COMMONWEALTH OF MASSACHUSETTS

METROPOLITAN DISTRICT COMMISSION

PARKS DIVISION

PROGRESS REPORT NO. 4

REPORT UPON

USE OF THE CHARLES RIVER BASIN AND LOCK FOR COMMERCIAL AND RECREATIONAL BOATING

NAB
6827
Bos-Cha
M276a

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CHARLES A. MAGUIRE & ASSOCIATES AND
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SUMMARY

This report presents the factual data upon which a program of improvement to the Charles River Basin can be based. In order to insure that a proposed development of the Basin will be consistent with present and future needs, a substantial amount of data has been compiled from many sources concerning the primary problems confronting users of the basin. These are the lack of adequate Basin elevation control, continuing pollution - in part attributable to salt water infiltration, - the recent rapid increase in pleasure boating, and the increasing cost of drawbridge operation and increasing interference with highway traffic by commercial traffic in the Basin. This report serves as a basis for the recommendation of facilities to be provided in the Charles River Basin Elevation Control Project study. This report was required because, during recent years, the facilities installed some 50 years ago although most satisfactory in the past, have proved inadequate for present needs.

In 1910 the construction of the Charles River Dam was completed. In this same year, the responsibility for the dam was transferred from the direction of the Charles River Dam Commission to the Metropolitan District Commission.

The purpose of the dam is to protect the low-lying areas of the Back Bay and Cambridge from high tides, reduce the surcharge of sewers and drains, eliminate the inconvenience caused by tidal flats and create a fresh water recreational area of scenic beauty.

To accomplish this, the Charles River Dam was constructed above the mouth of the Charles River. Since water from a drainage area of about 300 square miles has to be discharged through the dam into the tidal estuary which leads to Boston Harbor, sluicing facilities were provided in the construction of the dam. In order to allow navigation access to the newly-created Basin, a lock 350 feet long, 45 feet wide, and suitable for a vessel draft of about 18 feet at low tide, was constructed.

Since the dam's construction, land developments utilizing impervious materials, enlargement and extensions of storm drainage systems, and the progressive filling-in of upstream meadow areas have resulted in a marked increase of flow into the Basin during storms. These, together with the encroachment on Basin areas by land filling, have resulted in an inability to control the elevation of the Charles River Basin within desirable limits.

Entrance of salt water in recent years to the Charles River Basin has presented a number of problems. Salt water infiltration and methods for reducing it are studied in this report.

In recent years there has been a tendency toward increased recreational use of the Charles River Basin and a gradual decline in commercial vessel shipping. The rapid increase in small pleasure boat activity occasionally overtaxes existing locking facilities. Future facilities for locking, and provisions for passing navigation during the construction period, must anticipate the character and the amount of future boating. Statistics of boat traffic through the lock have been compiled in order to establish trends in commercial and pleasure boat traffic. Seasonal distribution of boat traffic, types of boats using the lock,

types of commercial material transported and the boat traffic on peak days are analyzed in detail.

The construction of the Charles River Basin Elevation Control Project should make substantial improvements to pleasure boating on the Charles. The effect of such construction, the method of operation, and the installation of additional facilities for maximum recreational utilization of the Basin are analyzed.

The continuing reduction in number of commercial vessels and the increased cost of operating several drawbridges, together with the increasing interference with highway traffic, require a re-evaluation of the importance of commercial vessel traffic and the establishment of a long range program to solve some of the problems that are presented by continuation of commercial traffic on the Charles. Regulations to reduce the cost of operation of drawbridges and alternative methods of transporting commercial vessel cargo are studied in detail.

The views of those most concerned with commercial and recreational boating on the Charles River Basin were obtained to insure that the proposed program of improvement would serve the boating interests to the maximum practicable extent.

Construction of Charles River Basin Elevation Control Project may require temporary closure of the existing lock. Effects of temporary closures on boating in the past due to failure and repairs to lock gates are summarized.

The objectives of this report are to present factual data for determination of the most effective future recreational uses of the Basin and to determine the physical effects and social implications of the

proposed Charles River Basin Elevation Control Project. The information presented here should be used as a guide in the Charles River Basin Elevation Control Project study, in establishing construction schedules and procedures, determining size and capacity of facilities for locking and passage of boats, establishing the necessary clearances and regulations for drawbridges, determining future regulations governing the use of the Basin by commercial vessels, and evaluating the future needs of commercial traffic and recreational boating.

SECTION I

INTERVIEWS CONCERNING PLEASURE AND COMMERCIAL BOATING

SOURCES OF INFORMATION

The material contained in this report was derived from three primary sources: interviews, available data and observations.

The principal source consisted of personal interviews conducted with as many boating interests along the shores of the Charles River Basin as possible. Similar interests were grouped together and an interview program was conducted during the summer of 1958 in which as many people as possible from each category were contacted. Following is a list of the categories and the persons interviewed within each:

PLEASURE BOATING

Yacht Clubs

1. Charlesgate Yacht Club
2. Charles River Yacht Club
3. Watertown Yacht Club
4. Newton Yacht Club

Boat Clubs

1. Union Boat Club
2. Riverside Boat Club
3. Cambridge Boat Club

Sailing Clubs

1. Community Boating Inc.
2. M.I.T. Nautical Association
3. Boston University Sailing Club
4. Boston College Sailing Club
5. Northeastern University Sailing Association
6. Harvard University Sailing Club

Public Landing and Mooring Areas

Collegiate Rowing
1. M.I.T.
2. Boston University
3. Harvard University

Scholastic Rowing
1. Browne and Nichols School
2. Belmont Hill School

Charles River Lock
1. Mr.Southwick, Supt. Charles River Lock and Drawbridges
2. Mr. Hodson, Assistant Supt. Charles River Lock and Drawbridges

M.D.C. Police
1. River Patrol

Commercial Boating

Towboats
1. Fournier Towboat Company
2. Boston Towboat Company
3. Ross Towboat Company

Fuel Transportation
1. Boston Fuel Transportation, Inc.

Excursion Boats
1. Donald B. Hill
2. Harvard M.V. Inc.
3. Matthew Hughes

Marine Contractors
1. Rev-Lyn Construction Co.
2. C. Ray Norris & Son
3. McKie Lighter Company
4. Charles Hazelton & Son, Inc.

Boat Sales and Service
1. Bay State Boat Company
2. Sears Roebuck & Company

Users of Boat Transportation
1. Boston Sand and Gravel Company
2. California Oil Company (Calso)
3. White Fuel Corporation (White)
4. Socony Mobil Oil Company, Inc. (Socony)
5. Cambridge Electric Light Company
6. Cambridge Gas Company
7. Old Colony Tar Company, Inc.

Non-Boating Commercial Concerns

1. Boston Woven Hose and Rubber Company, Inc.
2. U. S. Army (Watertown Arsenal)

Each of the above was asked a series of questions designed to stimulate conversation about his particular category, its use of the Basin, the effect of rises and falls of elevation and the anticipated effect of the proposed pumping station.

Figure 1 shows the location of the various concerns using Charles River Basin for boating.

on the Charles River Basin. Some 1500 boats are used for pleasure boating. Of these, about 800 also use Charles River Lock. Of the boats using the lock, some 400 are registered at the four yacht clubs within the Basin and another 400 are estimated to be moored at public mooring areas, launched from trailers, or come into the Basin occasionally from the outer harbor.

In an attempt to get some first hand information from the pleasure boat owners, an interviewer contacted pleasure boat centers and at each of these talked with an official and a person or persons using the facility.

The facilities contacted consist of yacht clubs, boat clubs, sailing clubs, collegiate rowing crews, scholastic rowing crews, landing areas, the facilities for locking, and the M.D.C. Police River Patrol. Each one of these interviews is summarized individually in this section of the report.

An attempt was made to preserve most of the language of the interviews. Some repetition is unavoidable. However, such repetition is indicative of problems foremost in the minds of the users of the Charles River Basin for recreational boating.

CHARLESGATE YACHT CLUB

LOCATION:	Just upstream of Lechmere Canal on the Cambridge bank	
NUMBER OF BOATS:	Sixty-eight (68)	
SIZE OF BOATS:	Average Length	30 Ft.
	Beam	10 Ft.
	Draft	3 Ft.
	Maximum Length	46 Ft.
	Beam	14 Ft.
	Draft	4-1/2 Ft.
TYPE OF LANDING:	Fixed Elevation	
PERSONS INTERVIEWED:	Two club officials, one member	

The elevation of the Charles River Basin is of the utmost importance to the Charlesgate Yacht Club members. This organization depends almost entirely on a fixed elevation marina for its anchorage. The marina is supplemented by several moorings.

Elevation is of prime concern to the persons tying up at the Charlesgate Marina, which consists of a platform fixed on top of driven piles. The immobility of the marina makes adjustments for variations in Basin elevation impossible. The only method of compensation is that of individuals directly letting out or taking up on the lines holding the boats fast in their slips. A rapid rise in elevation might create enough strain to snap the lines, while a sudden drop in the Basin level could allow enough slack so that the boats would be in jeopardy of hitting each other or the marina.

There is similar concern among people who use the moorings. Here too, should the river level rise rapidly, there would be a problem of

too much strain in the lines; and, should the elevation drop, the slack in the lines could permit boats at the moorings to hit one another.

The marina was constructed at the level most convenient for boarding and leaving boats when the Basin is at normal level. When the river level varies from the normal 108 elevation, boarding grows progressively more difficult.

The members of the Charlesgate Yacht Club feel there is no problem with running aground or with hidden navigation hazards in the lower end of the Basin. The water at the lower end is what they refer to as "good water".

They unanimously agree that in the upper Basin, beyond the Eliot Bridge, lies "poor water", where the channel is narrow and the water so shallow that the Charlesgate Yacht Club members refuse to take their boats upstream to the Watertown and Newton Yacht Clubs.

The interviewer asked for specific locations of mud and sand bars in the Basin. The only one known to the Charlesgate members was a mud bar upstream of the Eliot Bridge. No others were mentioned.

Sluicing currents present some problems to the Charlesgate boats. On the Basin side of the dam there is absolutely no effect at all; but, on the tidal side of the dam there is a cross current that can make navigating upstream into the lock a problem. To compensate for the current when the sluicing gates are opened, they felt that it would be necessary for shallow draft boats to hug the Cambridge wall in coming

into the lock from the harbor. The larger boats, too, must pass near the wall, but the currents are not as significant as for the smaller boats.

Pollution of the Basin is of principal concern to the boat owners. The interviewer was invited aboard one of the boats to see how dirty the water in the Basin actually is. He was taken to the toilet of one of the cruisers and instructed to pump the toilet flusher. It was indeed discolored water that spread over the white porcelain hopper.

A rather strange point was made about the corrosive action of the water. The chains used for moorings are only good for a period of about three years. At the end of the third year it is necessary to pull the chain and replace a section very close to the bottom. When the interviewer asked for an explanation of what was causing the corrosion, one of the members stated that there was a layer of "acid" above the floor of the river. The rest of the people present immediately agreed that this was the explanation.

There were strong protests against the tremendous pollution of the Charles River. When the interviewer asked why the boat owners preferred to keep their craft in the Basin rather than in the harbor, the reply was that they were willing to put up with the pollution and its effects on their boats in preference to the marine growth which accumulates on the bottom of boats in the harbor.

The members of the Charlesgate Yacht Club rate the operation of the lock as excellent. They commended the lock employees and indicated that they felt that these people were working to capacity with the facilities

CHARLES RIVER YACHT CLUB

LOCATION:	Between the Longfellow and Harvard Bridges on the Cambridge shore.	
NUMBER OF BOATS:	85	
SIZE OF BOATS:	Average Length	32 Ft.
	Beam	12 Ft.
	Draft	2-1./2 Ft.
	Max. Length	85 Ft.
	Beam	20 Ft.
	Draft	6 Ft.
	Height	24 Ft.
	Min. Length	18 Ft.
	Draft	9 Inches
TYPE OF LANDING:	Fixed elevation, and float	
PERSONS INTERVIEWED:	One club official, two members	

Because the immobility of a fixed landing precludes self-adjustment to varying Basin elevation, inadequate elevation control is of prime concern to the members of the Charles River Yacht Club. An extreme variance from normal Basin elevation makes boarding difficult and sometimes damages the boats in their slips by causing lines to become too tight or slack.

The Charles River Yacht Club has an additional problem of water and electric line linkage running from the fixed marina to the floats. The water line linkage consists of a length of slack rubber hose connected to water pipe on both the fixed dock and on the float. The

electric line is strapped to this slack hose. The slack is sufficient to handle the average extremes in elevation, but under extreme conditions, the linkage has broken. Should this occur when the landing is unattended, rather serious consequences could result.

Because some of the higher boats have very little clearance under the fixed bridges at the normal elevation of 108, inadequate control of elevation causes an additional concern. Sometimes, when the elevation of the Basin has risen between trips, serious damage has been done to the superstructure of boats.

Running aground is not a problem in the lower Basin. One member described the conditions here as "good water". The only navigation hazard mentioned was a broken dolphin near the Basin entrance to the lock. It was felt that this dolphin should be either repaired or replaced.

The Basin from the Eliot Bridge to the Watertown Dam is considered "poor water". The persons interviewed stated that it is impossible to list the sand bars or the hazards in that area, since there are so many.

Pollution of the river seems to be a major concern of the members. Instances of visual detection of pollution are frequent, sometimes causing damage to fish and plant life within the Basin. As is the case at the Charlesgate Yacht Club, the members believe "a layer of acid" in the Basin is responsible for corrosion of chains. However, at the Charles River Yacht Club the corrosion is most pronounced in a layer about 5 feet below the water surface rather than at the bottom. At both yacht clubs the corroded sections have to be replaced about every

third year. The portions of the chains above or below the layer of "acid" remain in excellent condition.

The increasing pleasure boat traffic on the Charles is creating problems. The members of the Charles River Yacht Club recognize that this growth is inevitable and justifiable, but they believe that some changes in the rules governing the use of the Basin are necessary. One of the first, according to the Charles River Yacht Club, is to lower the speed limit past landings to 5 MPH. Signs should be displayed at both ends of all landings as a reminder of the reduced speed limit. This recommendation was made because boats traveling at high speeds past the Charles River Yacht Club landing create washes that severely jostle the boats in their slips.

The operation of the lock is considered excellent, and the men at the lock are always most cooperative in the eyes of the Charles River Yacht Club members. However, the operation of the Boston and Maine Railroad Drawbridges frequently causes apparently unnecessary delays.

A recommendation was also made by the Charles River Yacht Club that storm warnings be displayed at both ends of the lock, and also at each one of the yacht clubs. This would give the boatmen the latest reports on the conditions in the open waters. The responsibility for the maintenance of the storm warnings could be either public or private. To assure that people are not jeopardizing their lives, it was suggested that the operation of the lock be curtailed during small craft warnings. This would keep small boats from passing into the harbor when the water is too rough for safe passage.

A recommendation was made that instructions be started to teach the safe operation of pleasure boats. The members believe that the rapid growth of boating on the Basin has reached a point where either the imposition of strict regulations or the use of the Basin only by well-trained boatsmen is necessary.

The Charles River Yacht Club members believe that a new and more clearly understood signal system for directing the boats should be installed at the lock.

Since the time of the interview the constructive suggestions by the Charles River Yacht Club members and by others, particularly in regard to storm warning signals, lower speed limits and other improvements, have produced safer and more enjoyable boating conditions.

WATERTOWN YACHT CLUB

LOCATION:	On the Watertown shore of Sunset Bay
NUMBER OF BOATS:	83
SIZE OF BOATS:	Average Length 30 Ft. Beam 10 Ft. Draft 2 Ft. Maximum Length 44 Ft. Beam 12 Ft. Draft 3-1/2 Ft.
TYPE OF LANDING:	Floating service dock and several floating landings with slips
PERSONS INTERVIEWED:	Club Steward, one member

The Charles River Basin just below the Watertown Dam is so shallow that running aground is a common occurrence. Conditions here

are such that the Watertown Yacht Club claims that there is only a 3-1/2 foot depth of water at the deepest point in their mooring area. When such "poor water" exists, an inch or two variation in the elevation of the Basin can make the difference between a safe voyage or running aground.

The problem of hitting the bottom is not limited to the larger craft. Many outboard owners complain that the water in Sunset Bay is so shallow that they frequently break the shear-pins.

Because of the "poor water", many of the larger boats from the Watertown Yacht Club are moored along the edges of the main channel. Since the channel is already narrow, this adds to the confusion of boat traffic in Sunset Bay.

Even when the Basin is at the normal 108 elevation, getting down-river is a major undertaking. The interviewer was taken on a down-stream trip by the Steward from the Watertown Yacht Club in a shallow draft boat. The trip was designed to show just what is entailed in getting to "good water".

Leaving the Watertown Yacht Club landing, the Steward headed generally upstream. The water around the club dock is about 3-1/2 feet deep and bears close watching for it grows shallow very rapidly. The Steward followed this course until clear of the entrance to the landing and moor-ing area. He then headed the bow of the boat directly for the Newton shore. At a point somewhat beyond the middle of the bay, he made a 90 degree turn downstream and headed toward the North Beacon Street Bridge.

After passing under the bridge, he made a 45 degree swing toward the Watertown shore. When approximately within 30 feet of the bank, the Steward straightened out his boat and hugged the bank adjacent to the Watertown Arsenal until arriving at the Arsenal Street Bridge. When he was questioned on this last maneuver, he replied that extending from the Boston shore, about half way between the North Beacon Street Bridge and the Arsenal Street Bridge, there is a concrete pipe. This pipe extends into the river almost 20 feet at a shallow depth.

At the Arsenal Street Bridge it is necessary to use the arch near the Boston shore. The other arch is too shallow for larger boats and there is a mud bar that requires close watching on the opposite shore. From this point to Eliot Bridge the water is fairly deep for the most part. There is one mud bar that runs parallel to the Boston shore close to the Metropolitan Boston Arts Center. This mud bar causes little trouble except to boats that run too close to the shore.

Elevation variations do not affect the Watertown Yacht Club dock. All of the club's landings are floats and are continually adjusting themselves to the Basin's variations.

An interesting fact came to light about the membership of the Watertown Yacht Club. Many of the members also belong to other yacht clubs. Membership here is established so that the boat owner will be able to use the Watertown Yacht Club facilities during the off-boating season. During the summer, the owners take their boats to open water yacht clubs, leaving behind the worry of running aground or the discoloration of their

boats from the pollution in the Basin. During other months, the boat owners are able to work on their boats and ready them for the boating season. It appears that the accessibility of the Watertown Club encourages this membership practice.

The operation of the lock is considered excellent by the Watertown Yacht Club. In their opinion, the men at the lock have the interest of the boat owners at heart and do all that is in their power to make boating on the Charles River Basin as enjoyable as possible.

This is not the case at the Boston & Maine Railroad Drawbridge. One of the interviewed owners said that just a few days before the interview, he had waited for 45 minutes, for no apparent reason, for a draw opening. During the 45-minute wait, no trains passed over the bridge.

When the sluice gates are open, the resulting currents require that a boat entering the lock do so with considerable care. It is possible to be forced up against the fender pier by the cross currents. To compensate for these currents, the boatmen make a run for the lock, keeping to the oncoming current side of the approach.

Discoloration attributed to pollution is another problem. People interviewed claimed that during the 1957 season, an oily, rubber-like substance came down the river. This slick ruined the finish on many of the boats. When club members traced the substance, they found that it was being discharged from a plant above the Watertown Dam. They claimed that this slick was a residue being flushed from a storage tank discharging to the middle of the river.

NEWTON YACHT CLUB

LOCATION:	Upstream of the Watertown Yacht Club on the Newton shore of Sunset Bay	
NUMBER OF BOATS:	140	
SIZE OF BOATS:	Average Length	30 Ft.
	Beam	9 Ft.
	Draft	3 Ft.
	Ht. Above Water	8 Ft.
	Maximum Length	44 Ft.
	Beam	12 Ft.
	Draft	4 Ft.
	Ht. Above Water	10 Ft.
TYPE OF LANDING:	Multiple unit marina	
PERSONS INTERVIEWED:	Club official	

Shallow water and mud make elevation control extremely important to the Newton Yacht Club. The elevational problems confronting the Watertown Yacht Club are duplicated at the Newton Yacht Club. Both organizations are located in Sunset Bay, which is well-known along the Basin for its "poor water".

There is, however, a difference in the manner of anchoring boats. While Watertown Yacht Club moors most of its boats in a central mooring area in the channel, Newton Yacht Club depends almost entirely on slips at the marina for anchorage. Because of this, Newton Yacht Club, like the yacht clubs in the lower end of the Basin is faced with the problem of damage to boats and lines by the wash from passing power boats.

Another problem of consequence is the navigation hazard created by abandoned moorings in the channel. It was recommended by Newton Yacht

Since the Union Boat Club has a floating dock, the distance from the top of the landing to the surface of the water is constant. This makes launching and retrieving boats a relatively simple matter. Elevation is of some importance to the Union Boat Club members when they scull in the shallow Storrow lagoon or canoe-way.

At the entrances to the middle lagoon there are granite blocks that narrow the openings considerably. It was recommended by the Union Boat Club that enough blocks be removed from each of these approaches to permit a shell with extended oars to pass without difficulty.

Oarsmen complain that children drop stones on them as they pass under the foot bridge that crosses the lagoon. None of the objects have hit the scullers so far, but considerable damage has been done to the shells.

A major problem confronting the Union Boat Club is the wash created by power boats. Swamping and capsizing are growing to be a common occurrence. As the boat traffic on the Basin increases, the accident rate rises. It is this growing traffic and threat of mishaps that is forcing the scullers onto the Canoe-way for safe recreation. Here, they are able to find refuge from upsetting wakes and strong winds existing in the lower Basin.

Sailboats as well as power boats are making sculling difficult in the Basin. However, the confusion that sailing craft add to the boating traffic is excused because of the nature of their propulsion. The oarsmen feel that when you are at the mercy of the whims of the wind, you have the right of way. It would be helpful, though, if the users of

the sailboats were more closely checked out. Many individuals at the helm appear to be not qualified.

The pollution of the Basin does not affect the shells. The salt water and other foreign matter is wiped from the hull just as soon as the boat is out of the water. However, the algae that grow in the River are most objectionable to club members. This algae growth starts to appear about the end of May and produces one of the most offensive stenches imaginable. At times, the stench grows so potent that the Basin is not desirable for recreation.

It is recommended by the Union Boat Club that the dock in the middle lagoon be removed. The club feels that the unused landing serves only to attract children. Removing the dock would eliminate this danger to children, and also provide the sculler with a straighter course through the pond.

As a means of making the Basin even better for boating, a suggestion was made that all boats over 14 feet be required to register. Registration numbers would make it easier to identify boats violating the rules of the river.

RIVERSIDE BOAT CLUB

LOCATION:	Upstream of Magazine Beach on the Cambridge shore
NUMBER OF BOATS:	48 Shells 1 Outboard
TYPE OF LANDING:	Float
PERSONS INTERVIEWED:	Four club officials, custodian

The Riverside Boat Club has a floating dock that makes elevation control of little importance. This landing, like the other floats, adjusts itself to the variations in the Basin elevation, so that getting boats in and out of the water is a relatively simple matter.

However, control of high water is important in keeping the debris out of the river. Logs and other objects are released from the shores by high water. As they float downstream in the Charles River, they become navigation hazards.

It is the contention of the Riverside Boat Club Members that the majority of the debris in the river is due to the construction in the lower end of the Basin. They believe that the debris floats upstream.

CAMBRIDGE BOAT CLUB

LOCATION:	Just downstream of Eliot Bridge on the Cambridge bank
NUMBER OF BOATS:	20 Shells 2 Canoes 4 Row Boats
TYPE OF LANDING:	Float
PERSONS INTERVIEWED:	Club custodian

The Cambridge Boat Club is not affected much by elevation variation. It is, however, greatly affected by the wash which power boats create. Swamping and capsizing have become a regular part of sculling since the recent rapid growth in motor boating on the Basin.

In the vicinity of the Cambridge Boat Club, there is no lagoon where a sculler may find protection. At this end of the Basin, the

oarsmen must keep near the shore to avoid being hit by a motor boat.

On weekends and holidays, the boat traffic is so heavy that most of the scullers either row before 8:00 A.M. or not at all. After this hour, traffic is such, that for a shell to venture out means almost certain diaster.

Debris released by high water is another problem to the sculler. As the water rises, much of the trash that is normally above water level is liberated, creating a navigation hazard. Many shells have been pierced by such debris.

Just as soon as the boats are taken from the Basin, they are wiped down. Consequently, discoloration from water pollution is avoided.

At this particular site, there is no problem with algae. The River is narrow and the water moves fast enough to prevent formation of growths.

However, there is a problem with slick which moves down the river from time to time. Once the slick arrives, it is a long time before it disappears, since it catches on the shores and under the docks. If it were not for the wiping of the boats after their use in the river, it was felt that there would be discoloration.

COMMUNITY BOATING INC.

LOCATION:	Just upstream of Longfellow Bridge on the Boston bank
NUMBER OF BOATS:	35 fiberglass sailboats
TYPE OF LANDING:	Fixed elevation on piles
PERSONS INTERVIEWED:	Dock master, manager

Community Boathouse has a fixed elevation landing on piles that is not affected by variations in the Basin's elevation. The dock was constructed high enough above the water's surface to handle the normal rise and fall of the Basin.

The sailboats at Community Boathouse are not pulled in and out of the water each time they are used. They are launched for the season in late March and remain in the water until sometime in November. When the boats are not in use, they are tied up along the inside edge of the landing. The front of the dock is kept clear at all times for boats landing and casting off.

The sailing area used is between the Longfellow and Harvard Bridges. The water in this portion of the Basin is deep enough to insure trouble-free sailing. The Manager of Community Boating Association stated that this area is deep enough to permit one of his boats to set its bow on the bank and still have plenty of "good water" under the centerboard.

Discoloration due to pollution or salt water is not a problem. However, it is felt that the marine growths which form on the hulls of the fiberglass sailboats are caused by salt water in the Basin. This condition has become so bad that Community Boating has coated the bottoms of all its sailboats with an anti-fouling copper paint. Generally, fiberglass boats are considered anti-fouling without copper paint.

While the interviewer was looking over the facilities at Community Boathouse, large algae formations were observed. These growths were behind the landing where there is little chance for circulation of the

water. When the Dockmaster was asked about the algae, his reply was that as the summer goes on the formations grow considerably worse, and the stench becomes most objectionable.

Power boats are a nuisance to the Community sailors. The wash created by passing power boats frequently is such that it either swamps or upsets the sailboats, or tosses them around to the point where they lose the wind. It is recommended by the Manager of Community Boating that the boats on the river be required to register and display registration numbers where they may be easily read. This would give interested parties a means of identifying boats violating the rules of the river and in turn make it possible for better police control.

M.I.T. NAUTICAL ASSOCIATION

LOCATION:	Downstream of Harvard Bridge on the Cambridge bank
NUMBER OF BOATS:	52 fiberglass dinghies
TYPE OF LANDING:	Fixed elevation, on piles
PERSONS INTERVIEWED:	Coach, two boathouse attendants
NUMBER OF PEOPLE PARTICIPATING:	Average 1000

The Massachusetts Institute of Technology Sailing Pavilion is the center of much collegiate sailing activity. Not only do some 1000 M.I.T.

students, faculty and employees use the facilities, but also the sailing clubs of Northeastern University, Boston College and Harvard University. Since these other colleges and universities do not have sailing facilities of their own, Massachusetts Institute of Technology has made available to these sailing clubs the use of the M.I.T. Nautical Association for recreational, practice and competitive sailing.

Elevation control is of importance at the nautical association. The landing is fixed at an elevation adequate for normal rises and falls in the elevation of the Basin. But, as the water level drops, it becomes considerably more difficult to launch and pull the sailboats after their use.

At M.I.T. Nautical Association a boat is pulled each time it is used, unless there is someone waiting to take it out again. The dinghies are lifted from the water by two persons and either left on the landing or carried to the boathouse, depending upon the demand or anticipated demand for the boats.

Running aground is not a problem here. Within the sailing area between the Longfellow and Harvard Bridges there are no areas other than the Canoe-way where a sailboat could go aground.

BOSTON UNIVERSITY SAILING CLUB

NUMBER OF BOATS:	8 Fiberglass dinghies
TYPE OF LANDING:	None
PERSONS INTERVIEWED:	Coach, one member
NUMBER OF PEOPLE PARTICIPATING IN SAILING:	135

The Boston University Sailing Club does not have its own boathouse nor a permanent base of operation. During the fall and spring months, the members use the facilities of Community Boating, Inc. When the rowing season on the Charles River is over, the sailboats are moved to the Boston University Crew's Boathouse for the summer.

While the boats are tied up at Community Boathouse, B. U. considers the area between the Longfellow and Harvard Bridges as the limits for sailing. But, when the sailboats are moved to the Boston University boathouse, the sailing area becomes the section of the Basin between Harvard and Boston University Bridges.

It is the hope of Boston University's Sailing Club to build its own boathouse in the near future. The money has been appropriated by the trustees of the University, but as yet, the M.D.C. has not approved the site. The site desired is a section of the Boston shore behind Shelton Hall, near Kenmore Square.

The major problem confronting the club is the wash created by passing power boats. The sailing coach expressed concern that most of the power boats are operated either by people lacking the ability to handle their craft properly or without regard for others.

Also, there is a problem with running aground. At the downstream ends of both the Community and B.U. Landings, the water is very shallow. When the sailboats enter these areas, the centerboards hit bottom. To remedy this, it is necessary to pull up the centerboard and pull in the rudder. During the summer of 1957, the problem of running aground was at its worst due to the drought conditions existing at that time.

BOSTON COLLEGE SAILING CLUB

The Boston College Sailing Club has neither equipment nor facilities of its own. The club uses the M. I. T. Nautical Association and equipment.

At present, the Boston College Sailing Club is not particularly active.

NORTHEASTERN UNIVERSITY SAILING ASSOCIATION

Northeastern University Sailing Association too, has neither equipment nor facilities of its own, and uses the facilities made available by the M.I.T. Nautical Association.

Currently, there are approximately forty members in the Northeastern University Sailing Association.

HARVARD UNIVERSITY SAILING CLUB

Harvard University Sailing Club also uses the boats and facilities of the M.I.T. Nautical Association.

PUBLIC LANDING AND MOORING AREAS

The principal public landing areas for boats are at Magazine Beach just upstream of Boston University Bridge in Cambridge and the landing area just upstream of the newly constructed Metropolitan Boston Arts

Center in Brighton. Most boats which are brought on trailers are launched at these two locations.

Launching of boats from trailers at other locations, with the exception of private clubs, is minor. On a good day, about one hundred boats, many of them using the lock, may be launched from the river banks.

The public landing area at Magazine Beach is the largest one on the Basin. On a sunny summer weekend the entire waterfront landing area and the parking facilities on shore are filled. Most of the cars and trailers are parked with trailers left in the water after launching, since parking space is at a premium. On good weekends, it is becoming a near impossibility to find space for launching a boat. At this location the wash from rather frequent passage of boats in front of the landing area adds to the problems of launching.

The principal public mooring areas for boats are in the lower part of the Basin, adjacent to the wall on the Cambridge bank. The space between yacht clubs and sailing pavilions from the dam to just upstream of Harvard Bridge is used for public moorings. The three main areas are just upstream of Harvard Bridge, between Charles River Yacht Club and Longfellow Bridge, and between Broad Canal and Charlesgate Yacht Club. The Boston side of the lower Basin is not used for mooring pleasure craft, and the river above Boston University is too narrow for development of extensive additional mooring areas.

M. I. T. ROWING

LOCATION:	Downstream of Boston University Bridge on Cambridge bank
NUMBER OF BOATS:	Shells - Eight man - 14 Four man 1 Two man 1 Singles 3
	Launches 3
	Row boats 1
TYPE OF LANDING:	Fixed elevation
PERSONS INTERVIEWED:	Crew coach

The major problem confronting the Massachusetts Institute of Technology Crew is the wash created by power boats. From the safety standpoint, the wash is rarely of the deep rolling variety that upsets shells; but, from the training standpoint, the wash is sufficient to make rowing in the Basin almost impossible. The M. I. T. Crew Coach stated that he finds it near impossible to make training runs over the race course without being disturbed by the wash from a passing power boat.

Interruptions of this nature affect the crew in two ways. First, the actual time needed to complete the course is hard to determine because of the adverse water conditions; and second, the crew is unable to maintain an uninterrupted rhythm for the distance of the course. This seriously affects the crew's readiness for competition.

The landing at M.I.T. is a fixed elevation dock. As at fixed landings at some of the yacht clubs in the Basin, getting in and out of

the shell becomes difficult. When the Basin is low, the out riggers on the shell hit the side of the landing. A drop of just an inch or two seriously affects this condition.

Navigational hazards in the Basin include driftwood and unused moorings. Wood, freed from the banks upstream, floats toward the harbor and is a threat to the hull of a shell. It has become necessary for M.I.T. to station one man in the launch to act as a lookout. This individual is responsible for spotting debris in the water and informing the coach and crew members of oncoming obstructions. Over the years, many shells have been extensively damaged when their hulls were pierced by driftwood.

Unused moorings are a second hazard. This is most serious in the off-boating months, when the moorings are not in use and are difficult to spot. The reason for this confusion stems from the fact that the race course for the shells is extremely close to the mooring area of the Charles River Yacht Club. If the moorings were moved in closer to the sea wall, then the racing course would be more accessible and safe.

The time it takes to traverse the racing course is seriously affected when the sluicing gates are open. Should the race be coming downstream when the gates are opened, the current speeds the boats up drastically.

BOSTON UNIVERSITY ROWING

LOCATION: Downstream of Boston University Bridge on the Boston bank

NUMBER OF BOATS: 8 Shells
2 Motorboats

TYPE OF LANDING: Fixed elevation landing on piles

PERSON INTERVIEWED: Crew Coach

The wash from power boats is of major concern to the Boston University Crew. The rapid growth in motor boating on the Charles River Basin has made rowing increasingly more hazardous.

Also mentioned was the pollution of the Basin. Although the slick that came down the river in summer of 1957, was an annoyance, it did not damage the Boston University shells. Probably this is because almost immediately after the shells are taken from the water, they are completely wiped down; any foreign matter that may have collected on the hull is cleaned off before the shell is placed on the racks.

Boston University Crew has an ever present problem with Basin elevation. During the fall months, the front edge of the B. U. landing is often under 6 or 8 inches of water. The remainder of the year, the dock is inaccessible because the boats hit bottom within a foot of the landing.

HARVARD UNIVERSITY ROWING

LOCATION: Between Eliot and Larz Anderson Bridges

NUMBER OF BOATS: 3 Launches
2 Outboards
52 Eights
2 Fours
60 Singles

TYPE OF LANDING: Floating

PERSONS INTERVIEWED: Crew Coach, Director of Boating

Harvard University maintains two boathouses on the Charles River. The Weld Boat Club, with facilities located just below Larz Anderson Bridge on the north side of the river, is used primarily for single shells. The boathouse used primarily for eight-man crew shells is located just upstream of this bridge on the south side of the river.

The Harvard University Crew is virtually unaffected by variations in Basin elevation. Both boathouses have floating docks that adjust themselves to the Basin's level.

Basin elevation, however, is important in controlling the amount of debris that finds its way into the river. When the river rises, a large amount of trash on the banks is freed. This trash then floats downstream and becomes a hazard to boats.

The Harvard Crew Coach has observed that when the sluice gates are open, the rowing time of his crew is greatly affected. The currents are so strong that in a mile and 5/16 upstream race, one minute is added to the time. This has the same effect as rowing an additional 1/4 mile.

Sluicing currents are particularly strong just upstream of the Boston University Bridge where the river is narrow.

Like the other collegiate crews using the Basin for rowing purposes, Harvard's Crew is extremely concerned with the wash created by power boats. The crew coach pointed out that on a good day, it is virtually

impossible to row; only when the weather is bad is the crew able to get an uninterrupted workout.

Harvard's director of boating feels that it is only a matter of time before someone in a shell is killed by a motor boat. He recommends that all boats should be required to have registration numbers by which they may be identified. The police and interested parties would have a means through which to check excessive speed of a boat in the Basin through reports of the boat's number.

Over the past few years, motor boat operators have seemed to have little respect for the shells and other manually operated boats. They disregard the shouts of the oarsmen to slow down and consequently swamp or capsize shells. Recently, though, there seems to be an improvement in this attitude. Many of them seem to be more concerned for the shell's safety as they pass, and cut their speed to a safe passing limit.

The Belmont Hill School dock is considered an obstruction in the eyes of Harvard. The landing is located behind the upstream side of Eliot Bridge on the Cambridge shore. Its location and length require the oarsmen to be careful as they travel in this area.

The Harvard Crew has also had trouble with slick. During the summer of 1957, considerable cleaning of the boats after each trip in the Basin was necessary.

The condition of the river has improved considerably during 1958. There is, however, still considerable foreign matter wiped from the shells each time they are taken out of the water.

BROWNE AND NICHOLS SCHOOL

LOCATION:	Downstream of Eliot Bridge on Cambridge bank
NUMBER OF BOATS:	3 Outboard runabouts 9 Fours 2 Eights
TYPE OF LANDING:	Float
PERSON INTERVIEWED:	Crew Coach
NUMBER OF PEOPLE PARTICIPATING:	85

The coach of the Browne and Nichols Crew stated in the interview that the real problem confronting the oarsmen is not water conditions, but objects dropped from the bridges. As the shells pass under the spans, children lining the bridge drop rocks and clumps of sod on the passing shells. So far, nothing more serious than a hole being pierced in the deck or hull of a shell has occurred. But, it is just a matter of time before a crewman is seriously hurt.

Like the other institutions with facilities for rowing, Browne and Nichols is confronted with the rapid growth of motor boating on the Basin. Each year, as the spring advances, the number of motor boats increases. By May, it is impossible to find smooth water for practice.

The problem is not limited to just finding an area for practice. It also extends to the point where it becomes impossible to find water smooth enough for a time trial. The crews' rowing time is severely affected by the condition of the river. When the sluicing gates are open at the lock, the time required to cover the race course is greatly affected.

BELMONT HILL SCHOOL

LOCATION:	Just upstream of Eliot Bridge on the Cambridge shore
NUMBER OF BOATS:	8 Shells 2 Outboard motor boats
TYPE OF LANDING:	Floating
PERSONS INTERVIEWED:	Crew Coach
NUMBER OF PEOPLE PARTICIPATING:	50

Like most of the other crew coaches along the Charles, the Belmont Hill School coach feels that boat traffic is the major problem on the Charles River Basin. Fast-moving motor boats often produce a dangerous wash. It was pointed out by the Belmont Hill crew coach that the construction of the shells does not permit them to ride out a roller, as conventional boats would. Invariably when a shell is subjected to a tossing around from a strong wash, they take in a considerable amount of water.

Secondly, the coach commented on the unsanitary conditions of the river. Pollution is dangerous, not only from a health standpoint, but also it has caused some discoloration to his boats.

The effects of varying elevation upon racing in the Basin are negligible. However, the racing time is seriously affected by sluicing currents. Over a course of half a mile in length, the time can be slowed down as much as ten seconds.

Sluicing currents also affect the landing of the shells. If the

coxswain does not know that the sluice gates are open, he can have considerable trouble coming alongside the landing.

CHARLES RIVER LOCK

Mr. Southwick, Superintendent of the Charles River Lock and Drawbridges, seems particularly interested in the safety of the pleasure boat owners using the lock. This interest is not limited to the present. It is his feeling that certain measures must be taken during and after the construction of the proposed pumping station to assure the boatmen of safety while using the lock.

At present, conditions on a busy weekend are such that the lock and crew are working at peak output. The tremendous growth in boating activity on the Charles River Basin over the past few years has speeded the inevitable antiquation of the existing equipment. These locks were constructed some fifty years ago to last approximately twenty years. Mr. Southwick is constantly concerned about breakdowns that will force the gates to be closed for major repairs. (Since the time of this interview with Mr. Southwick, a breakdown of the lock gate occurred, resulting in no passages of boats through the lock from August 22, 1958 through September 4, 1958. New lock gates were installed during the period from April 20, 1959 through June 26, 1959).

On a "good boating day" it is not unusual to find as many as forty boats to a locking and lockings being performed in rapid succession. During these high volume traffic periods, the equipment is kept moving

only through careful handling by experienced operators. Because the lock area is too small to accommodate the large volumes of boat traffic and the speed of lockings is the maximum possible with existing facilities, some boats are forced to wait for a locking.

It is during such periods that a public address system, operated from the tower, would be very helpful. Such a facility would permit the operator in the tower to control the traffic by directing the waiting boats in an attempt to fill the locks in a more organized and systematic fashion. Also, if the proposed third locking gate for the pumping station location just below Charles River Dam should become a reality, some means of communication from the tower will be imperative. The downstream location of the gate will make handling of the boat traffic without a public address system impossible.

Another suggestion offered by Mr. Southwick was to place recessed rings in the sea wall and fender piers below and above the lock. He stressed that such rings should be placed at various elevations, permitting boats to tie up during waiting periods regardless of water's elevation. It is felt that such arrangements would help greatly in reducing the congestion of traffic caused as boats leave the lock, passing by the waiting boats.

Also, these rings could aid in preventing accidents because of strong currents expected after the pumping station is installed downstream of Charles River Dam. Mr. Southwick feels that currents caused by the pumping station would seriously endanger small boats. If there were rings for the boatmen to tie up to, then they would be able to

ride out strong currents by simply securing a line. Overturning due to strong currents is sometimes a problem now. There is a history of boats being overturned in the vicinity of Warren Bridge because of strong sluicing currents. Regardless of the location of the proposed pumping station, sluicing currents from the flow through the lock and the sluices will continue to exist below the dam. Since many of the boatmen using the Charles River Lock are novices, all possible safety measures should be taken.

During construction of the pumping station, the area open to boating is certain to be extremely limited. By providing rings for the boatmen to tie up to, it will be possible to keep the limited channel clear for traffic actually moving in or out of the lock.

Mr. Southwick also expressed the opinion that before any further action is taken on the proposed launching area on the banks of the Basin, serious reconsideration should be given to the existing boat traffic problems. There is already a serious traffic problem in the very limited area of the Basin, and it is rather doubtful that the lock can be worked at any faster rate than it is now.

The interviewer asked Mr. Southwick about the possibility of using the small boat lock during construction. This lock has been blocked for many years and it would be dangerous and impractical to consider opening it. Only the smallest boats using Charles River Basin could pass through the small boat lock. It would take a crew of five additional men to operate it on a 24-hour basis. The danger and the cost of this in relation to its potential seems to rule out the practicality of such a move.

Running aground has been a problem in the upper reaches of the Basin. From time to time, the Watertown and Newton Yacht Clubs have contacted the lock about shallow water in that area that has caused grounding.

In an interview with Mr. Hodson, Assistant Superintendent of the M.D.C. Lock and Drawbridges, the following information with regard to the size of pleasure boats using the Charles River Lock was obtained:

Boat Length	Average	35 Ft.
	Maximum	85 Ft.
	Minimum	12 Ft.
Beam	Average	9 Ft.
	Maximum	20 Ft.
	Minimum	3 Ft.
Draft	Average	2 Ft.
	Maximum	6 Ft.
	Minimum	8 In.
Height of Boat Above Water	Average	6 Ft.
	Maximum	24 Ft.
	Minimum	10 In.

Many of the larger boats, according to Mr. Hodson are restricted in their travel on the Basin because of shoaling and low bridges. The first such bridge is the Harvard Bridge. Boats with a sizeable amount of superstructure are unable to pass under the low spans. The next obstacle is the Railroad Bridge under the Boston University Bridge. Excursion boats on the river have trouble with clearance here, especially when the Basin is above normal 108 elevation. Many pleasure boats on the river are unable to get beyond this point.

Navigation is limited not only by bridges, but also by shoals.

From Eliot Bridge to the Watertown Dam, it is necessary that someone aboard be familiar with the very narrow and irregular channel. The worst grounding problems are above the Watertown Yacht Club. When the water here falls below Elevation 107, the majority of boats in this region are on the mud.

Sluicing currents are also a problem. When the difference in elevation between the Basin and harbor exceeds about five feet, the currents caused by sluicing are extremely severe. Many of the commercial boats are unable to buck these currents. It is common practice for boat owners to tie up below the dam, come ashore and telephone the locks, asking to have the sluice gates shut down while they make their way upstream.

The rules for passage through the Charles River Lock are indicative of the procedures and problems in locking. They are quoted in full:

"The following rules are given in the interest of public safety, quicker and more efficient service in your passage through the Charles River Lock."

"At both ends of the Lock there are semaphore signals for controlling the traffic through the Lock. Learn their meaning and obey them. When the semaphore arm is in a horizontal position (red) DO NOT ENTER. Enter only when this arm is down (green) so as it points in the direction of the ground. Never enter the Lock if there are boats waiting to leave in the opposite direction from your intended course."

"Small boats will remain out of the Lock until the larger boats have entered and have been secured. It is safer to have large boats tied up to the wall and have small boats lay along side them."

"When there are several boats waiting to enter the Lock and the semaphore signal is positioned for entrance, do not rush to enter. Three or four boats all coming in at close quarters cannot be handled properly. Remember the boats around you may not have as capable skippers as the one aboard your boat."

"The upstream line should always be held first."

"The captain of the boat should instruct his stern line man that upon being given the line to take the slack in and take one or two turns around the bitt. Trying to stop the boat by holding this line by hand often results in severe rope burns of the hands and may pull you overboard. Do not secure the lines to the bitts by half hitches or other knots that will prevent slackening of lines as water is lowered in the Lock. Keep all limbs inside your boat where they will not be crushed.

"When the Lock gate is opened in preparation for your departure, do not let your lines go until told to do so by the Lock man on the wall.

Obeying these few rules and directions of the Lock man will help us to help you to better service and safety in your passage through the Charles River Lock."

Closed hours of bridge are 6:15 A.M. to 9:10 A.M. and 4:15 P.M. to

7:40 P.M., but no closed hours on Sundays or holidays."

"The Lock has no closed hours."

M.D.C. POLICE

Officer Luccirelli, who patrols Charles River Basin in an M.D.C. Police Boat was interviewed concerning his knowledge of the Basin. According to him, wakes created by boats have drawn considerable complaints and present a major problem. To combat this, the police boat has tried to patrol the mouth of the Lock as well as possible. All speeding boats that can be seen are stopped and their owners reprimanded. (Since this interview, the problem due to wakes seems to have improved appreciably.)

On week days one police boat patrols the river. On weekends and race days all three police boats are out on the river.

At present, most of the mooring facilities for boats on Charles River Basin are filled. Most of the clubs have filled their quotas and public docks are crowded. The landing areas are used to capacity. The owners back their trailers into water and leave them in the water after launching the boats since space for parking is limited.

According to Officer Luccirelli, boating is the major recreational use of the river. Fishing from the bank by children is of little consequence; swimming and water sports such as skiing are outlawed.

There is considerable complaining about waiting time at the lock by the boat owners. The complaints are not criticism of the operation of

the lock which most boat owners feel is handled very well. When there is heavy wind, some of the smaller boats have trouble navigating into the lock.

During very low water there are a few obstructions in the lower portion of the Basin which may hinder navigation. Most of these are along the wall and none are in the area of normal traffic. Since they are well known, there is little chance that accidents would occur.

The speed limit in the Basin at the time of interview, during the summer of 1958, was 15 miles per hour. It is Officer Luccirelli's recommendation that the speed limit be lowered to 10 miles per hour.

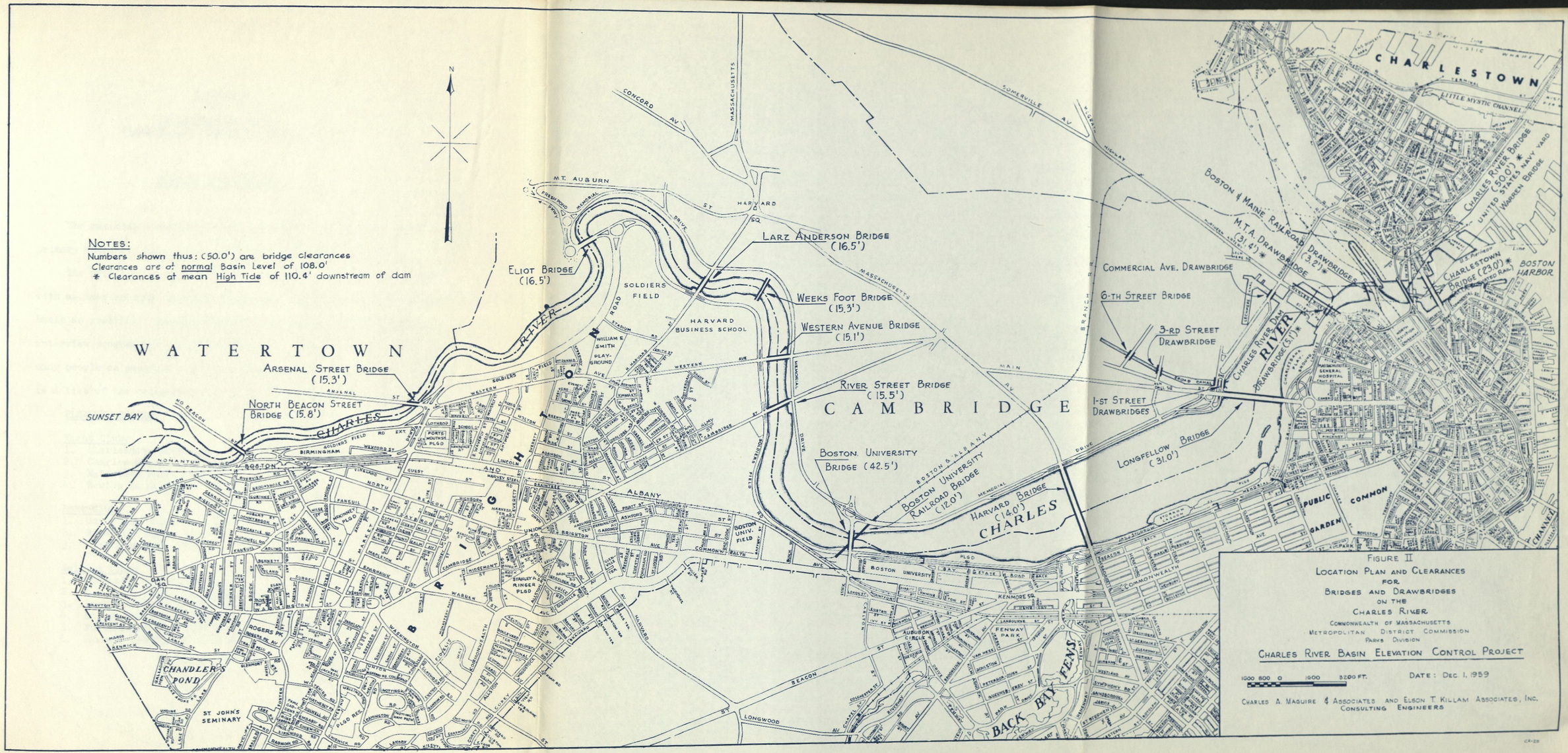

FIGURE II

LOCATION PLAN AND CLEARANCES FOR BRIDGES AND DRAWBRIDGES ON THE CHARLES RIVER

COMMONWEALTH OF MASSACHUSETTS
METROPOLITAN DISTRICT COMMISSION
PARKS DIVISION

CHARLES RIVER BASIN ELEVATION CONTROL PROJECT

1000 800 0 1000 3200 FT.

DATE: DEC. 1, 1959

CHARLES A. MAGUIRE & ASSOCIATES AND ELSON T. KILLAM ASSOCIATES, INC.
CONSULTING ENGINEERS

CK-28

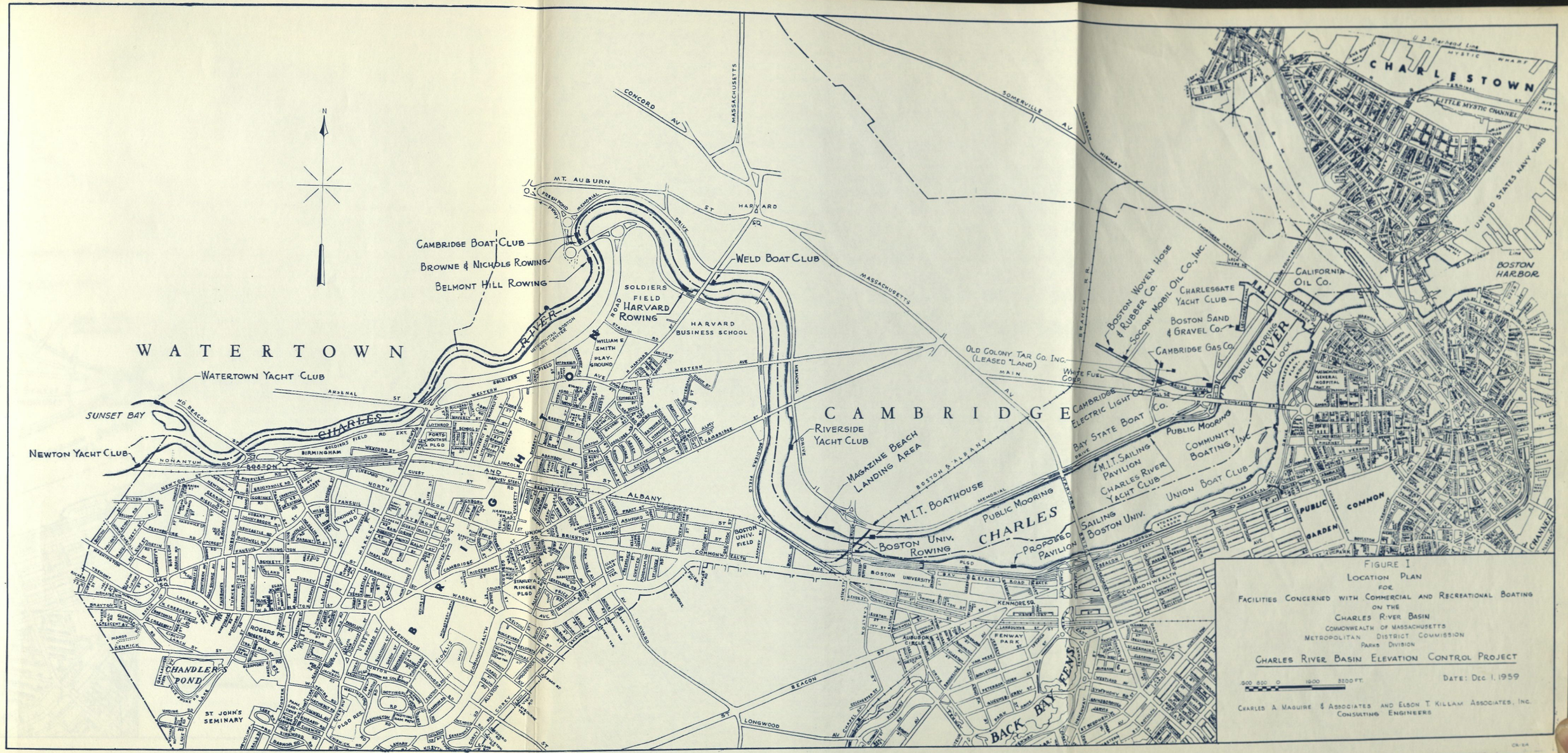

FIGURE I

LOCATION PLAN

FOR

FACILITIES CONCERNED WITH COMMERCIAL AND RECREATIONAL BOATING ON THE CHARLES RIVER BASIN

COMMONWEALTH OF MASSACHUSETTS
METROPOLITAN DISTRICT COMMISSION
PARKS DIVISION

CHARLES RIVER BASIN ELEVATION CONTROL PROJECT

1000 500 0 1000 2000 FT.

DATE: DEC 1, 1959

CHARLES A. MAGUIRE & ASSOCIATES AND ELSON T. KILLAM ASSOCIATES, INC.
CONSULTING ENGINEERS

SECTION III

ENTRANCE OF SALT WATER TO CHARLES RIVER BASIN

When construction of Charles River Dam was started in 1908, one of the expected advantages of the project was the creation of a fresh water basin. In recent years it has been increasingly difficult to maintain the Charles River Basin as a fresh water area. During summer months there is a substantial increase in salt water content, which becomes particularly noticeable during prolonged periods of drought.

The recent increases in salt water content can be attributed to the increasing number of lockings; leakage through corroded lock gates; reduced inflow into the Basin during dry spells because of many new water users upstream; and the maintenance of lower Basin elevations in anticipation of storm, which otherwise could cause flooding.

In order to evaluate the various methods by which salt water finds its way into Charles River Basin and fresh water leaves it and the conditions which occur during prolonged dry spells, a large amount of data has been compiled. Such data will be useful in determining what provisions should be made in the construction of Charles River Elevation Control Project to reduce the inflow of salt water and the loss of fresh water and in evaluating these conditions following the completion of the project.

TESTS FOR SALT WATER CONTENT

Shut-off gates in Charles River Dam were dropped on October 20, 1908.

The salt water tests showed a chloride content of 13,000 ppm at the surface and 18,000 ppm at the bottom near the dam in November. By March, 1909, the salt water content had decreased to 80 ppm at the surface and 4,500 ppm at the bottom. Since that time the salt water content has been fluctuating periodically, decreasing following high river inflows in late fall and early spring, and increasing, due to the reduced fresh water inflow, in the summer and early fall.

Chlorinity tests were conducted by Woods Hole Oceanographic Institute on November 28-30, 1950 with the results of chlorides in ppm as follows:

Depth Feet	Between Arsenal St. and N. Beacon St.	Between Western Ave. and River St.	Between River St. and B.U. Bridge
0	40	200	280
2	40	190	270
4	50	220	270
6	50	260	400
8	50	1140	2220
10	-	2520	2970
12	-	3120	-

Additional tests were made more recently by Mr. Thomas J. Rinaldo on October 26-27, 1957, and August 30, 1958. The results of the laboratory tests for chlorides were as follows:

Location	Depth Feet	1957 Chloride-ppm	1958 Chloride-ppm
Near Lock	1	6,950	1,440
	5	7,850	1,480
	10	12,200	4,150

Location	Depth Feet	1957 Chloride-ppm	1958 Chloride-ppm
Near Lock (Cont'd.)	15	14,100	7,200
Near Sluice Gates			
	1	6,920	1,460
	5	7,830	1,440
	9	---	1,740
	10	12,400	---
Bridge over Broad Canal			
	1	6,630	1,450
	5	7,280	1,410
	10	12,300	5,550
	15	15,000	7,250
Center of Longfellow Bridge			
	1	6,220	1,280
	5	6,920	1,440
	10	12,200	4,470
	14	14,400	7,100
Center of Harvard Bridge			
	1	5,980	1,150
	5	6,060	1,380
	10	12,200	2,390
Center of B.U. Bridge			
	1	5,280	850
	5	5,460	1,390
	10	11,600	2,250
Western Avenue Bridge			
	1	5,380	560
	5	7,450	560
	10	12,200	3,600
	13	12,600	---

Location	Depth Feet	1957 Chloride-ppm	1958 Chloride-ppm
Arsenal St. Bridge			
	1	3,030	312
	5	7,900	650
	8	---	1,760
	8 1/2	11,400	---
N. Beacon St. Bridge			
	1	3,050	20
	5	7,950	19
	8	10,200	20

Since sea water has about 18,000 ppm of chlorides and fresh water less than 10 ppm, it is evident that the water in Charles River Basin contains substantial amounts of salt water.

The tests during 1957 show what can happen after a prolonged dry spell, whereas the tests during 1958 probably represent present average summer conditions.

SOURCES OF SALT WATER INFILTRATION

In order to determine the reason for the substantial amount of salt water at the end of October, 1957, the records for four months, July through October, 1957, were studied in detail.

From U. S. G. S. records at Waltham gauge, it is estimated that fresh water inflow to Charles River Basin during the four dry months, July through October, 1957, averaged 34 cfs from the total drainage area.

Location	Depth Feet	1957 Chloride-ppm	1958 Chloride-ppm
Near Lock (Cont'd.)	15	14,100	7,200
Near Sluice Gates			
	1	6,920	1,460
	5	7,830	1,440
	9	---	1,740
	10	12,400	---
Bridge over Broad Canal			
	1	6,630	1,450
	5	7,280	1,410
	10	12,300	5,550
	15	15,000	7,250
Center of Longfellow Bridge			
	1	6,220	1,280
	5	6,920	1,440
	10	12,200	4,470
	14	14,400	7,100
Center of Harvard Bridge			
	1	5,980	1,150
	5	6,060	1,380
	10	12,200	2,390
Center of B.U. Bridge			
	1	5,280	850
	5	5,460	1,390
	10	11,600	2,250
Western Avenue Bridge			
	1	5,380	560
	5	7,450	560
	10	12,200	3,600
	13	12,600	---

The inflow rates for each month were as follows: July - 43 cfs, August - 22 cfs, September - 25 cfs, October - 45 cfs.

During the same period, sea water was sluiced to the Basin in order to maintain a minimum elevation of at least 107.5. The rate of salt water sluicing during the four months averaged 8.5 cfs. Salt water was sluiced 7 times in August, 3 times in September and 3 times in October.

The inflow of salt water during locking operations when the harbor level is higher than that in the Basin is minor and averaged 2.5 cfs rate for this period. There were 3,243 lockings from July through October of 1957.

Leakage of salt water to the Basin through the dam, lock gates, and sluices has been estimated from records of water levels during tidal cycles: The approximate leakage rate of salt water into the Basin was 12.5 cfs.

Thus, about 34 cfs rate of fresh water and 23.5 cfs rate of salt water for a 57.5 cfs total are estimated to have entered the Basin.

The outflow from the Basin consists of sluicing for elevation control, sluicing for lockings, evaporation, and leakage.

Sluicing for high elevation control during this period was minor. Some water was sluiced for one rainstorm - on October 8 - and a minor quantity between July 1 and July 9. The average sluicing rate for the four month period was 6.5 cfs.

Loss of water due to equalizing operations in the lock when the Basin is higher than the harbor is also minor, and amounted to an average rate of 11.5 cfs. Approximately an 18 inch depth of water has

been estimated to have evaporated from Charles River Basin water surface, resulting in a 4.5 cfs average rate of loss during the four months.

Leakage from the Basin, which is the balance between 57.5 cfs inflow rate and outflow rate of 22.5 cfs, was about 35.0 cfs. Thus, during the four month period there were 34.0 cfs of fresh water and 23.5 cfs of salt water entering the Basin and 57.5 cfs of brackish river water leaving it.

In 1910, sometime after the existing lock was placed into operation, tests on the salinity of water in the lock were conducted. The lock was filled with salt water and then opened to fresh water. Samples of water for determination of chloride content were obtained at various depths at several time intervals and surface currents were measured. It has been estimated, on the basis of these tests, that complete replacement of salt water in the lock with fresh water from the Basin takes place in about 20 minutes. The lighter fresh water flows in at the top and the heavier salt water flows out at the bottom.

For an average locking with the upper gate open for about 5 minutes, about 60% of total lock volume is estimated to be interchanged. For the 3,243 lockings during the four month period, July through October 1957, the interchange rate is estimated to have averaged 36.5 cfs. This constitutes the major source of salt water infiltration into the Charles River Basin.

Salt water entered at a rate of 36.5 cfs interchange of lock water, 12.5 cfs leakage, 8.5 cfs sluicing for elevation control, and 2.5 cfs

sluicing for lockings. The salt water interchanged as a density current from the lock is estimated to have averaged 14,000 ppm and the rest 18,000 ppm.

Salt water left at a rate of 36.5 cfs interchange of lock water, 35.0 cfs leakage, 11.5 cfs sluicing for lockings, and 6.5 cfs sluicing for elevation control. The brackish water leaving the Basin averaged about 3,000 ppm chlorides in July and about 8,500 ppm chlorides in October.

On the basis of these rates, it is estimated that about 280 million pounds of salt due to sea water inflow and about 340 million pounds of salt due to density current inflow entered the Basin between July and October, or a total of 620 million pounds.

The brackish water leaving the Basin averaged approximately 6,300 ppm and amounted to about 380 million pounds.

The gain of 240 million pounds of salt to 440 million cubic feet - the volume of the Basin - increased the average chlorinity by approximately 8,700 ppm, from about 1,800 ppm at the beginning of July, to about 10,500 ppm at the end of October. Sometime during October, equilibrium was reached where the rate of salt entering the Basin equaled the rate leaving.

In terms of percentages the amounts of water leaving the Basin were as follows:

Difference between leakage out and leakage in	57%
Difference between sluicing out and sluicing in for lockings	18%
Sluicing to control high elevations	15%
Evaporation	10%
	100%

In terms of percentages the amounts of salt entering the Basin were as follows:

Difference between salt entering and leaving as a density current during lockings	83%
Difference between sluicing water in and sluicing out for elevation control	31%
Difference between leakage in and leakage out	-8%
Difference between sluicing out and sluicing in for lockings	-6%
	100%

During a prolonged dry spell, such as July through October, 1957, the loss of water from the Basin exceeds the inflow of fresh water. Most of the water is lost through leakage, with minor losses occurring due to locking, sluicing and evaporation. During such periods, large quantities of salt enter the Basin. Most of the salt enters as a density current when the upper lock gate is opened for navigation. A large volume of salt is also added when sea water is sluiced in order to maintain adequate Basin levels. Salt entering due to sluicing for lock equalization and leakage in is more than offset by salt leaving the Basin by sluicing for lock equalization and leakage out.

These conditions apply only in times of extreme drought.

The results of samples taken on October 26-27, 1957 show that the average chlorinity of all the water within the Charles River Basin was about 10,500 ppm, which means that the Basin contained about 60% sea water.

DISADVANTAGES OF SALT WATER

The disadvantages of salt water are many. Some communities take extensive measures to limit the travel of the salt water wedge from the ocean up rivers by constructing expensive salt water barriers. One of the principal disadvantages of salt water in the Charles River Basin would be in aggravating the pollution problem which would reduce the recreational value of the water area. Violent changes in salinity may cause many fresh water fish, algae, and other plants and organisms to die. Salt water accelerates settling by aiding flocculation of silt particles in water and causing their precipitation. The result is formation of sludge banks which contain substantial amounts of organic matter. The salt water wedge, which forms on the bottom of Charles River due to greater density, remains stagnant. This stagnation is evidenced by the absence of density gradients which are indicative of motion. For example, the chloride content on October 26-27 at a 10-foot depth varied only from 11,600 to 12,400 ppm at seven different locations, some 3 to 4 miles apart. This stagnation cuts off vertical circulation of water which is a normal occurrence in fresh water due to temperature changes, wind, and flow currents. The lack of vertical circulation reduces the absorption of oxygen except in the layer of water several feet deep near the surface which is subject to wind-produced waves and induced turbulence. The settled organic sludge at the bottom of the river, due to lack of oxygen, experiences an anaerobic digestion which

causes odor, scum, froth, and color formation. Conditions during the summer of 1957 brought many and vigorous complaints on pollution in the Charles. At that time the salt water content of the Basin was very high and sea water had to be sluiced in order to maintain the Basin level.

Other disadvantages of salt water are reduction to navigation in available draft because of accelerated formation of mud banks; formation of scales and marine growth, corrosion of pipes, and release of material from the river bottom at industrial water intakes; and possible pollution of the many wells located near Charles River.

FUTURE PROVISIONS AND CONDITIONS

Some reduction of salt water content can be expected as a result of installation of new lock gates, since the old gates were corroded and leaked badly. Construction of a pumping station would allow retention of more fresh water by maintaining a higher water level in the Charles River Basin during a dry spell with less danger of flooding. For example, on October 8, 1957, a large volume of fresh water was sluiced away from the Basin, lowering the level from 108.67 to 107.45. This drop of 1.22 feet was necessary to reduce the danger of loss of level control in case another storm followed or the same storm continued. With a pumping station, most of this water could have been retained safely, so that sluicing of 0.77 feet of salt water into the Basin on October 14 and October 18 to maintain the level near 107.5 would not have been necessary.

It is expected that with the new lock gates and the elimination of the necessity to sluice sea water for control of water level, the salt water content within Charles River Basin will be decreased appreciably. Nevertheless, since the major portion of salt entering the Basin is through interchange of sea water and Basin water each time the upper lock gate is opened, it will not be too long before the increase in the number of lockings will produce conditions no better than those which occurred in 1957.

It should be emphasized that with an estimated present interchange during the four dry months of 36.5 cfs of Basin water due to locking density currents, and with some 57.5 cfs lost from the Basin due to leakage, sluicing for level control, sluicing for locking, and evaporation, small quantities of leakage through future dam closures amounting to about 5 cfs and perhaps 10 cfs can be tolerated.

In order to reduce the salt water content in the Charles River Basin in the future, it would be necessary to reduce the volume interchanged during lockings. Other factors are minor and will be improved by repairs and revised operating procedures.

With the pumping station at the Charles River Dam site, efforts to reduce the number of lock openings by increasing the interval between lockings, and greater emphasis on the speed of opening and closing of the gate, could produce only a minor decrease of salt water inflow. In order to produce a significant reduction in salt water concentrations, a salt water barrier would be advisable at this site. Such a barrier could be located upstream of the upper lock gate.

Since about 95% of all lockings can be made with less than a 7 foot draft, a timber barrier with a top at elevation 101 would reduce the depth of salt water flowing out of the lock when the upper gate is open by about 2/3. However, this barrier would have to be tilted for loaded commercial vessels with draft up to about 12 feet. The barrier would also have to be tilted during sluicing and pumping operations through the lock. It is estimated that even with substantial increases in locking the reduction of leakage, the elimination of the sluicing of sea water to maintain level, and the construction of the barrier would keep the salt water content in the Basin to less than half that of July through October, 1957. However, the cost of construction and operation of the barrier may rule out its practicability.

With the pumping station at Warren Avenue, similar results could be obtained by use of smaller locks. The proposed volume of the lock for vessels would be about 42% of the present lock volume, and the volume of small boat locks would be about 17% of the present lock volume. The small boat locks would be used more frequently and even with 50% increase in the number of openings, the amount of salt water interchanged could also be reduced by about 2/3.

Tests for chlorides show a substantial stratification of water throughout the Basin. A low setting of sluice gates and pump intakes would insure egress of more concentrated salt water from the Basin during sluicing and pumping operations.

SECTION IV

EFFECTS OF TEMPORARY LOCK CLOSURE ON BOATING

Charles River Lock was closed to boating from August 22 through September 4, 1958, due to a mechanical breakdown. It was also closed during installation of the new lock gates from April 20 through June 26, 1959. In order to evaluate the effect of lock closure on pleasure and commercial boating, interviews were conducted during and immediately after each one of these periods. Such information will be helpful in the event it is necessary to close the lock again to shipping for any length of time during construction of Charles River Basin Elevation Control Project. The effect on commercial vessel transportation should in addition be useful in evaluating the alternative transportation methods which are available to concerns dependent on navigation.

CLOSURE DUE TO LOCK FAILURE

The closing of the lock for approximately two weeks in late August and early September of 1958 occurred as a result of a broken wheel on which the lower gate was rolled. The closing of the lock was entirely unexpected. Unfortunately, this occurred during a period when pleasure boat use of the lock is at a maximum. Many pleasure boats were stranded within the Basin. Most of the pleasure boat owners understood the situation, recognizing that the failure was unavoidable. Nevertheless, many expected to get out of the Basin sooner than they did. Many took their boats out of the Basin and carried them on trailers or

SECTION V

EFFECT OF COMPLETED ELEVATION CONTROL PROJECT ON PLEASURE BOATING CONDITIONS

CONTROL OF LOW WATER LEVELS

The proposed Charles River Basin Elevation Control Project would greatly improve boating conditions on the Charles River Basin. A pumping station would be able to control the elevation of the Basin for most storms within rather narrow limits. With these more positive facilities for controlling the rise in Basin level, capable of functioning even when the tide is higher than the Basin level, it would not be necessary to prelower the Basin level as frequently as in the past to avoid possible loss of level control.

Boat owners using the upper portion of Charles River, from Eliot Bridge to the Watertown Dam, are extremely conscious of river elevation. Many of the boatmen in Sunset Bay, a section of the Basin between the North Beacon Street Bridge and the Watertown Dam, moor their boats in anchorages that are normally only inches above the bottom. When the water level drops to 107.5, many of these boats are resting on the mud. As the elevation of the Basin drops, members at the Watertown and Newton Yacht Clubs and users of the upper Basin are plagued with excessive running aground. The low water exposes shoals and mud bars that severely hamper the passage of boats in a channel which is difficult to navigate, even at normal Basin level. An unfamiliar mariner encounters extreme difficulty in making his way between Eliot Bridge and Watertown Dam.

The problem is so serious in this region that the function of the Newton and Watertown Clubs has changed drastically. Instead of being around-the-year boating and social organizations, the members now use the facilities almost solely during the off-boating season to store their craft. During the height of the yachting season, most boats are taken to deeper water either inside or outside the Charles River Basin.

As the water level drops in the region of Sunset Bay in Watertown and Newton, objectionable odors, and a generally unappealing view becomes of concern. This condition first becomes apparent when the water drops below elevation 107. As the water continues to drop, the problem is magnified.

In the lower portion of the Basin low water is of no particular consequence to boating. Here the only concern is that, as the water level drops, mooring lines will become too long, allowing boats within the limited space to come in contact with each other. However, the increased use of marinas with individual slips for docking pleasure craft will tend to alleviate this condition.

Low water is also important to commercial concerns that use water for industrial purposes. As the water level drops, many of these intake pipes lose their effectiveness. Whenever the elevation of the Basin drops below 107, Cambridge Electric Light Company's Kendall and Blackstone Plants, Boston Woven Hose and Rubber Company, and Massachusetts Institute of Technology must be notified. Whenever the Basin level drops below 106.5, serious reductions in water intake quantities occur which are particularly troublesome at the Kendall Plant of Cambridge

Electric Light Company and at Boston Woven Hose and Rubber Company.

CONTROL OF HIGH WATER LEVELS

High water appears to be of little consequence to boating. Very little damage to boat facilities has been recorded during periods of high water. The major inconveniences are reduction of clearances under bridges, floating debris, difficulty in operating from docks of fixed elevation, and possible snapping of mooring lines. Figure 2 shows the location of various bridges in Charles River Basin and normal clearances under them.

DECREASE IN SLUICING CURRENTS

Charles River Basin Elevation Control Pumping Station would be of some advantage to commercial vessels. By avoiding frequent low elevations, the available draft for loaded scows and barges would be increased. At present one of the major problems shared by both pleasure boats and commercial vessels is getting up the tidal estuary to the lock, when the sluice gates are open. Downstream currents at times are such that it is impossible for boats to buck them. An equally serious problem exists when the gates are opened behind a boat heading downstream from the lock.

While the sluice gates allow discharge to the harbor only at low tide, a pumping station would make it possible to discharge from the Basin at any time. The hours required for pumping, as compared to sluicing,

would be considerably fewer and could be selected in order not to interfere with boating, irrespective of tide. With a facility capable of pumping large quantities of water in a short period of time, some risk could be taken to allow the Basin to rise during the day and be either sluiced or pumped out at night. By scheduling pumping operations carefully, interference of sluicing currents with the large number of rowing crews on the Charles River above the dam, and with commercial and pleasure boats below the dam, could be avoided.

REDUCTION OF POLLUTION

Pollution is one of the major problems confronting improvement of boating conditions on the Charles. The better control of low elevation would eliminate the need for sluicing salt water into the Basin, the serious increase in pollution resulting from addition of salt water was discussed in Section III. In addition, the better elevation control would eliminate from the Basin much of the debris now released from the banks at high water, and which frequently damages boats.

The major sewerage and sewage disposal construction program of the Metropolitan District Commission will reduce the pollution of the Charles River Basin appreciably. This project, together with the Charles River Elevation Control Project, will make the Basin more enjoyable for boating and other recreational uses.

INCREASED LOCKING CAPACITY

With the construction of a pumping station near Charles River Dam,

the area for locking of boats can be enlarged and the area of locking facilities increased to reduce the number of lockings for boats on peak boating days. However, with the increased length of time to complete the lockings in a larger lock, the increase in locking capacity would be minor.

If the pumping station is to be located near Warren Bridge the capacity of the lock can be made adequate to satisfy future locking needs for the rapidly growing small boat activity. Also normal locking times with the use of several smaller locks can be reduced appreciably.

Pleasure boat traffic statistics and estimates to be utilized during the construction period and in the design of navigation locks are evaluated separately in the section dealing with facilities to be provided at Warren Bridge in the "Report Upon Alternative Sites for Charles River Basin Elevation Control Project."

ADDITIONAL MOORING AREAS

Extension of Charles River Basin to Warren Bridge would open up for future development a new fresh water area below the present dam. This would provide much needed space for boats and other uses. Exclusion of commercial vessels from the Basin in the future would make available additional canal areas presently used by commercial vessels. Since available space for expansion of mooring facilities is being rapidly used up, additional areas are needed badly.

Although some increases in mooring areas can be made within the

present Basin, any substantial increase would interfere seriously with commercial vessels, sailing, rowing, and motor boating activities. Considerably more boats could be moored within present limits of mooring areas by utilizing the available space more efficiently with the use of marinas with individual closely spaced slips for mooring of boats.

OTHER IMPROVEMENTS

Other improvements could be made together with the pumping station construction for the Charles River Basin Elevation Control Project, or under a separate contract.

Such improvements would consist of repairs to existing dolphins and fender piers, rings and bumpers on walls above and below the lock, improved communications systems at the lock, and dredging.