3.0 HYDROLOGY

3.1 History of Canal Water Supplies

The St Helens Canal was originally supplied, within St Helens, by tributaries of the Sankey Brook including:

Rainford Brook,
Windle Brook, including Mill Brook,
Thatto Heath Brook, and
Black Brook.

The exact area of the original canal catchment could not be determined, as few records exist detailing which tributaries were used to supply the canal. The original Act of Parliament mentioned three tributaries of Sankey Brook and one or more of the above appear to be those to which it refers.

The chronology of the canal sources is given below together with key events in the canals history to act as reference dates :-

Table 3.1 : Chronology of the St.Helens Canal and its Sources

Date	Event
1755	The Canal Bill receives Royal Assent. The Act mentions 3 tributaries of the Sankey are to be used to supply the Canal. (probably the Black, Rainford and Windle Brooks.)
1757	The Canal opens to traffic between Sankey Bridges and Black Brook.
1762	The Canal is extended from Sankey Bridges to Fiddlers Ferry.
1775	The Ravenhead, Sutton and Gerrards Bridge Branches in St.Helens are completed.
1786	Mill Dam and Big Dam appear on the OS plan (the earliest available) in the Windle Brook Catchment. Their purpose is unknown. It is almost certain that Mill Dam was constructed as a supply to Eccleston Mill, but whether the Big Dam was constructed to secure supplies to the canal or as additional storage for the Mill cannot be determined.
1801	The earliest reference to Carr Mill Dam appears in an agreement allowing the Proprietors of the Sankey Navigation to construct an embankment at the upper end of Carr Mill Dam. It is likely that the original Carr Mill Dam was considerably smaller than the present reservoir and predates the canal.

Table 3.1 : Chronology of the St.Helens Canal and its Sources

Date	Event
1818	Little Dam appears on the OS plan and was originally much larger than it is at present. Its purpose is unknown, but a new Mill also appears between Big Dam and Mill Dam and this may have necessitated its construction rather than the needs of the canal.
1828	Little Dam, Big Dam and Mill Dam appear on the OS plan, but there is no evidence of the Paddock Dam and the Leg of Mutton Dam. The Canal company acquire additional water rights at Carr Mill Dam.
1830	The Canal Company acquire additional rights at Carr Mill.
1842	The Canal Company acquire the leasehold to Carr Mill Dam and all the water rights to Black Brook.
1844	As part of an early water supply scheme for St.Helens, Samuel Taylor (owner of the Eccleston Hall Estate) conveys to the St.Helens Waterworks Company Paddock Dam and the Leg of Mutton Dam.
1845	The Canal Company is amalgamated with the St.Helens and Runcorn Gap Railway Company.
1849	The OS map (surveyed in 1845-46) shows Little Dam, Big Dam, Paddock Dam, the Leg of Mutton Dam, and Mill Dam. It also indicates that a number of watercourse diversions may have taken place to supply these. Eccleston Mere does not appear on these plans. Carr Mill Dam is shown as 2 smaller reservoirs separated by an embankment (presumably the one mentioned in the agreement of 1801). In addition, Carr Mill is shown situated at the edge of the lower reservoir. This was possibly a large grain mill which is presumably now buried in the right flank of the present Carr Mill Dam and Reservoir.
1851	Samuel Taylor leases Big Dam, Little Dam, Mill Dam and Eccleston Mere to the Canal and Railway Company. The Waterworks Company transfer their rights to Paddock Dam and Leg of Mutton Dam to the St.Helens Improvement Commission (a for-runner of St.Helens MBC).
1860	The lease on Carr Mill Dam is renegotiated to allow the cill on the upper dam to be raised by 4 feet.
1864	St.Helens Canal and Railway Company is absorbed by the London and North Western Railway (LNWR). As a subsidiary part of the London & North Western Railway Company Act, agreements were reached with the Gerrards Estate to raise the level of the southern most embankment at Carr Mill Dam by 15 feet. These agreements also required the supplies to Stanley Mill and Carr Mill to be maintained during and after the raising of the embankment.
1866	The LNWR acquire Carr Mill Dam from the Gerrards Estate for a proposed new embankment (the one that exists today) and the diversion of roads around Carr Mill.
1888	The St.Helens Corporation make a unsuccessful attempt to claim the right to modify the watercourses supplying Paddock Dam. They also make an unsuccessful attempt to acquire the Railway Company's water rights in the catchment.

Table 3.1 : Chronology of the St.Helens Canal and its Sources	
Date	**Event**
1890	Carr Mill Reservoir and certain shallow mineral rights are conveyed to the LNWR (predecessors of British Waterways), but the sporting, fishing and recreational rights are retained by the Vendor (Gerrards Estate).
1893	St Helens Corporation acquired Little Dam and Big Dam and the associated water rights through a series of agreements and Deeds of Gift as part of the Taylor Park package.
1898	The end of the Ravenhead branch is abandoned. Thatto Heath Brook that used to supply this section is diverted into Hardshaw Brook. Windle Brook is diverted to supply the canal near Pilkingtons
1912 to 1914	By 1914 Pilkington Bros. Ltd appear to have acquired Mill Dam and Eccleston Mere from the Railway Company.
1931	The Canal is officially abandoned between St.Helens and Earlestown.
1959	Last cargo of sugar carried to the Sankey Sugar Works.
1963	The remainder of the Canal is officially abandoned.
1974	The ownership and rights to Paddock Dam and the Leg of Mutton Dam which formerly belonged to the St.Helens Waterworks Company, were transferred to the Water Authority. However, the surrounding land at Leg of Mutton Dam is retained by St Helens MBC.
1985	The Sankey Canal Restoration Society (SCARS) is set up.

The various owners of the canal pursued an active policy of extending and improving their water rights in the area throughout the canal's history. This reached a peak around the middle of the 1800's when water supplies to St. Helens were being developed.

However, no evidence can be found that indicates that this policy was in any way due to a specific shortfall in-water resource or operating problems associated with the canal. The extending and acquisition of water rights in the catchment by the canal companies seems to have been a means of protecting their commercial interests by establishing security of water supply.

During commercial operation of the canal it is understood that the water supplies to the lower pounds could be supplemented by:

- operating sluices at Water's Meeting at Dallam to cause levels within Sankey Brook to back up until water was high enough to flow into the canal

- using pumps to transfer water from the River Mersey at Widnes

3.2 Existing Situation

The sections of canal which still remain in water are sustained by the following sources:

Pilkington's Canal Feeder
Rainford Brook
Carr Mill Dam
Callands Brook
Cooling Water from Fiddlers Ferry power station
Discharges from stormwater sewerage systems and minor land drains

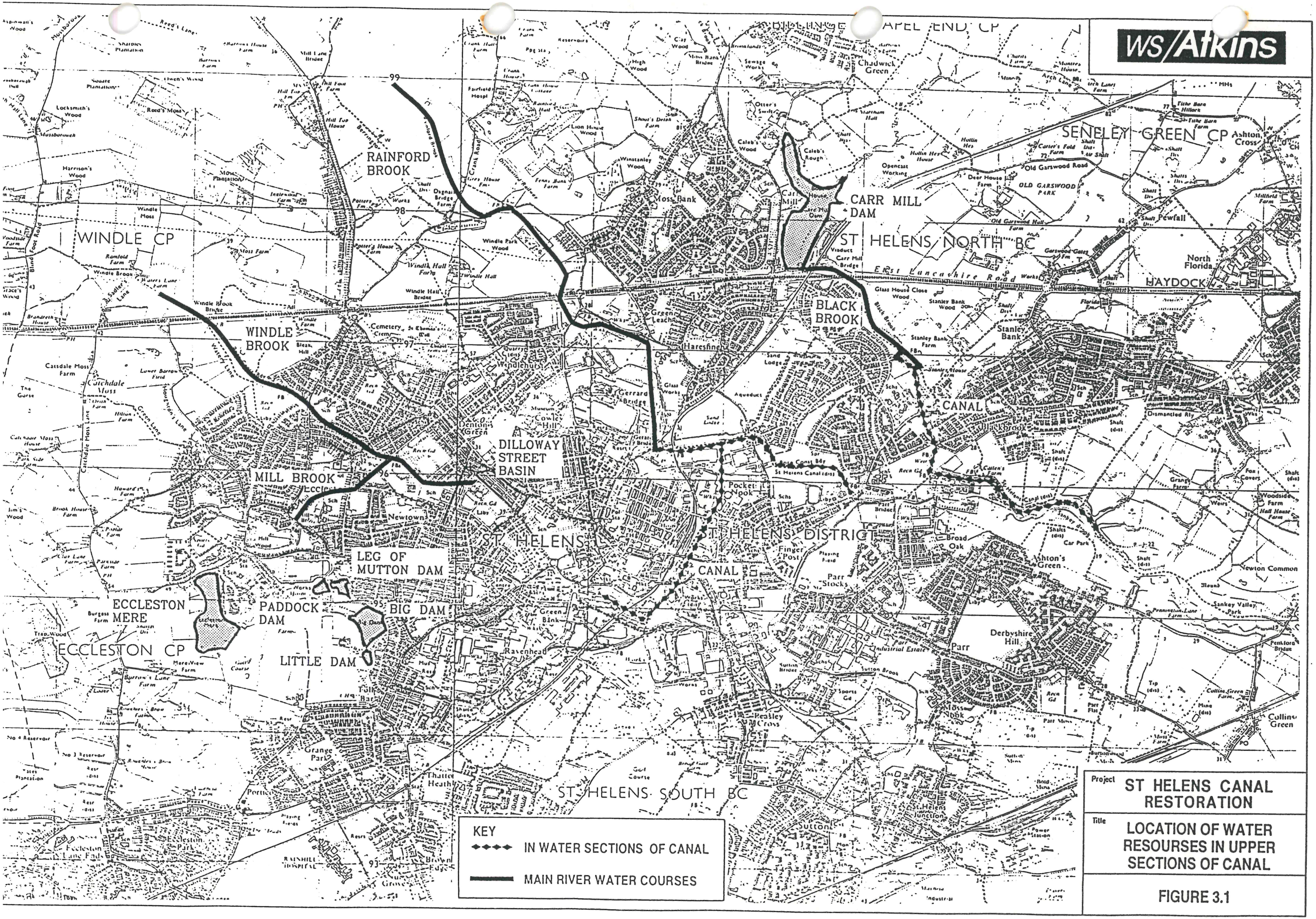
These are described below, with Figure 3.1 showing the location of the water resources in the upper sections of the canal. Figure 3.2 is a schematic layout of the existing supply regime in St Helens.

Pilkington's Canal Feeder

The glass manufacturer Pilkingtons own and maintain the reservoirs to the west of St Helens, Mill Dam and Eccleston Mere, which secure a water supply for their manufacturing process. Water from these reservoirs joins Mill Brook and eventually Windle Brook and the combined volume of water flows on into Dilloway Street Basin in St Helens.

At the Basin the flow is split equally between the canal feeder and Hardshaw Brook. The water diverted into the canal feeder supplies 'The Hotties' near the Safeway Supermarket, from where it is abstracted by Pilkingtons for cooling in their manufacturing process.

Downstream of the abstraction point there is a weir which is used to monitor the supply of water from 'The Hotties' into the main canal. Pilkingtons have an obligation to supply 12 Ml/day over this weir which was originally intended to maintain supplies to other companies abstracting water from the canal downstream of Pilkingtons. Although these firms have now closed down, or found alternative supplies, Pilkingtons still maintain their obligation, even though it is not monitored by any regulatory body.

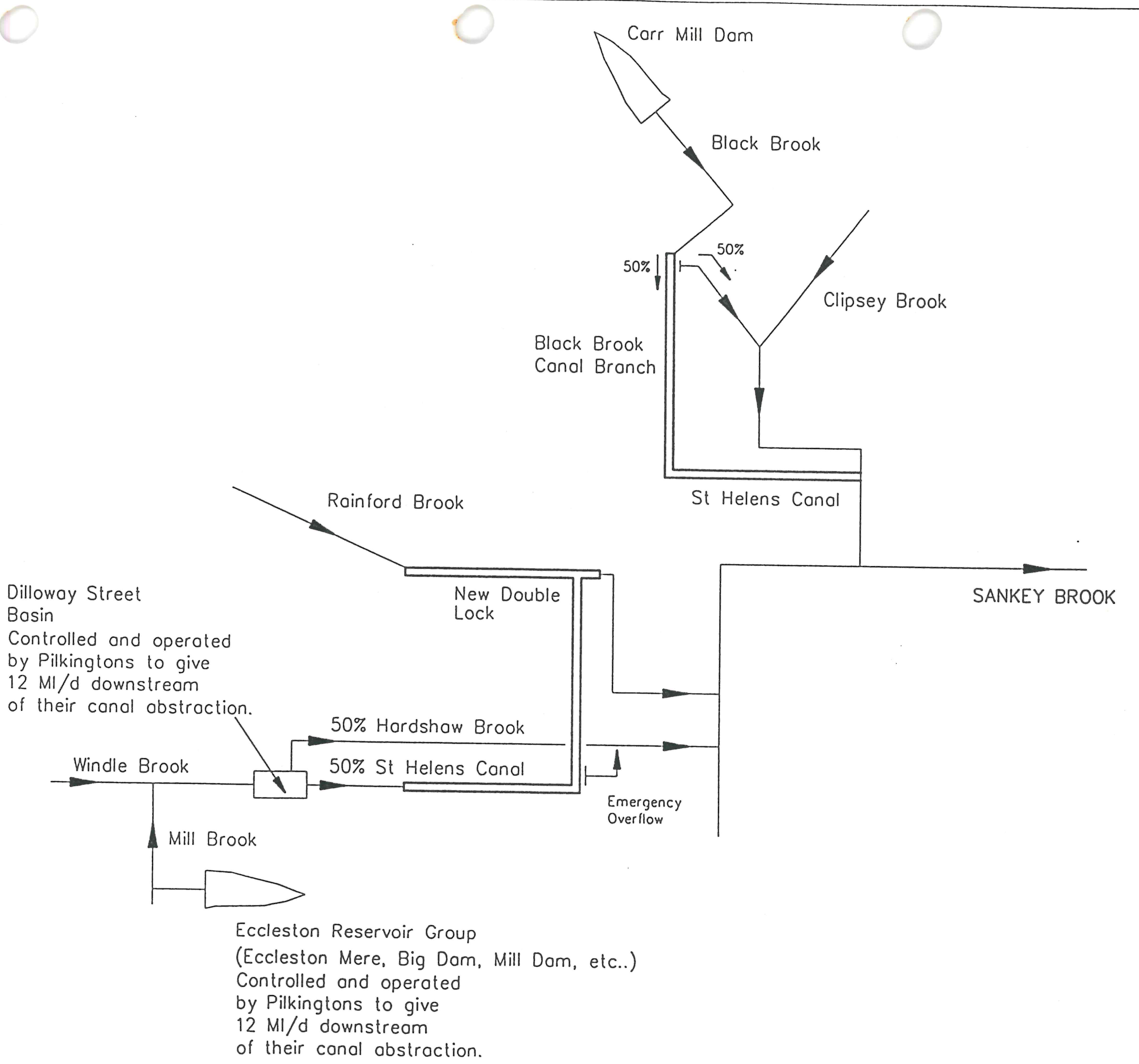


WS/Atkins

Project: ST HELENS CANAL RESTORATION

Title: LOCATION OF WATER RESOURSES IN UPPER SECTIONS OF CANAL

FIGURE 3.1



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Project ST HELENS CANAL RESTORATION

Title EXISTING SUPPLY REGIME IN ST. HELENS

FIGURE 3.2

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Pilkingtons have a long term objective to cease canal abstractions and, if this is achieved, they have expressed a willingness to negotiate a transfer of the reservoirs and water rights to a canal operating body at minimal cost. In the meantime, modification of the existing system to supply the canal would be supported by Pilkingtons.

Rainford Brook

Rainford Brook was originally diverted into the Gerrards Bridge section of the canal but, since the infilling of the section from Park Road it has discharged over a weir into Sankey Brook. The canal is designated "main river" by the Environment Agency (EA)[2] from Gerrards Bridge to the overflow weir and Rainford Brook is considered to be a high quality source.

Use of this water as a canal supply will require an abstraction licence from the EA and the level of compensation water to be released to the Sankey Brook agreed. As Rainford Brook provides dilution to Sankey Brook it is unlikely that abstraction from Rainford Brook would be permitted under low flow conditions.

Carr Mill Dam/Black Brook

Carr Mill Dam impounds the upper reaches of Black Brook and is owned by British Waterways. The reservoir was originally used to control flows to the Blackbrook branch of the St Helens Canal but in more recent times it was used to supply 6 Ml/d of process water to an industrial user (Sidac). Water discharges over the spillway into Black Brook and then into the Blackbrook branch of the St Helens Canal. The dam is inspected under the 1975 Reservoirs Act and was last inspected in 1988. No problems were reported and the next inspection is due in 1998. British Waterways have expressed a willingness in the past to dispose of Carr Mill Dam to a canal operating body at minimal cost.

The Blackbrook branch of the St Helens Canal is designated "main river" by the EA. Black Brook originally fed the canal at Stanley Bank Basin, above the Ship Inn, but the point of its connection was subsequently moved upstream to the present branch terminal basin. There is an overflow from the canal into the original course of Black Brook at Stanley Bank Basin. Black Brook, from this point a minor watercourse, causes occasional flooding to properties near the Ship Inn on the A58. In the past,

2 The "Environment Agency" is the successor body to the National Rivers Authority

this has been due to overtopping of the basin wall due, in part, to the restrictive nature of the outlet from the basin into a culverted section of Black Brook.

High flood water levels are currently prevalent in the canal branch due, most probably, to the reduced waterway capacity resulting from siltation and the spread of vegetation growth in the canal.

Dredging of this branch section of the canal is problematic and restricted through various legal obligations and safety requirements associated with the North West Multiple Pipeline Route, which includes pipes laid in the bed of the canal. High minimum water levels are required in the canal branch and these are provided by a sheet piled weir at the downstream end. This, together with the level of the basin overflow, is such that, even during dry weather, a proportion of the water released from the dam spills into the Black Brook and, hence, is lost from the canal.

Callands Brook

The catchment is heavily urbanised and the brook flows through Gulliver's World Theme Park, entering the St Helens Canal just downstream of Bewsey Lock. It is usually dry for much of the summer which may be due, in part to the activities within the Gulliver's World site. The EA has advised, however, that this was an unreliable source even prior to the opening of the Theme Park.

On the west bank of the canal just north of the seven arches railway viaduct there is another supply to the canal from a land drainage system (at chainage 9,815m). The extent of the area this drains cannot be determined and the drainage does not appear on any maps. It is thought that this may drain a large area as the flow into the canal is continuous and can, at times, be considerable.

Fiddlers Ferry Power Station (PowerGen)

PowerGen can discharge water from Fiddlers Ferry Power Station into the canal. This water, abstracted originally from the River Mersey, is pumped into a lagoon south of the canal to allow solids to settle out, prior to the water being used for cooling within the power station. There are facilities to transfer water into the canal either from the feed or return pipework.

There is no formal agreement committing PowerGen to supply a specific quantity of water to the canal but it is subject to discharge consent conditions in terms of quality. Water is supplied on an ad-hoc basis and PowerGen has advised Warrington Borough

Council that no reliance should be put on these supplies and that summer shut downs are likely.

Stormwater Systems and Land Drainage

These are not reliable sources and can only be assumed to contribute to the canal during storm conditions. During a drought period such sources will not contribute any significant water volume to the canal. These sources only contribute to the canal during storms following a long drought period when the canal water level has fallen below the level of the overflow and by-wash weirs. The water quality impacts of these type of discharges can be detrimental.

3.3 Canal Water Resource Requirements

It is difficult to make a direct measurement of canal losses as none of the inflows to the canal are measured and the existence of some, such as groundwater infiltration, are difficult to quantify. A full monitoring exercise was not possible as part of this study but some ad hoc water level measurements were taken in order to assess the effect of dry weather in the summer of 1995 and to ensure that a reasonable estimate of canal water requirements was being made.

The 3 main areas of water demand for a fully restored canal are:

Lockages - the quantity of water needed for boat movements through locks; this is normally passed on down through the canal, together with any leakage through lock gates

Seepage - the volume of water required to replace that lost into the ground through the canal bed and structures

Evapotranspiration - the volume of water necessary to replace that lost due to evaporation from the surface and the transpiration of waterside plants

These are discussed below:

Lockage Losses

The use of all locks on the canal, with the exception of the two river entrance locks, results in a transfer of water along the canal. The loss of water from the canal system during dry weather, when none is lost via overflow weirs, is limited to that used in lockages to and from the River Mersey at Fiddlers Ferry and Spike Island.

The transfer of lockage water and the demands this puts on the upstream pounds is dependent on the number of lockages assumed and the lock volume. For the purposes of this report, it has been assumed that, generally 18 lockages per day[3] would be the desired level of use, which would allow for over 20 boat movements in busy periods and is consistent with the boat yard businesses adopted in the economic benefits. However, in certain circumstances, lockages may need to be restricted in order to conserve water in the upper pounds. Also, the peak number of lockages into the River Mersey from each of the existing marinas has been assumed at 5 per day. The estimated lockage volume assumes that these only occur within a limited window around high tide, in order to conserve water.

Leakage

Leakage from lock gates has been assessed separately and calculated in relation to the water level difference. For intermediate lock gates this loss has been assumed to be transferred into the downstream pound except at the new Park Road Lock where leakage would form an abstraction from Rainford Brook. Leakage from the lock gates into the River Mersey would be lost to the system and a notional figure of 0.5 Ml/d per lock has been adopted at each marina.

Seepage

The standard texts and accepted design principles indicate a range of seepage for puddle clay lined canals of 25-50 mm/day. Considering the age of the St Helens Canal, and the fact that no evidence of a puddle clay lining can be found, it might be reasonable to assume a seepage level in excess of the 50mm/day figure. However, the performance of the canal under the drought conditions of 1995 would seem to indicate that the seepage losses from the remaining in-water sections is much less than 25mm/day.

It is understood from British Waterways sources that the average leakage figure of 25mm/day was a reasonable target for this canal when it was in operation. Significant effort was required to maintain this level, with leaks being repaired with puddle clay as necessary. The prediction of the leakage levels from the canal bed and

[3] 18 lockages ie. 18 fillings per day would see the locks in constant use for 6 to 8 hours and is thus a reasonable limit.

sides following restoration depends on a number of factors such as; adjacent groundwater levels, adjacent geology, disturbance caused to the canal structure during restoration and the quantity of silt left in the canal.

Each reach of the canal has been assessed subjectively within the parameters given above and an appropriate seepage rate adopted. A high seepage loss in the recently restored St Helens section has been adopted, as it may take some time for the canal bed and walls to reseal following dewatering of this section during the restoration works. In areas of high groundwater, a conservative approach has been taken, whereby a lower but positive loss from the canal was used. The greatest uncertainty and, also, the largest potential loss is the scale of seepage from the lower pound. The geology (see Volume 3) indicates that the pound upstream of Fiddlers Ferry Lock is underlain by sand lenses. Therefore, potentially high seepage losses could occur in this section. Also, in the pound adjacent to Fiddlers Ferry Power Station sheet piles have been installed in order to stabilise the canal bank. A range of seepage values has been used and, as little monitoring of water levels in this pound is undertaken, initially cautious values of 75mm and 50mm/day have been used for various sections in this lower pound.

The seepage loss over the total length of canal was estimated to be 19.3 Ml/day. However, mitigation measures have been considered in the restoration proposals as described in the next section.

Evapotranspiration

The assessment of likely losses resulting from evaporation from the canal surface and transpiration of adjacent plants is highly subjective. A number of factors prevail and some standard hydrological references provide guidance. As a further guide, the Sankey Brook catchment's average potential evapotranspiration was calculated from the hydrometric records from the main gauging station at Causey Bridges.

For a section of canal with substantial bankside vegetation, an evapotranspiration rate of 5mm/day per water surface area was adopted. A lower figure was used for artificial sections of canal, where evaporation was deemed to be the main loss.

Total Canal Water Demand

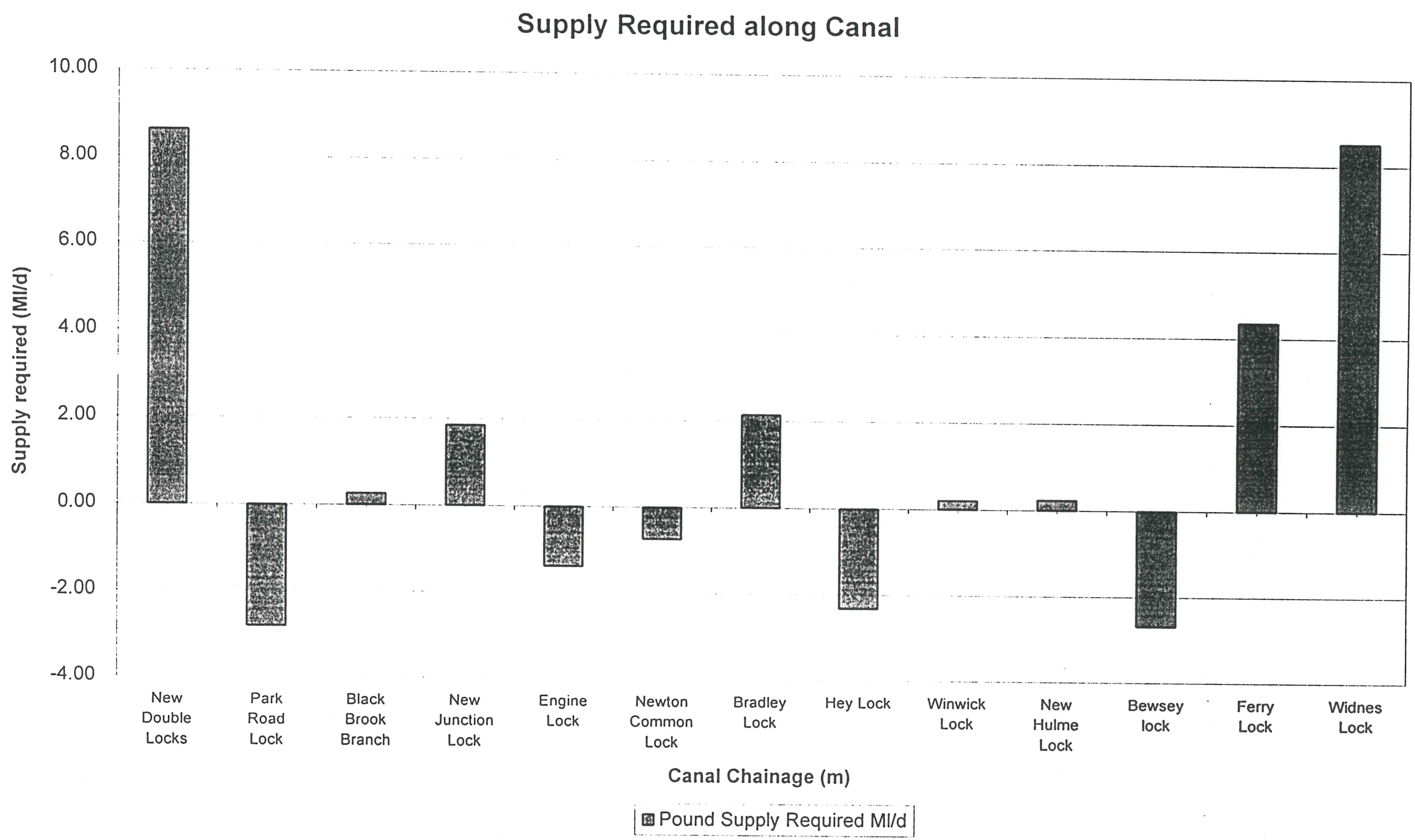
The losses and supplies to the canal are made up of a number of complex and variable factors. In order to simulate the water balance in each pound of the canal, a spreadsheet model of the canal network was prepared. This is based on the assumptions described above, together with the planned usage of the canal system, the revised lock arrangement and the form of construction proposed for restoring the canal track.

Without detailed geotechnical information over the whole length of the canal, it has been assumed that lenses of sand could be present and that reduction of seepage would be a key objective, as the restored canal would have limited options for water supplies of suitable quality. The use of impermeable membranes has a dramatic affect on seepage levels and, where the canal is being re-excavated, it has been assumed that a geo-membrane liner would be used. A liner would serve, also to reduce the risk of any residual leachate contamination entering the canal water body but it would disturb any potential groundwater inflow to the canal.

As restoration commences, the need for a liner can be reassessed with the benefit of a comprehensive ground investigation. For the purposes of the cost estimates and the assessment of canal seepage, the use of a HDPE liner has been assumed. It should be noted that a residual seepage rate of 5mm/day has been allowed for in the analysis, although not based on any field trials, is a conservative approach in the design of a liner.

A number of scenarios were investigated, which included an assessment of the sensitivity of the assumptions adopted in the water balance model. The results of the anticipated water balance, together with its component build up in each pound, are shown in Figures 3.3 a and 3.3b. Figure 3.3a shows which pounds are not self sufficient in their water supply, such as New Double Lock, New Junction Lock, Bradley Lock, Ferry Lock and Widnes Lock. These tend to be the longest pounds with the highest seepage losses. Figure 3.3b gives the relative quantities of demand in each pound, where lined sections of canal only form a small portion of the demand. This demonstrates the need for major inflows at the two upper branches in St Helens and in the long, lower pound between Warrington and Widnes. Elsewhere, the pounds are in balance, with the lockage water transferred downstream exceeding the losses from each individual pound.

The impact of various supply projections and operational considerations on the performance of the canal in drought conditions was assessed using the model, with the results discussed in Section 3.4.5



SANKWAT.XLW

Fig 3.3a

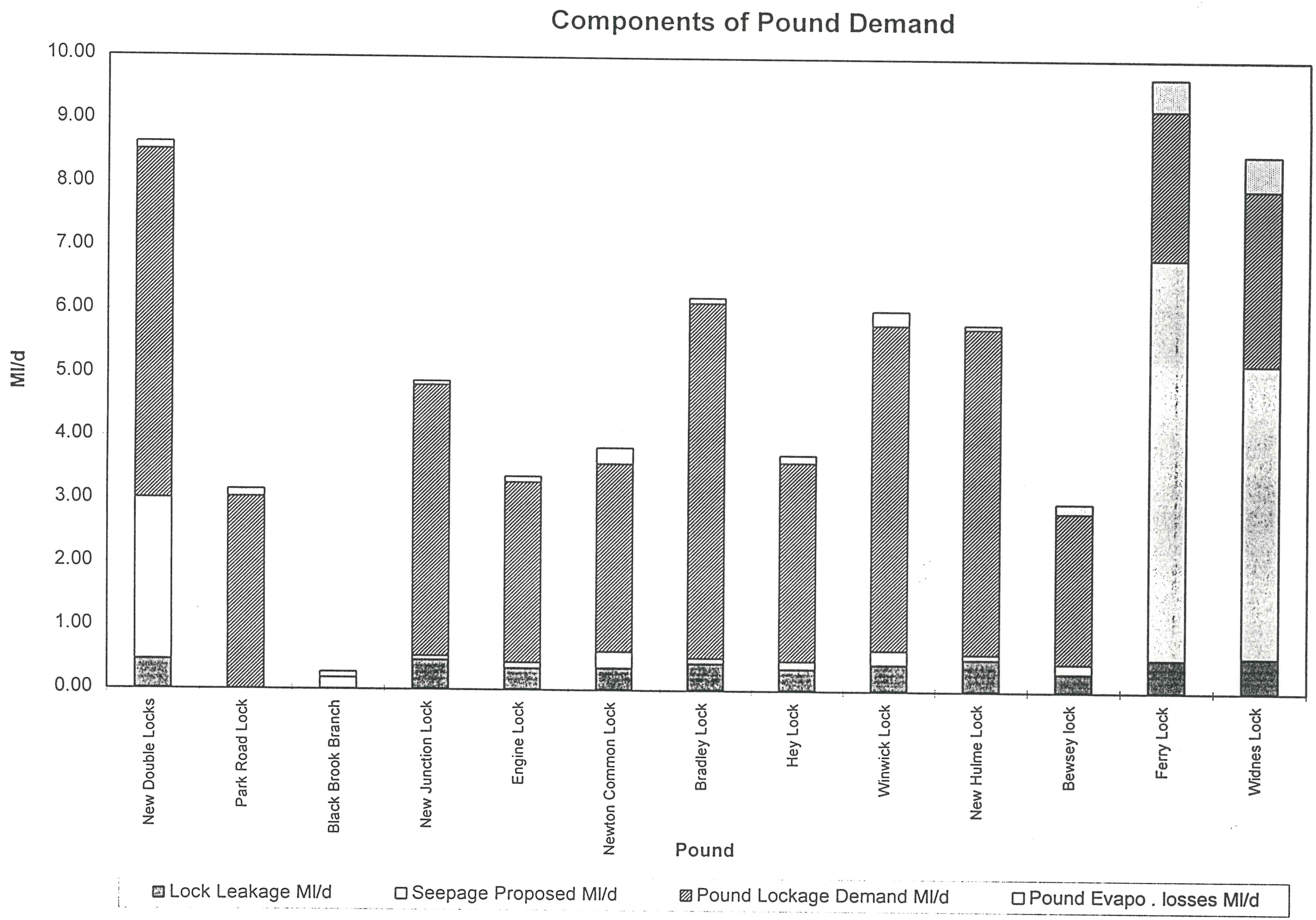


Figure 3.3b

SANKWAT.XLW

3.4 Available Supply

3.4.1 Methodology

The investment scenarios assumed in the cost benefit analysis would be detrimentally affected if a serious shortfall in water resources were to occur during the summer months and boat movements were heavily restricted or even prevented.

In considering the water resources required for the canal, therefore, it has been assumed that sufficient water resources should be made available to operate the canal in a 1 in 10 year drought event, which is a lesser event than that experienced in 1995.

The supply available during an average low flow period, sometimes described as the Q_{95} flow (no connection with the year 1995) and its impact on the operation of the canal is also described in Section 3.4.5.

The techniques included in the Institute of Hydrology's Low Flow Studies Report were applied. These use the annual water balance calculation for the catchment, factored to produce the average yield during a drought of a specific frequency of occurrence. The critical duration for this catchment was found to be 60 days.

This analysis does not account directly for the influence of reservoir storage and, for the purpose of this study, the inflow to the canal's abstraction or inflow point has been assessed. In addition, the average releases from storage reservoirs are then assumed to supplement the flow at these locations.

This imposes a number of constraints, in that control rules need to be developed to suit the operation of the canal. The storage available is finite and a significant reduction in reservoir level would not be acceptable on environmental, recreational and aesthetic grounds.

The previous sources that were dedicated to supplying canal could, possibly, be reinstated following a full investigation of the legal status of these sources. The Environment Agency's aim of improving water quality in Sankey Brook relies on the dilution available from Rainford Brook and Black Brook, hence, the use of these sources for the canal would not be supported. It should be recognised that the co-operation of the Environment Agency would be required elsewhere in the promotion of the overall restoration scheme and this would suggest that some negotiation would be needed over what would be a sustainable abstraction from these sources. This is linked to the water quality issues in the catchment which are discussed in Section

3.4.3. In general, a compensation release or a residual flow to the watercourse currently receiving discharges from these sources has been included in the assessment of the net yield available to the canal.

3.4.2 Surface Water Sources

Pilkington's Supply

The canal supply from the Windle Brook catchment is currently under the control of Pilkingtons, who operate the weirs at the Dilloway Street basin that divide the flow between the canal feeder and the Hardshaw Brook culvert.

The estimation of the total available supply from the catchment is difficult to determine as there are a number of abstractions within the catchment for irrigation together with the operation of numerous reservoirs.

At present, the reliable yield at the abstraction on Dilloway Street is considered by Pilkingtons to be 12 Ml/d and they are required to supply this quantity over the weir into the canal. This is an obligation which was set up to maintain supplies to other industrial users who abstracted from the canal downstream of Pilkingtons.

Hydrological analysis of the catchment indicates that the long term average daily flow (ADF) is 18.92 Ml/day. This would seem to indicate that the flows of 12 Ml/day to the canal is a reasonable long term average to assume. However, when a low flow analysis is conducted this indicates that the supply available from the catchment is much reduced during drought periods, and for the 1 in 10 year, 60 day drought the supply is likely to be approximately 2.4 Ml/day. It is unlikely that the main reservoir, Eccleston Mere, has sufficient storage to allow the 12 Ml/day to be maintained. From the analysis of the natural flow and that released from the main reservoir, 4.8 Ml/day would be a more achievable reliable yield under the drought conditions assumed. This allows for a residual flow in Hardshaw Brook to be maintained at 0.5 Ml/d.

The supply agreement could be transferred to the new "canal authority" if the restoration is extended up to the existing Pilkingtons weir. If restoration is required up to the Chalon Court Hotel and Safeway then the issues of ownership and water rights may have to be faced and probably re-negotiated.

It should be noted that good quality groundwater is pumped to Hardshaw Brook from Pilkingtons' Watson Street Works. This is estimated to be 0.5 Ml/d. Pilkingtons have expressed a willingness to divert this flow to the canal should their abstraction from the canal cease and a closed loop cooling water system installed. This was found to have a beneficial effect in the water balance analysis and would reduce the overall requirement for additional sources. It has not been included in the results as it is dependent on changes at the Pilkington plant.

Rainford Brook

The EA have indicated that at present they cannot set a figure for the allowable abstraction from this source to supply the canal. This is due to water quality problems in the Sankey Brook which are alleviated, in part, by the diluting effect of the water from Rainford Brook. In drought conditions it would be likely that abstraction from Rainford Brook would not be permitted and that only flows released from New Double Lock could be diverted back into the canal from Rainford Brook at Park Road Lock.

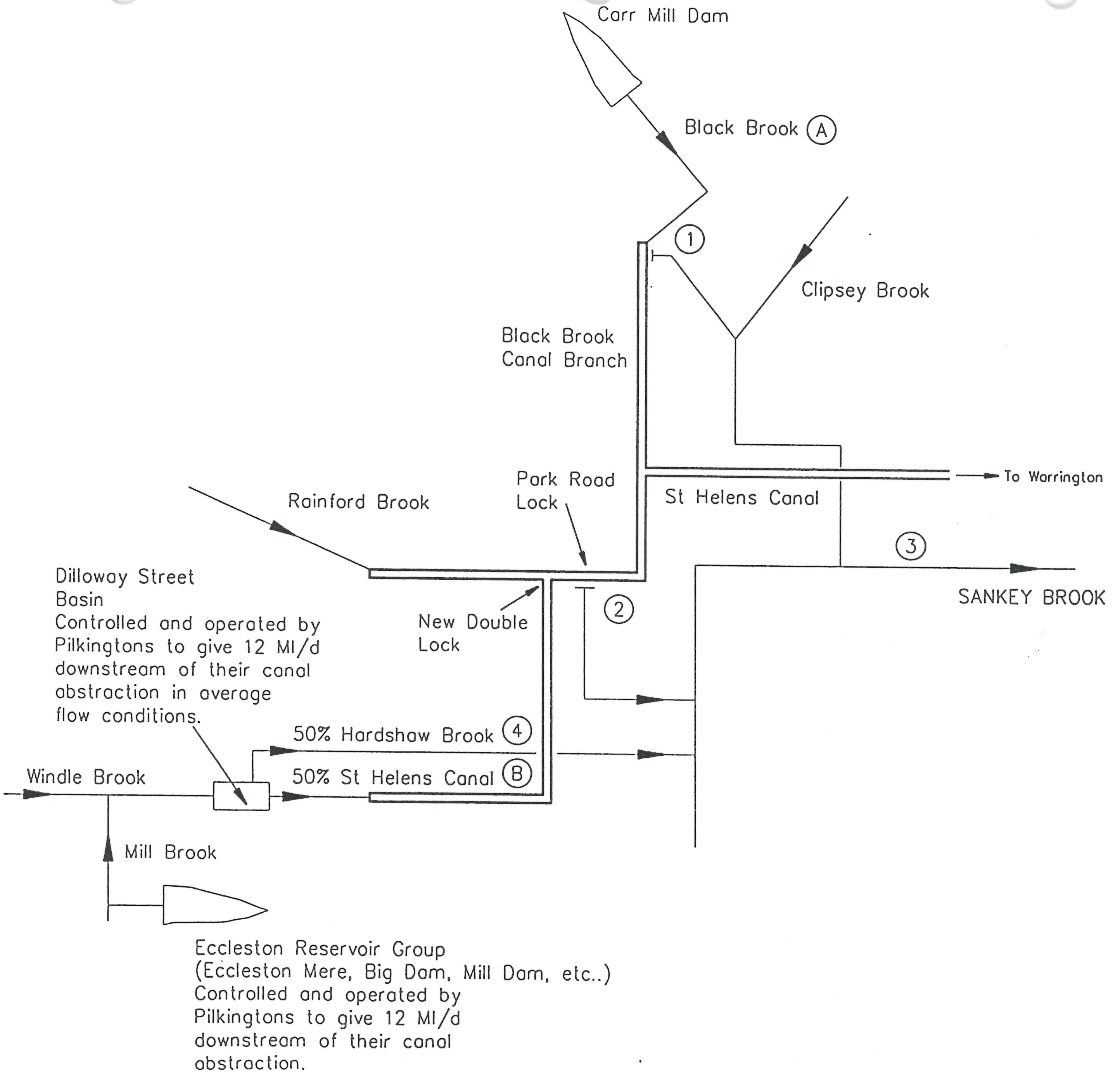
The use of excess water from this source in winter would allow storage in other catchments to be reserved until the drier summer period. Rainford Brook flows would enter via a bypass at the new Park Road Lock. Flood flows would continue to pass directly to Sankey Brook via the existing overflow.

Black Brook and Carr Mill Dam

A hydrological analysis of the catchment predicts that the long term average daily flow is approximately 19.7 Ml/day and the flow under the drought condition adopted is 2.5 Ml/d.

These figures are similar to those measured at the gauge downstream of Carr Mill Dam in 1980, which was the last year supplies were provided to Sidac and the flow monitored automatically. The long term average flow was estimated at 20.55 Ml/day for the catchment from this data and an average flow of 6.5 Ml/day was supplied to British Sidac in that year.

During a drought period, water could be released from Carr Mill Dam. This draw-down would be welcomed by the EA and the Groundwork Trust, as this could provide storage for storm flows at the start of the winter season, thus reducing the risk of flooding in Black Brook. The variation in water levels also could reduce the bankside erosion being experienced due to the recreational activities on the reservoir. However, it has been assumed that, due to the boating and fishing interests, the maximum allowable draw-down would be 1.7m. Using this criteria, the average yield



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Notes

(1) Remedial work to be undertaken on Black Brook Canal Branch. Overflow to old course of Black Brook raised to act emergency overflow only.

(2) Compensation releases set to the level of the base flow in Rainford Brook and hence can be used to top up the Canal.

(3) Reduction in Sankey Brook flow under Dry Weather Conditions would be the current flow from Black Brook (A) and the current supply to the canal from Dilloway Basin (B).(Approx 13Ml/d)

(4) The flow to Hardshaw Brook would be reduced during dry weather. This release to be agreed with EA.

Project	ST HELENS CANAL RESTORATION
Title	PROPOSED SUPPLY REGIME IN ST. HELENS
	FIGURE 3.4

AutoCAD File Ref. E:\Y2311\030\FIG3_4.DWG from this source under the design drought condition is estimated to be 6.0 Ml/d but it would require new reservoir control rules to be established.

The management of water levels in Carr Mill reservoir is within the control of British Waterways and, although the water rights reside elsewhere, re-establishment of navigation rights would, potentially, allow for an increased yield from Carr Mill Dam, as the water level could be reduced much further. This would, however, lead to conflict between users, with St Helens MBC involved with both parties, and it is recommended, therefore, that agreement would need to be reached on the limitation to reservoir draw down.

The water released from Carr Mill Dam discharges into the head of the Blackbrook Branch of the canal and, at the Stanley Street basin, an overflow currently discharges about half of the water from the canal into the original course of Black Brook. Whilst this was not the original arrangement the overflow, which is controlled by the weir at the downstream end of the branch, currently assists in the diversion of flood waters and provides dilution to the poor quality Clipsey Brook, hence, its removal would be resisted by the Environment Agency. Therefore, a notional compensation release of 0.5 Ml/d from the canal to the brook has been allowed for in the water balance model during low flow periods. However, the exact quantity would have to be negotiated with the Environment Agency. The proposed supply regime for these upper sources in shown in Figure 3.4.

Newton and Sankey Brooks

If pumped abstractions from Sankey or Newton Brook downstream of St Helens were to be made, with the current water quality in the Sankey Brook, there would be a significant deterioration in the recreational and environmental value of the sections of canal still in-water. There could be a reduction, also, in the water quality of Sankey Brook downstream adjacent to the residential area of Callands and Dallam. Until significant progress has been made in reducing the ingress of contaminated groundwater within the catchment, investment in a pumping installation at Waters Meeting or Newton-le-Willows could not be recommended. In flood flows, however, the canal would form an obstruction to flow and it may be necessary to allow overtopping of the canal bank and for the canal to convey these flood waters to an overflow structure.

Callands Brook

This minor brook flows through the Gullivers World Theme Park and has undergone significant modifications to make it an attraction in the park. It dries up most summers and the NRA records indicate that it was an unreliable resource even prior to the Theme Park development. It cannot therefore be relied upon to contribute a quantity of water under the design drought conditions.

Penketh Brook and Whittle Brook

Abstractions from these relatively small watercourses would need to be pumped. Flows during dry weather would not be sufficient to yield a significant proportion of pound demand. The environmental impacts downstream of the abstraction points may also preclude these options and, therefore, these sources were not considered any further.

River Mersey - PowerGen Abstractions

PowerGen have an annual abstraction licence from the Environment Agency, which allows water to be pumped from the River Mersey during 3 x 4 hour periods per day in order to suit the tidal cycle and ensure use of the fresh water layers at this point. The pumping station houses 4 No pumps, with a maximum of 3 No used as duty pumps and, as might be expected, the pumping and control systems are quite complex. The river water is transferred to a lagoon for settlement of sediment prior to its use as cooling water within the power station. The daily average daily abstraction is estimated to be 33 Ml/d. The quality of water discharged to the St Helens Canal and the River Mersey is subject to consent conditions and is monitored by the EA.

There are two possibilities that may be worthwhile discussing with PowerGen as a means of providing an additional water supply to the canal on a commercial basis during drought conditions.

- during summer drought conditions the power station may not be operating at its maximum output and PowerGen may be amenable to operating one of their pumps to provide water to the canal.

- PowerGen may be amenable to the canal authority installing its own pumps at their pumping station, thus utilising the existing intake screens.

Such arrangements obviously would be subject to detailed discussions with PowerGen and to reaching agreement over financial matters and respective environmental liabilities.

The longer term future of the Fiddler's Ferry Power Station is in doubt as there is a possibility that the power station could close within 5 to 10 years. The operating philosophy of the plant is to reduce discharges to the canal to a minimum. This is, in part, to reduce pumping costs but also to mitigate the possibility of contamination from the power station entering the canal via the cooling water return pipework. Canal restoration must, therefore, assume that flow will not be available from this source. However, as indicated above, the intake structure and pumps may be useful infrastructure to include in the canal restoration proposals.

River Mersey - Use of Side Pounds

A significant proportion of the pound demands in the lower section are the lockage water lost to the River Mersey. Provision of a back pumping facility with side pounds may reduce this and is described in more detail in Section 3.4.5.

Stormwater Drainage

By definition, flows from these sources will be zero during the drought design condition chosen.

3.4.3 Water Quality

The National Rivers Authority, which was absorbed into the new Environment Agency from 1 April 1996, designated the Sankey Brook as Class 3/4 under the current National Water Council Classification System and the Rainford, Windle and Black Brook tributaries were designated Class 1/2.

The in-water sections of the St Helens Canal are generally Class 2.

Class	Parameters	Quality
1a	DO> 80% BOD< 3mg/l NH_3< 0.4mg/l (non toxic to fish)	Very good - ie. suitable for potable abstraction and able to support high class fishery
1b	DO> 60% BOD< 5mg/l NH_3< 0.9mg/l (non toxic to fish)	Good - of less high quality than Class 1a but usable for substantially the same purpose
2	DO> 40% BOD< 9mg/l (non toxic to fish)	Fair - suitable for potable water supply after advanced treatment and reasonably good coarse fisheries, and of moderate amenity value
3	DO> 10% BOD< 17mg/l	Poor - waters which are polluted to an extent that fish are absent or only sporadically present. May be used for low grade industrial abstraction. Considerable potential use if cleaned up
4	DO< 10% BOD> 17mg/l	Bad - ie. heavily polluted and likely to cause nuisance
DO = Dissolved Oxygen Content BOD = Biochemical Oxygen Demand		

<u>Table 3.2 : Water Quality Classification System</u>

The aim of the Mersey Basin Campaign is the cleaning the River Mersey and its tributaries. As part of this, the Sankey River Valley Initiative was launched in October 1995. One of the stated objectives of the SRV Initiative is to improve the water quality in the Sankey Brook from its current classification Class 3/4 to Class 1/2 by 2004. The EA had no firm programme of improvement works to achieve this objective by the stated date. Instead they were pursuing a series of legal actions against polluters in the catchment in the hope that this would result in the necessary improvements.

New statutory water quality objectives[4] will be introduced shortly and will allow the EA to increase constraints to discharges to meet an improved future target standard. However, much of the pollution in the Sankey Brook is due to the ingress of contaminated groundwater. It is felt that, even with the additional powers of the new

4 The programme of Water Quality improvements on the Sankey Brook is contained in the recently launched Local Environment Agency Plan (LEAP) for the Sankey and Glaze Brooks. This is currently at the consultation stage with comments required by 1 October 1996.

classification system, it is unlikely that these sources of pollution will be treated so that the Class 1/2 objective can be achieved in the next 10 years.

It is, considered, therefore that as the existing in-water sections of the canal are Class 1/2, it would be preferable to make gravity abstractions from the tributaries of Windle Brook, Black Brook and Rainford Brook. This will prevent deterioration of the water quality in the canal.

However, there is a problem associated with abstracting water directly from Windle, Black or Rainford Brooks. These abstractions would result in a loss of some of the good quality water currently entering the Sankey Brook which dilutes the pollutants from contaminated ground in and around St Helens. Effluent from Parr WwTW, which discharges to Sankey Brook is currently of a fairly high standard and could, following tertiary treatment, be used for supply into the canal. However, as it forms the dominant flow in summer it is essential in order to maintain a reasonable water quality in Sankey Brook downstream of St Helens.

If a deterioration in-water quality in the Sankey Brook is to be avoided, careful programming of abstraction will be required and co-ordination with the EA will be necessary. Therefore, the programme and timescales for development or reinstatement of canal supplies is dependent on the improvement in the water quality of the Sankey Brook.

3.4.4 Use of Groundwater Supplies

The Sankey Catchment has a history of groundwater abstraction for industrial and domestic water use and there are a number of boreholes within the catchment which are owned and operated by North West Water and several private firms. The possible acquisition of or purchase of water from one or more of these sources was investigated as part of the feasibility study.

Hydrogeology

The hydrogeology of the area is dominated by Triassic sandstone from which most of the groundwater in the area is abstracted. This sandstone overlays the deep coal measures (>500m) exploited by the local mining industry and is itself overlain by a thick (10-40m) layer of glacial drift (Boulder Clay).

The area is criss-crossed by a number of major faults which form structural barriers to the movement of groundwater within the sandstone aquifer. Therefore, changes in groundwater levels within sections of the aquifer defined by a series of faults will have only a minor influence on an adjacent area, if the change in-water level is only temporary.

The glacial drift which lies above the sandstone is mainly clay, with pockets of sand and gravel. The general impervious nature of this drift material gives rise to localised 'perched water tables' with groundwater levels that can be at or near ground level. These groundwater levels can be maintained throughout periods of dry weather.

Although generally impervious, seepage/infiltration from the overlying drift into the lower sandstone aquifer does occur, as contaminants from the drift are present in small but significant concentrations in some of the abstractions.

Existing Abstractions

The level of the abstraction from the sandstone aquifer is high, with North West Water being the main operator of abstraction boreholes. It is North West Water's operating and pumping regime that determines water levels in the aquifer. Groundwater levels across the aquifer vary greatly. In the parts of the aquifer where abstraction is highest, groundwater levels can be several hundred feet below sea level. However, in sections where abstractions have ceased due to quality problems or the use of an alternative source, groundwater levels have risen to or near ground level and are continuing to rise.

In areas where water abstraction is or has historically been high, saline intrusions are beginning to occur, causing a deterioration in-water quality. Despite the fact that the groundwater levels are well below sea level at these locations, water quality tests have indicated that the source of this brackish water is the deeper coal measures and not the Mersey Estuary. This emerging problem is seen as indicative of the aquifer being at or near the limit of its allowable abstraction level and application for new abstractions in these sections are unlikely be considered by the EA.

In Winwick, to the east of the Warrington to Glasgow railway, groundwater has risen to or near ground level and is beginning to adversely affect the surface hydrology. What was previously good quality farmland has become, in places, an undrainable marsh; flows in certain brooks have increased; remedial measures have had to be undertaken; and sections of the M62 drainage system have become permanently flooded.

Groundwater levels have also been steadily increasing in the Bewsey area over several years. These have recently stabilised at approximately 4 to 5m below ground level but it is believed that there is potential for these to rise even higher. The cause of this rise is unknown but may be due to the closure of Burtonwood Airbase and the possible cessation of its groundwater abstraction.

At present, due to the saline intrusion, the EA are attempting to reduce the level of abstraction, so additional groundwater abstractions will not be permitted. In sections where the rising groundwater becomes problematic in the future, then abstraction may be allowed. If a groundwater source is required then it must be purchased from an existing licensee.

Due to the recent drought orders imposed in the area, none of the existing licensees capable of supplying the canal are willing to agree to relinquish any of their present resources.

New Abstractions

At the site of the Hotties Arts and Science Centre, groundwater is currently pumped to Hardshaw Brook. When this source of water is of proven, consistent quality it could be appropriate to divert flow into the canal. Pipework is already in place to facilitate this diversion of approximately 1 Ml/d. At this stage, this volume has been assumed not to be available and has not been included in the water balance analysis.

The possibility of renewing lapsed abstraction licences and abandoned boreholes was pursued with the EA. Former supplies at Anglian Canners and Penketh Tannery were identified as possible sources. Their proximity to the Mersey Estuary means that reinstatement would be permitted by the EA as they are unlikely to cause a worsening of the saline intrusion.

It is estimated that approximately 8 Ml/d would be required in the lower pound. However, the combined, lapsed licences for these 2 sources would only produce 0.4 Ml/day in total which would not be sufficient to sustain the section between Widnes and Bewsey.

The possibility of developing a new borehole source adjacent to the Mersey which would not adversely affect the saline intrusion was discussed with the EA. Although, in principle, the EA would not object to a new abstraction adjacent to the Mersey it would necessitate a degree of study work to determine if a borehole supply would be suitable.

3.4.5 Summary of Canal Water Balance

The water balance model allowed a number of supply and operational options to be investigated. As demonstrated in Figure 3.3(b) the main supply requirements are into the pound above New Double Locks (8.6 Ml/d) and the bottom pounds between Warrington and Widnes (13 Ml/d). The predicted drought yield for the Windle catchment, via the Pilkington system is significantly lower than that required and some restriction in boat movements would be necessary between Park Road and New Double Lock. The deficiency in supply in the remaining pounds downstream are then made up by releases from Carr Mill Dam.

Back pumping could be installed at New Double Lock but this then results in an increased shortfall downstream and it is considered that restrictions in boat movements would be preferable. Additional supplies from local pumped groundwater sources that currently discharge to Hardshaw Brook would assist in reducing these restrictions.

It has been assumed that any pound with an excess water balance can transfer this volume downstream via the bywash. As the lockage water passes downstream, the losses from evapotranspiration and seepage are normally replenished by this water.

In general this balance is maintained along the canal until the combination of the lockages out of the canal system into the Mersey and the high seepage losses predicted in the pound between Warrington and Widnes, result in a significant shortfall in supply.

The results of the analysis, prepared for the adopted critical drought condition, are shown in the Table 3.3

During a more usual low flow period in an average summer, the simulation of the water balance along the canal demonstrates that no operational restrictions would be necessary and that there is unlikely to be any shortage of water, if the upper sources in St Helens can be hydraulically linked to the lower pounds, ie. full restoration is in place. An estimate of the 95 percentile flow, ie. the flow that is not exceeded for 18 days in an average year, has been used for this analysis.

	Scenario	Inflow from Windle Brook inc. releases from storage[1] Ml/d	Inflow from Black Brook Branch inc. releases from storage[2] Ml/d	Lockages u/s of New Junction Lock[3] No.	Lockages to River Mersey[4] No.	Additional Supply requirements into Lower Pound[5] Ml/d	Comments
1.	Maximum use of upper sources, reduced lockages in upper pounds, use of HDPE liners between New Junction Lock and Bewsey Lock	4.87	5.98	8	5	7.60	Increased lockages in upper pounds cannot be supported by existing sources. Drawdown on Carr Mill Dam estimated at 1.7m
2.	As above but seepage minimised in lower pound by use of liners or silt stabilisation process	4.66	5.48	14	5	0	Assumes a lower seepage in upper pound in St Helens, but lockages in upper pounds still limited. Reservoir drawdown reduced.
3.	As 1. but boat movement to Mersey suspended (ie. no lockage loss)	4.87	5.98	8	0	3.90	
4.	As 1. except that an average seepage loss of 25mm/day/m^2 adopted for lower pound	4.86	5.98	8	5	1.2	
5.	As 1. Compensation releases to Hardshaw and Black Brook are set at 2 Ml/d by Environment Agency	3.37	7.08	3	5	8.2	This is the most sensitive scenario
6.	As 1. but reduced navigation depth in lower pound accepted (minimum 1.5m, based on initial depth of 2.5m)	4.87	5.98	8	5	4.65	Large volume of storage is available in the lower pound and can be utilised

Constraints
1. Eccleston Mere is used to its full extent, and a nominal compensation release is provided to Hardshaw Brook.
2. Maximum draw down of reservoir set at 1.7m, and a nominal compensation release is provided to Black Brook
3. Boat movements may not be significantly affected if advanced warning of restrictions provided, and doubling up at locks is arranged
4. Lockage volume based on MHWS condition. No lockages at lower tide levels should be allowed in drought conditions
5. Daily supply volume would need to be transferred over limited tidal window
6. Lockages elsewhere on the canal network based on 18 per day

Table 3.3 : Review of Supply Requirements During 1 in 10 year Drought

During the remainder of the year, Rainford Brook can assist in topping up the canal and no restrictions in boat movements or additional abstractions are necessary.

Due to the possible variations in the assumptions that have had to be adopted in the analysis the capacity of the abstraction required for the lower pound could range from 0 Ml/d to 8.2 Ml/d. The most sensitive issue that affects the canal water supply provision is the quantity of the compensation release negotiated with the Environment Agency for the upper sources in St Helens. If a value of 2 Ml/d is set, close to the natural flow in both Windle and Black Brooks in such a drought condition, the lockages in the St Helens pounds upstream of New Junction Lock are restricted even further. In order to accommodate these compensation flows, increased drawdown in Carr Mill Dam would be necessary. This scenario assumes a maximum drawdown of 3m below crest. Without this, significant shortfalls may occur in the middle pounds. This local problem could be solved by some back pumping or small scale abstraction from some of the springs/land drainage ditches in the vicinity.

The quantification of the EA's requirements, which will involve a detailed water resource study and also a legal review of the historic canal supply agreements that could be available to a new "canal authority" body is an important early activity. Without this study the identified water shortfalls in the lower pounds may increase and affect the central sections of the canal in Sankey Valley.

Scenario 6 demonstrates that significant reduction in pump capacity can be achieved if the full storage available in the lower pound is utilised by allowing a reduced navigation depth. However, the additional costs of overdeeping the canal specifically for this purpose are considerably higher than the small incremental costs of having a larger installed pump capacity.

It is considered that Scenario 1 is a realistic representation of the situation that may prevail upon restoration of the canal and, therefore, provision of an additional daily supply of 8 Ml/d has been included in the restoration proposals. This should be located in the vicinity of the lower pounds between Warrington and Widnes. This could be reduced if a combined side pound, back-pumping and tidal storage basin scheme were to be installed at Widnes Dock. The benefit of this arrangement is difficult to quantify at this stage, as little information is available on the variation of the water quality at Widnes, and further investigation would be required.

3.4.6 Recommended Supply Options for Full Canal Restoration

The supply options are reviewed as follows:

- It is unlikely that increased utilisation of the existing surface water sources in the St Helens area will be permitted by the Environment Agency and hence the estimated yields of the existing reservoired catchments have been adopted. These sources are currently controlled by British Waterways and Pilkingtons. There exists the possibility to purchase these sources from their respective owners. However, the liabilities involved are considerable, in terms of maintenance of the dam structure and ancillary equipment. An alternative solution would be to purchase the water through an agreement with Pilkingtons and British Waterways. However, there are commercial considerations of the current owners, who may prefer to dispose of these reservoirs rather than to sell their water to the "canal authority".

- The possibility of renewing lapsed abstraction licences and abandoned boreholes was pursued with the EA. Former supplies at Anglian Canners and Penketh Tannery were identified as possible sources. Their proximity to the Mersey Estuary means that reinstatement would be permitted by the EA as they are unlikely to cause a worsening of the saline intrusion. However, they are only licensed to 0.4 Ml/d in total and would not be sufficient.

- The possibility of developing a new borehole source adjacent to the Mersey which would not adversely affect the saline intrusion was discussed with the EA. A groundwater abstraction of a size necessary to sustain the Widnes to Bewsey pound independently from the rest of the canal would have to be carefully operated and controlled. Any new borehole supply would be equivalent to an abstraction from the Mersey which is being 'filtered' through the Estuary Bank. Therefore, a strict control regime would have to be developed that prevented saline water from entering the canal and did not adversely affect the surrounding marshland habitats. A detailed study of this option would be required.

- A direct abstraction from the Mersey would probably be more cost effective and potentially less damaging to the surroundings. A deep water channel already exists near Fiddler's Ferry which could be used for this abstraction. The pumps could only operate over a limited period, governed by the tidal cycles at this point. PowerGen currently operate such an abstraction and estimate that three 4 hour fresh water lenses are available. Therefore, the pump capacity has to be at least twice the required daily transfer rate, ie. 16 Ml/d or 0.19 m^3/s. This, together with minimisation of lockages at Widnes Lock, would be the preferred water supply solution.

Preferred Solution - River Mersey Abstraction

The construction of such an intake and provision of pump set(s) and power would form a significant project. It would be a permanent installation and the purchase of a suitable site could be difficult, as well as locating it along the environmentally sensitive banks of the River Mersey.

A possible solution would be to utilise the existing intake, pumps and pump house associated with Fiddlers Ferry Power Station. The capacity of the existing pumps is far greater than the duty required for canal filling. It is possible that, within the horizon of the restoration programme, the power station may be decommissioned but, at this stage, this is purely speculation.

With both of these options, the provision of settlement lagoons is necessary in order to reduce the silt load from the River Mersey. The use of the existing PowerGen settlement lagoons may be the solution, if the power station is closed down.

Management of the Canal Network

The effect of the management systems in place to cater for a drought condition will determine how successfully the limited canal water resources are utilised. As has been noted in previous sections, restrictions in boat movements and optimisation of lockages in the upper pounds in St Helens is essential. At the two tidal marinas lockages into the River Mersey should be carefully controlled and only occur at peak tide levels.

At Spike Island, the former dock could adjacent to Widnes Lock could be used as a side pound to minimise lockage losses when boats enter or leave the canal and, hence, reduce the water demand of the bottom pound.

The former dock could also act as a storage/settlement basin as part of an alternative river abstraction installation to top up the bottom pound using fresh water from the Mersey Estuary at high tide. It is envisaged that this installation could save 2.8 Ml/d of lockage water and yield an additional 2 Ml/d of supply into the lower pound, ie. providing tidal water in excess of the local lockage demand. This would reduce the overall abstraction capacity of the main Mersey intake installation. In average dry weather conditions, this may be sufficient to obviate the need to abstract from the proposed main pump installation at Fiddlers Ferry.

The design of such a system would require careful consideration to cover the range of operating and tide conditions.

3.5 Interim Supply Arrangement

Full restoration of the canal from Widnes to St Helens enable all the water resources to be linked hydraulically. The canal would be easier to operate in this state. Currently, however, currently certain sections are experiencing severe difficulties with ensuring adequate water supply. This is particularly true of the lower pound between Warrington and Widnes which is dominated by the conflicting demands of the two marinas, one in each borough, and the bund at Fiddlers Ferry, which controls the flows released further downstream.

The water supply arrangements that are required to support the existing uses of the canal and allow formal use of the canal as it is restored to navigable standard should, preferably, be complimentary. However, there may be circumstances where additional supply projects are required to meet current "non canal-related" needs. In essence, the water resources form one of the major constraints in the development of a navigable canal and its impacts on the restoration strategy are discussed in Section 9.

Existing Situation

The main in-water pound is that between Bewsey Lock and Spike Island. This has high potential seepage losses, although considerable siltation has occurred and may be controlling the level of seepage experienced at present. The only significant supply into this pound is from PowerGen and, as there is no monitoring of the quantities discharged or of the losses experienced in this pound, it is difficult to quantify the short term resource requirement. As described previously, this is can no longer be considered to be a reliable source and Callands Brook is unlikely to replace the shortfall.

The options available to provide for these losses and keep both marinas operational are limited. The construction of a dedicated abstraction system from the Mersey could not be justified solely from the revenue available from the marinas.

Also, the operation of these pumps to draw only fresh water into the canal would involve complex monitoring equipment and dedicated supervision. The silt load in the Mersey is such that settlement of the river water would be essential and this would require the location and construction of a lagoon alongside the canal. The three main options available are:

- Utilise PowerGen's pumping station and intake complex on the banks of the Mersey:- Installing a small pump and dedicated pipework may be possible, for which PowerGen may be willing to provide the power and operational control for an agreed fee. Detailed discussions would be needed with PowerGen to establish the acceptability of this option.

- Utilise PowerGen's existing process water settlement lagoon and construct an abstraction system from within the lagoon to the canal:- This has the advantage of settlement of the river water prior to its discharge into the canal. However, a separate discharge consent would be required and provision would need to be made to ensure that any contaminants returned via the power station cooling system do not enter the canal. PowerGen would have to operate their Mersey abstraction pumps more frequently and reimbursement of these costs would be necessary. Detailed discussions with PowerGen would be needed to establish the acceptability of this option.

- Provide back pumping/tidal storage basin at Widnes Lock:- If lockages at Widnes Lock form a substantial element of the overall losses in this lower pound, then provision for back pumping of the lockage water from a side pound would be an effective means of minimising water losses and maintaining water levels. Should further investigation prove that fresh water inflow to the side pound at Widnes Dock could be achieved via a controlled inlet weir, then additional top-up of the canal could be achieved. In the short term this would be worth pursuing should negotiations with PowerGen not be successful.

<u>Restoration Phases</u>

The development of the restoration strategy for the remainder of the canal has been undertaken to ensure that adequate water supply can be achieved. The first phase is likely to involve restoration of the central section of the canal, from the M62 to Old Double Lock. Once hydraulic continuity is achieved, by linking the discharges from the Blackbrook Branch to rest of the canal system, this section of canal should be self sufficient during average summer conditions.

3.6 Flood Defence Implications

Restoration of the St Helens Canal would change the hydraulic characteristics of the Sankey Brook. This could have a number of potentially serious flooding implications for the Sankey Brook catchment.

The EA has undertaken a number of studies and flood defence works which have resulted in a significant improvement in the level of flood protection. Unfortunately this work was undertaken assuming that the canal would not be restored and therefore some of the defences constructed either utilise parts of the abandoned canal or rely on the fact that the canal has been abandoned.

The approach adopted, has been to derive a canal restoration solution which would have a minimal effect on the existing flood defence provision in St Helens and Warrington.

A computational hydraulic model of the Sankey Brook catchment was utilised to test the sensitivity of the proposals on existing flood levels. However, a revised model would need to be developed incorporating all the changes the canal would impose on the catchments drainage network.

The five locations where restoration of the canal will influence the existing flood defence regime are:

- Rainford Brook
- Havannah Flashes
- Gemini Business Park (formerly Water's Meeting)
- Bewsey Lock
- Sankey Bridges

The flood defence regime at these locations and the effects of canal restoration are discussed below.

Rainford Brook

The canal is currently part of the main river network and as a result of restoration normal water levels would rise in the brook. However, few low lying properties would be affected in this reach and only minor embankment works are envisaged.

Havannah Flashes

These ponds, which resulted from mining subsidence, provide storage of flood waters during low return period ie frequent storms, thereby reducing water levels in the Sankey Brook downstream.

The restoration scheme must, therefore, retain these ponds and ensure that they can be utilised during flood conditions. Additional ponds in the area upstream of Penkford Bridge may also be required to maintain this flood attenuation function.

Gemini Business Park

The open area just to the south of the M62 is part of the flood plain of the Sankey Brook. The Gemini Business Park on the edge of this area is at risk from flooding and a scheme is planned to improve the flood defences in the area. This scheme does not take into account the canal's restoration and its impact on the hydraulic regime.

Restoration of the canal would involve crossing the Sankey Brook in this area, re-establishing the original 'Waters Meeting'. This would cause a restriction in the channel of the Sankey Brook causing an increase in the frequency of flooding upstream of the crossing point, and higher flood water levels than those presently experienced. This would compromise the currently proposed flood protection scheme.

This increased frequency of flooding could be used to create an intermittently flooded grassland habitat but this would require an extensive modification to the EA's flood defences in the area and would impact on a proposed business park development. The alternative is to reduce the restriction caused by the crossing and provide additional flood relief around the canal crossing point.

This would involve a change in alignment from the original canal which is discussed in more detail in Section 4.1.

The proposed solution is to move Hulme Lock to a position downstream of the Sankey Brook crossing and then construct a flood relief channel from the Sankey Brook upstream of the crossing to a point downstream of the new Hulme Lock.

Thereby, the risk of blockage at the Hulme Aqueduct crossing is partly ameliorated by providing an additional route for flood waters to by-pass the structure. This would address some of the concerns raised by the Environment Agency. This overflow would then replace the existing overflow structure in Dallam without raising water levels upstream. The canal would then be used as a flood channel over a greater length ie, from Hulme Lock through to Sankey Bridges. This is predicted to occur relatively infrequently, estimated to be once in ten years, although that would need to be confirmed using the hydraulic model of Sankey Brook. In more extreme events both the brook channel and the canal would be totally inundated. It would be imperative, therefore, that a flood warning system be installed so that adequate warning could be given for boats to be removed from this section of canal and for the lock gate at Hulme Lock and the swing bridge at Sankey Bridges to be closed. A telemetry installation has been included in the cost estimates.

Bewsey Lock

The existing flood relief channel from Sankey Brook utilises the stretch of the canal to Bewsey Lock. This channel and chamber maintains a hydraulic balance between the canal and the Sankey Brook downstream of Bewsey.

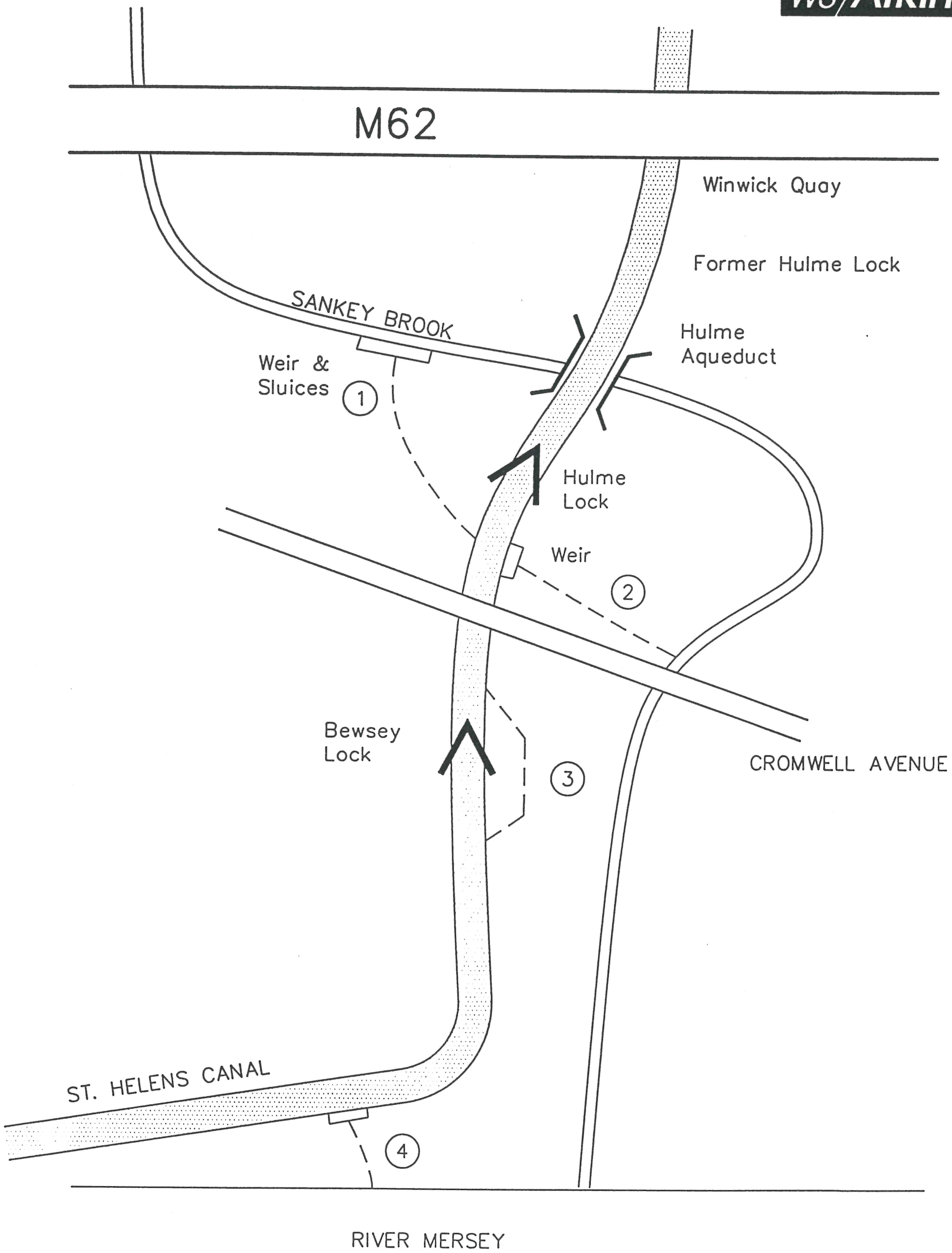
The introduction of gates at Bewsey Lock would have to be designed to accommodate this flood water. The existing by-wash chamber is probably not adequate for these flows and, hence, an overflow spillway channel on the east side of Bewsey Lock would be constructed. Overtopping or by passing of the lock gates would have to take place in a controlled manner so that, downstream, the hydraulic balance between the canal and the brook is maintained. If this balance is not preserved then there would be an increased risk of flooding at Sankey Bridges and a possible increase in flood levels upstream.

The layout of the proposed revised hydraulic regime between Gemini and Sankey Bridge is shown in Figure 3.5.

Sankey Bridges

The flood defences which have been designed and constructed in this area and upstream rely on the existing relationships between the canal and the Brook to provide the necessary level of flood protection.

After restoration, the water level rise experienced during extreme flood events, when the canal would be used as a flood relief channel, would reduce the air draft at the fixed structures to below that needed for navigation.



1. Aqueduct bypass channel.
2. Overflow channel.
3. Bypass around Bewsey Lock.
4. Sankey overflow.

WS/Atkins

Project: ST HELENS CANAL

Title: REVISED HYDRAULIC REGIME

FIGURE 3.5

Modifications to canal overflow levels and dimensions risk changing the existing balance between the canal and the brook during storm conditions and compromising the flood defences at Sankey Bridges. Any changes to canal overflow structures, therefore, should be carefully considered and designed together with any necessary modifications to upstream flow control structures.

Conclusions

It would be possible, with careful design, to restore the canal without conflicting with the existing flood defence policy of the Environment Agency or increasing the risk of flooding in the Sankey Catchment.

These may be short periods when boat movements on the canal between Hulme Lock and Sankey Bridges would be restricted or prevented during flood conditions.