number of sites were developed as leather and oil mills, the oil mill supplying dressing for the skins. In 1619 Tottenham mills were described as corn and leather mills newly rebuilt. By 1622 there was an oil mill which caught fire and burnt down in 1723. The site was used intermittently for oil production until 1857 when the oil mill again burnt down [*ERO T/P 48/2: GLRO Acc 695/9 ff27-9*]. In Walthamstow a former corn mill was operating as a leather in mill 1711, however by 1742 the site was an oil mill producing Linseed oil. Production of linseed continued until 1808. [*ERO D/SH 1, ff24-46*]. Enfield mill which had two water wheels driving both a corn mill and leather mills. The leather mill was working in 1678 and in 1786 was described as a oil leather mill worked by water by Dutton Greenwood, leather dresser. By 1845 the site was used solely for flour milling. [*Sun fire insurance: Geographical Journal 1958: ERO D/DOp B19/3*].

Much Mill on the river Can, Writtle was in 1802 an undershot grist mill with a store for drying leather. By 1839 it was an Oil Mill occupied by William John and others. In 1853 a sale catalogue described the site as an oil and leather mill with a 7 foot fall of water, engaged in the manufacture of wash leathers. Beaches oil and leather works continued until 1870 when the mill was destroyed by a fire that started in the oil mill.

During the mid nineteenth century Lawford mill, Manningtree, a pond feed water corn mill was replaced by the Lawford Leather Works, an oil and leather mill. The site was taken over in 1930 for a pumping station by Tendring Hundred water works. [*ERO D/F 31/5*]

OIL MILLS. A number of mills were were used solely in the production of oil. A rape seed oil mill existed in Fobbing marsh in 1669 *[ERO D/DSq E1*]. This was a tide mill at the head of Shellhaven Creek marked as Island Mill in 1775 (*Andre and Chapman, map of Essex*). Oil production had ceased by 1818 when the site was marked as Oil Mill Farm at the head of a dammed up Creek, in Corringham marsh (*ERO D/DU 762/1*). Spilemans mill, on the river Lea backwaters in Westham. a former fulling mill and later a corn mill was referred to as an oil mill in the 17th cent. [*ERO T/P 48/1,2*].

Colchester was another centre for oil production. A Colchester deed of 1656 refers to a wind "oyle" mill and horse "oyle" mill which a few years later became a wind corn mill formerly an oyle mill, this stood near Hull mill on the Bourne Brook. Hull mill was then developed as a water powered corn and oil mill. Oil production ceased in 1820 when the mill was replaced by a malt distillery and corn mill. Lexdon mill, on the river Coln, Colchester, was converted from a corn mill (previously a fulling mill) to an oil mill in the early nineteenth century but burnt down in 1878 and was not rebuilt. Water power was later augmented by a steam engine [*ERO D/DE1 T289*]. Seed crushing continued in Colchester at a steam powered mill erected in 1884 by a Owen Parry, this mill finally closed in 1938[*History of Seed Crushing in Gt britain. H WBrace*]. Crockleford mill, on the Salary Brook

near Colchester, a former fulling mill converted to a corn mill was further converted to an oil mill about 1822. In 1823 after only three weeks working it burnt down. The mill was rebuilt and was up for sale in 1837 as a "chemical plant and water corn mill with three pairs of edge stones, two shod with iron". With this plant the London Chemical Works manufactured something called Mother Liquor. The mill was finally re-converted to a corn mill [*Benham, Some Essex Mills*]. Cooks mill, West Bergholt, when put up for sale in 1781 was said to be two fulling mills quite separate which might at small expense be converted to corn or oil mill and in 1825 was advertised as a capital corn mill part of which lately used as an oil mill [*Ipswich Journal 1781, 1825*].

OIL and CORN MILLS. Some sites operated as both oil and corn mills. Abbey mill, Westham, a wind and water powered mill was used for the production of Rape and Linseed oil during the early eighteenth century; production of Oil ceased by 1731. Langham mill on the Stour was also shown as a oil and corn mill on Andre and Chapman's survey. Stratford St Mary mill, the next mill down stream from Langham, an oil mill in 1752 an oil and corn mill in 1775, but was rebuilt as a corn mill in 1825. Wakes Coln mill, on the river Coln, was a oil and corn mill in 1775. Separate water wheels drove each process. The mill was fitted with six foot diameter edge runner stones which remained in use until the 1890's, although flour milling continued until 1974 [*ERO D/DB T005*].

Early seed crushing mills seem to have been sited in marsh lands near the main seed growing areas, away from population centres. This may have been due to poor transport but also because the process of pressing rape seed produced unpleasant vapours. This would seem to have been the basis of a complaint from James I [*History of Seed Crushing. H W Brace. London 1960*].

Whereas there is an oyle mill erected or used about Tottenham either in the highway or neare it, which is so offensive and noysome to his majestie when he passeth that way as it may not longer be suffered; these are therefore to require you to send for the partie or parties before you that have the use of that mill and straightly to charge and commaund them to leave making those oyles in that place which presently is to be done, because shortly his majestie may be occasioned to passe many times that way and if they shall refuse to doe and obey this commaund then wee require and hereby authorise you to see the said mill stayed from working and the parties to be brought before us presently, that we may take such course as shalbe fitt, for which this shalbe your warrant.

BARK MILLS. Bark was required for the tanning process of leather. Most tanners would have possessed a bark mill which were probably horse powered although there was some use of windmills and water mills. In 1829 a small water mill in Finchingfield was offered for sale with 2 pair of stones and also "an excellent cast iron BARK-MILL detached with wheel shaft on a improved plan". Applications were to be made to John Simpson late of the tan office Finchingfield [*Chelmsford Chronicle 1829*].

A tannery in Witham run by O H & E. Gray used a horse powered bark mill until about 1905 [*ERO D/F 21/26 pp660-61*]. In 1799 a John White, farmer and miller, insured his windmill in Maldon which was used for grinding corn and bark, but when the policy was renewed the following year there was no mention of bark grinding [*Royal Exchange fire policy*]. Daniel Taylor, a tanner of West Wickham Cambs, insured Hadstock windmill which was described as a "Bark Wind Millhouse" in 1806 [*Royal Exchange fire insurance policy*].

[Key map number 7]

COPPER MILLS. A copper mill stood in Sewardstone and was described in 1740 as a ruinous shed. The mill may have been out of use for some time. The site of the mill is shown on a map of the dated 1767 being marked as "here formally stood the copper mill and lock". The water ways that feed the mill wheel having been blocked off. [*ERO D/DQt 125: GLRO Acc 1953 bundle 42*].

In 1808 the site of Walthamstow oil mill was acquired by the British Copper Company, who had smelting works at Landore near Swansea. The building was equipped for rolling copper ingots into sheet, by millwrights Lloyd and Ostell, at a cost of £5,500. The British Copper Co was acquired about 1825 by Henry Bath & Co who in turn sold their interest in the copper mill in 1832 to William Foster & Co who continued copper rolling on the site until 1857 when the machinery was dismantled and shipped to their Morfa Rolling Mills near Swansea. At the time of the sale to Henry Bath & Co the copper mills consisted of a Rolling Mill, Back Mill, Crane House, Hammer Mill, Refinery, Smiths Shop and Mint also living quarters. The site was acquired by the East London Water Works in 1860. [*ERO D/CT 382: East London Papers vol 12, no.2, 1969/70*]

GUN MAKING. Daniel Defoe wrote of a water mill which had been erected at Temple Mills, Westham, for the purpose of boring guns [*D Defoe, An Essay upon Projects. London, 1797*]. The project it seems was under the patronage of Prince Rupert, uncle to Charles 2nd, who had devised a metal that Defoe describes of being of a reddish colour, different either from brass or copper. Guns of this metal were bored at Temple Mills and fitted on board his majesties ship the Royal Charles. This particular enterprise seems to have been short lived and probable come to an end with the death of Prince Rupert in 1682.

In the period that folowed the French revolution and the ensuing war with Britain the British government found itself dependant on private and foreign suppliers. To ensue the production and supply of armourments the The Royal Small Arms Factory, at Enfield Lock, were developed by the British government.

In 1812 land at Enfield Lock on the river Lea was purchased with a view of building a small arms factory. The manufactory was built to a design submitted by Lloyd and Ostell in 1814. In this design there were two water wheels, one 13 foot wide and 18 foot in diameter, the other wheel 14 feet wide and 18 feet in diameter. One wheel was to drive 6 rough boring benches on the ground floor the second wheel was to drive 2 grind stones on the ground floor and on the top floor 9 fine boring benches, 1 chamfering bench, 2 cross cutting laths, 1 rifle barrel lath and 10 turning laths. The factory was at first concerned with the assembly of the Brown Bess musket, in 1816 gun barrel manufacture was transferred from Lewisham. The manufactory were awarded a contract to produce five thousand Baker rifles. In the main gun barrels were produced with other components being made by subcontractors. The weapon being then assembled at Enfield. A map drawn in 1852 gave two undershot water wheels working at the the Armoury Mills.

In 1854 a Select Committee on Small Arms found that the manufacture of guns on which the Government relied upon in times of emergency had many short-comings and the Board of Ordinance decided to take over the full manufacture of small arms. At a cost of £240,000 the Enfield factory was rebuilt with most of the old buildings being demolished. Water power was discontinued. [*PRO WO/78/1461: ERO D/DOp B19/3: Edmonton Hundred Historical Society, occasional paper No.50*]

IRON WORKING. Around 1693 an attempt was made ar Temple mills, Westham, to

smelt iron using pit coal. A partnership had been set to exploit a patent granted in 1687 (patent number 253) for a new method of smelting metals. This venture however failed when the partnership failed to raise sufficient finance.

In 1733 there was at Abbey mill, Westham, a "water mill iron forge" erected by William Bodaker a London merchant who had obtained a lease around 1731. The site was used for forging iron and milling corn. Abbey mill had two water wheels and a wind mill, the iron forge probably replaced an earlier oil mill.

LEAD MILLS. In 1776 there was a lead mill at Temple Mills, Westham, which had been in operation smelting lead since about 1716 although the exact nature of the business is not recorded [*ERO D/SH 3*].

PIN and NEEDLE MAKING. Abbey Mill, Waltham Abbey, was fitted with two water wheels which in 1775 drove a corn mill and a silk mill. The silk works become a pin manufactury in 1788 owned by Timothy Harris, who was granted a patent (No.2182) in 1797 for "A New Method of Manufacturing Pins with Iron and other Materials and making the same White." Pins were made of iron or brass wire with the head made of either spun wire or cast metal, usually lead. Water power probably drove the stones which were needed for putting a point on the pins, Harris notes in his patent that "the face of my mill must be for iron much harder, and have a sharper cut, or it will not stand the grinding, iron being much harder to point than brass. In 1814 the pin works were said to be an extensive factory that could be worked by steam or water. The works were then moved to another site in the Rome Land. In 1818 there were proposals to use the pin factory as a store for the corn mill which was producing 300 quarters per week and was short on storage space. By 1821 the pin factory was a small saw mill with two buildings marked as storage for the corn mill, these may have been used for pin making [*ERO D/DC 27/803, 804: D/CT 8*0].

There was another pin manufactory at Lea Bridge mills, Hackney. On the 14 January 1796 a fire totally consumed the flour mill. Newspaper reports also noted that "The works which supply Clapton with water were also destroyed; and a considerable pin or needle manufactory, with much timber on the wharf, and about 3000qrts of wheat and flour, the property of the government**"** [*The Times*]. The flour mill and water works were rebuilt but of the pin Manufactory nothing else is known.

TOOL MAKING. A cutters mill, which replaced a gun powder mill, existed at Temple Mill, Westham, which in 1627 was said to be decayed. [*ERO T/P 48/1*]

[Key map number 8]

The essential chemical constituent of paper is cellulose, the main component of plant tissues. In early paper mills this was obtained from rags, the other essential ingredient being water. For white paper linen rags were used, old ropes, ships sails and cordage being used for coarser brown paper. The process of paper making required the separation of the fibres from surrounding substances leaving a mass of macerated fibres in suspension. Before the eighteen century this was carried out by washing and sorting the rags into heaps which were then allowed to rot until fermentation set in. Whilst rotting the piles of rags were turned and watered. After fermenting the rags were pulped in a water driven stamping mill. The requirement for copious supplies of clean water for washing the rags and driving the water wheel dictated the location of paper mills. The earliest known paper mill in England was near Hertford and was at work when visited by Henry VII in 1498. Until the end of the seventeenth century the greater part of paper used in England was imported [*The British Paper Industry 1495-1860. D C Coleman*].

In Essex, paper mills seem to have been developed on sites previously used for other industrial processes such as fulling or powder making. In the early eighteenth century the process of pulping the rags was greatly speeded up by the adoption of beating-engines or "Hollanders", a dutch invention which reduced costs and speeded production. There is insufficient information available to date the introduction of the "Hollander" in Essex paper mills, although the demise of paper making on the river Lea, at a time of rising UK paper production and consumption, may have been due to the introduction of the "Hollander" elsewhere.

Along the river Lee a number of paper mills were developed during the latter part of the seventeenth century. In 1619 Tottenham mills was a water corn mill and leather mill, by 1622 there was an oil mill which probably replaced the leather mill and in 1656 the corn mill was being used for making gunpowder. By 1678 a paper mill had been erected on the site and remained in use until 1697 when the mills were again given over to oil production. [*John Holwell survey of the Lea 1678*]. 1723 the oil mill court fire and was burnt down but had been rebuilt by 1735 as a paper mill when Israel Johannot, paper maker insured the mill, which consisted of a mill, timber and tiled, dwelling house, store house and drying house. For the years 1757 to 1761 Thomas Cooke, was the paper maker, the mill also included a rag house. The Society of Arts made awards in 1763 and 1764 to a Thomas Cook for making paper for copper plates. Paper making had ceased by 1770 when the mills were leased to Edward Wyburd, miller, who rebuilt the mill in 1788 after a fire [*GLRO Acc 695/9: Acc 1016/475*]. Walthamstow mills produced gun-powder until 1690 when the site was sold and the mill converted to a paper mill by William Church. Church was involved with the White Paper-Makers Company which would seem to suggest that he was producing the finer quality white paper. Church died in 1694, the business was carried on by his widow, paper making ceased around 1703 [*ERO D/SH 1, ff 24-46*]. Saint Thomas mill, Westham, was converted from a corn mill to a water powered paper mill in 1764 by John Keats, a Stratford paper maker. However litigation by the owners of Three Mills over the water supply to their mills, forced him to close the mill some time after 1769 [*ERO T/P 48/3: PRO C12 1017/7*].

On the river Stour, Lower Marsh Mill, Long Melford was to be let as a "convenient" paper mill in 1711 with a good drying house and all utensils [London Gazette 16-19 February 1711]. Michhael Beadle was paper maker in 1759 when the mill was described as both a paper and corn mill [*Sun Fire Insurance policy 223787 20/8/1765*]. In 1834 the mill had two engines ("Hollanders") and three vats. The last occupiers were F W Reeves and Co who in 1862 were turning out "Browns" etc. The site later became part of the Stafford Works Essential

Oil Distillery. The next mill down stream from Long Melford was Liston Mill which was described as a paper mill in 1736-7 [*ERO D/DQ 84/80,82*].

At Greenstead Green on a small stream feeding the river Coln an overshot corn mill was converted to a paper mill in 1823. The water supply proved insufficient and the business was expanded with additional steam power. In 1862 the mill was said to be the only paper mill in Essex. In 1870 the mill was put up for sale, however, four years later it was pulled down and the machinery removed to establish the steam powered Halstead Paper Mills Co which survived until 1889 when it closed down due to competition from cheap foreign imports [*ERO D/DCc T26*].

In central Essex, on the river Chelmer, Hurscardes mill in Hatfield Peveral, was described as a corn and fulling mill in 1589 [*ERO T/P 39*]. By 1677 the fulling stocks had been replaced by a paper mill. In 1679 a new drying house was built by the land lord for the tenant John White [*ERO T/M 190*]. A stock of ropes in the yard, insured in 1776, suggests that common paper was being made from rope materials at the mill [*Sun Fire insurance policy 367529 11/4/1776*]. The site was still a corn and paper mill in 1816 operated by Benjamin Livermore, paper maker and miller. The Livermores gave up making paper around 1850. The site being then used for a number of industrial uses including grinding of mica and carbon for arc lamps. An attempted was made at making embossed paper, which failed due to the dampness of the site.

[key map number 9]

The East London Water Works was established in 1808 taking over a number of established undertakings. The company went on the acquire a number of water mill sites along the river Lea either adapting existing water wheels for water pumping or pulling down the mills and replacing them with turbine powered pumping stations. Not all mills were used, some such as Temple mills and Tottenham mills were acquired for the water rights and then pulled down.

One of the undertakings taken over by the East London Water Works was the Westham Water Company This company, founded in 1743, were the owners of a water works on the site of Saynes mill, Westham [*ERO D/SH 3: ERO T/P 48/1*]. The Westham company were until 1783 rival of the Shadwell company, founded about 1670, who used horse-driven pumping machinery [*East London Papers, vol 12. 1969*]. Saynes mill was purchased from the Bridge House Committee by John Cox in 1723 [*Journals of the Bridge House Committee*]. In 1742 Cox sub let some of the land he leased from the City to a Resta Patching of Dorking, for the erection of a steam engine and construction of several reservoirs [*ERO D/DU 621/1-9*]. Perhaps the steam engine was not a complete success for in 1762 John Smeaton was asked to drew up plans for a new corn mill and water pumping engine, on the site of Saynes mill.

Smeaton was during this period also building steam engines, however the choices of water power seems been one of operating costs. The main problem with early steam engines was the prodigious consumption of coal. The proprietors of the York Buildings Water Works, in the Strand London, got into serious financial difficulties, in 1731, through using a steam engine which consumed some £1000 worth of Newcastle coal per annum. The Company was forced to continue using only using horses and did not return to steam until 1752. In Pimlico, the Chelsea Water Works also drew water from the Thames but with both steam and water power, using two steam engines, and pumps driven by two water wheels [*A Treatise on the Steam Engine. J Farey, London 1827*].

The new works at Westham had been constructed by 1766 at a cost of upwards of £40,000. The building was to contained two water wheels, one driving the pumping machinery the other the milling stones [*act of Parliament for improving the river Lee, 1767: Smeatons designs vol 6, ff 84v*]. It seems through insufficiency of water the corn mill was never completed, it was pulled down in 1789 to make way for further improvements in the pumping equipment. The East London Water Works, who acquired the Westham company some time before 1864, demolished the water works by 1893 [*6" OS map*].

Lea Bridge Mill was another mill acquired by the East London Water Works. These mills had been working as a corn mill and water works since about 1710 supplying the inhabitants of the parish of Hackney "with good wholesome water". The mill and water works were destroyed by fire in 1796 and were back in operation by 1798 [*An Act for Improving the River Lee. 1766: John Smeaton, A Survey of the River Lea, 1766: The Times 1796*]. The East London Water Works took over in 1828 and in 1837 the corn mill was pulled down being replaced by a a pump house with two water wheels driving four pumps [*Antiquities of Hackney, 1842: ERO Q/RUm 1/29*]. In 1885 a new pump house was erected to house two Hercules water turbines. The water turbines went out of use when the site was enlarged with the use of steam engines.

In 1860 the East London Water Works purchased the site of Copper mill, Walthamstow. The existing water wheel was then adapted to drive plunger pumps. In 1864 the company added an italianate tower to the west side in which they housed a Bull steam engine [*East London Papers, vol 12, 1969*].

The next mill to be purchased by the East London Water Works was Chingford mill which

was acquired in 1873 in order to secure the water rights. Corn milling continued until 1883 when the mill demolished and replaced by a pumping station [*The Miller 1883, 1886*]. A 450 foot deep bore hole was sunk on the site. A water turbine was set up in temporary building on the site of the former mill, this was used as a standby to a steam engine set up over the well head. A second turbine was subsequently added and a permanent pump house built, the steam engine was dismantled and pumping continued by water power only. In 1895 a second well was dug over which a steam driven pumping station was built. In 1903 an aqueduct was built upstream of Chingford mill to increase water abstraction from the river Lee to newly built reservoirs, this greatly reduced to flow of water to the mill pumping station which resulted in the water turbines having to be augmented with pumps in the new steam pumping station. The turbines subsequently fell into disuse and were removed around 1914 [*Chingford Historical Society, bulletin No. 9*].

Terling Water Works. In 1868 the village of Terling was stuck by an epidemic in which over fifty villagers died of typhoid. The epidemic was blamed on contamination of wells by sewage, and a plan to supply the village with clean water was immediately implemented. The source of water chosen was a spring in the grounds of Terling Place occupied by the Strutt family who also owned Terling water mill, then disused [*ERO D/P 299/5/2*]. A water powered pump was installed at the water mill, water from the spring flowed down to the mill to be pumped up to stand pipes set up around the village. This arrangement proved adequate until around 1920 when a new iron water wheel and a three cylinder pump was installed raising water to a concrete cistern. In 1932 electricity arrived in Terling and a new pumping station was built to replace the water powered pumps [*A Story of Terling, G Isted 1977*].

Chelmsford Water Works. To meet a rising demand for water the Corporation of Chelmsford purchased in 1923 Sandford mill, on the Chelmer, with the millers rights regarding water flow. The wooden corn mill was pulled down and replaced by a brick pump house fitted double acting piston pumps powered by two Armfield water turbines and 105 h.p diesel engines [*Inauguration of the Water Works at Sandford Mill, Chelmsford 1930*]. Water power lasted only until the 1930's when the works were expanded and the old mill stream dammed off. The use of water turbines may have been due as much as anything to the enthusiasm of Alfred Bradbridge of Springfield Watermill. An influential member of the county council Bradbridge had served his apprenticeship at Sandon mill, under John Perry the last miller [*Some Essex Water Mills. H Benham*].

CONCLUSIONS

Essex is a county of small sluggish rivers, flowing through gently sloping river valleys with limited potential for large hydro schemes. The establishment of some industrial processes in Essex which although reliant on water power seem to have been dependant on a number of external factors.

Undoubtedly the greatest use of water power in Essex was in the commercial production of flour. From the twelfth century water grist-mills were to be found in every Essex parish. Although there are few early records it would seem that from the thirteenth century the demise of many small water mills corresponded with the rapid spread of the independently owned windmill. However a reduction in mill sites would have enabled the larger mill owners to raise their dams and so increase the power of their water wheels. The loss of trade to the windmillers would have caused mill owners to look for tenants outside of the traditional business of grist milling. The availability of clean water to cleanse the cloth and drive the fulling stokes undoubtedly dictated the location of the major cloth towns in Essex. Around Colchester, and Bocking, almost all of the available mill sites were given over to the fulling of cloth, and such was the demand it also became necessary to build new fulling mills on previously un-exploited streams. Although some mills were duel function, being both grist and fulling mills, it would seem that windmills became major suppliers of flour in these areas. There do not appear to be any record of a wind powered fulling mill operating in the county.

The application of water power enabled the silk industry to grow more rapidly than would have been possible with horse-mills. In Essex, the arrival of silk throwing coincided with the end of the cloth industry and seems to have been fuelled more by a ready supply of cheap labour, rather than the availability of redundant fulling mills. Although the establishment of the industry in Bocking and Halstead was based on water power, expansion was by the use of steam engines; unlike the cloth industry, which came and went using only water power,

This study highlights the lower Lea as being the area of greatest exploitation of water power. Clearly an important area from early times since the Doomsday survey lists some thirteen mills. We do not know what these mills were used for but the importance of flour milling diminished as sites were developed into industrial complexes by 1600. This process of industrialization, which seems to have speeded up following the sale of Abbey lands and Mills, was greatest in Westham but eventually extended up river as far as Waltham Abbey. Undoubtedly this was due to the close proximity of the London markets. This and readily available mill sites does seem to have attract significant numbers of entrepreneurs, who held patents of invention, into the area in order to exploit their monopoly. The diversity of manufacturing processes that existed along the river Lea did not occur elsewhere in Essex. The establishment of the gunpowder industry in the Lea valley was probably due as much to the political affiliations of the powder makers as the availability of suitable mills sites. The area being sympathetic to the government cause, during the conflict between King and parliament.

The development of the steam engine allowed manufacturers to site their factories away from river sites and effectively brought an end to an era of water power. This diminishing importance of water power enabled the exploitation of water resources for other reasons to be increased. In metropolitan Essex it was a rising population and their need for clean water which put the greatest pressure on water-mills. Although early water works were themselves water powered drawing water directly from the river, any subsequent development of water reservoirs supplied by steam driven pumps was hindered by the water rights of millers. To ensure greater extraction rates the expanding water companies found it necessary to buy up and remove water mills. It would appear that only the tide mills of the lower Lea were free

from the interest of the water companies, although one of them, Four Mills, eventually lost its water rights to meet the demands of a tidal lock on the Lea Navigation.

By the mid nineteenth century, outside of the traditional area of grist milling, the use of water power appears to have been rapidly phased out.

INDEX TO MAPS