

**INDUSTRIAL PROCESS AS
ARCHITECTURAL LANDSCAPE
A Small Brewery**

by

Andrew James Garvin

B.A., Duke University, 1979
M.S.E.E., Stanford University, 1984

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Submitted to the Department of Architecture on January 20, 1989 in
partial fulfillment of the requirements for the degree of Master of
Architecture.

Abstract

An exploration into whether the processes and artifacts of an industrial process can be integrated with the enclosing architecture into a mutually-enriching landscape. The particular vehicle for this exploration is the design of a moderately small brewery in Lowell, Massachusetts. To expand the range of design issues, a restaurant and galleries for public tours are included in the program.

Thesis Supervisor: Barry Zevin
Title: Lecturer, Department of Architecture

To Beth, Farkel, and Abnu Bhinder



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Chapter 1

Introduction

Industrial processes and the machinery/equipment that comprise them are usually organized under many constraints -- both economic and physical. As I was neither prepared nor qualified to do extensive analysis of economic aspects, I attempted to make economically viable decisions while I focused on exploring the physical aspects of design of a complex to be inhabited by an industrial process.

Many manufacturing processes end up sprawling through large warehouse-like buildings. Certainly, the prevalence of these warehouse-like factories is a result of economic constraints. However, it is more than just a desire to keep the costs of the physical plant to a minimum that leads to this result: many manufacturing processes need to be in climate-controlled environments (to protect the workers if not the machinery) even though it would otherwise be desirable to let the process itself dictate the most efficient arrangement of the equipment. Thus, the process might like to exist in a big dome or tent, unfettered by columns and intervening floor plates and other structure or envelope.

The warehouse-like factories make it easy to think that the desired connections in a process are best served by distributing the equipment on an uninterrupted plane. However, the necessary adjacencies may be far too complex for a two-dimensional solution of this sort. Petroleum refineries and chemical plants are obvious examples of very three-dimensional organizations of

processes; however, they are also cases where people take on a very subordinate role to the enormous machinery and tanks. The scale of these operations (not to mention the fumes) makes it fairly impractical to enclose them in a controlled environment (the volume would be immense), so the components are built to withstand the weather; these are factories turned inside out.

In many other cases too complicated for planar solutions, the scale of the equipment and the importance of human operators in direct contact with the equipment make a three-dimensional enclosed solution desirable. Here, the elements of the process might like to float in space, connected only by the pipes, wires, and paths of mechanical transfer. In outer space, solutions approaching this may be possible. On earth, gravity poses an as yet unsolved problem for floating equipment.

I think that this need for enclosing but unfettering architecture presents an opportunity for mutual enrichment of the industrial process as a place of work and of the architecture. The elements of the process can become the objects of a landscape within the architecture, while the architecture can reinforce and enliven the spatial characteristics of the process, making an enjoyable place to work and/or visit.

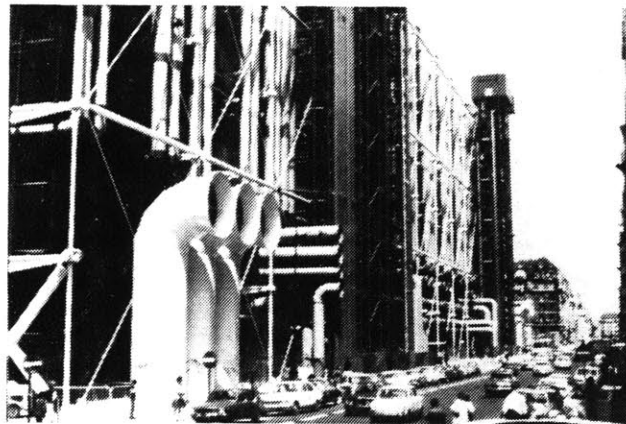
The choice of a brewery was a very conscious and careful one. Beermaking (especially on a relatively small scale) is as much steeped in tradition as in science. While some of the complexity of the necessary connectivity in brewing is mitigated by the fact that the materials being handled are fluids, the necessary set of adjacencies is still too complicated for a reasonable planar solution. Moreover, gravity transfer is important to several stages of the beermaking process, forcing some equipment out of the plane. In

addition, some of the elements are too large to be easily entirely contained by a building.

The choice of Lowell as a site was equally conscious. Water is one of the three important ingredients in beermaking. Lowell sits on an extensive canal system along the Merrimack River. Even though the Merrimack has been upgraded to a Class B waterway (from its recent much filthier classification), this is still not clean enough for untreated use. However, although the presence and quality of a water source was paramount in the choice of location for a brewery at one time (because transporting large quantities of water over long distances was impractical), today, few water sources are clean enough to be used directly in brewing without treatment and filtering. As a result, ease of access to truck and rail transportation and proximity to population centers that comprise the market for a beer usually dictate the location. Lowell has inherited a good transportation infrastructure from its history as a great mill town. Its location near Boston and fairly central to the rest of New England give a Lowell beer a good potential market. And Lowell's municipal water is no less treatable than that in many other places where beer is successfully and profitably produced.

Unlike other cities of the same era, Lowell's industrial buildings and districts are still standing. The enormous mill architecture in Lowell has an interesting relationship to my program. Like a brewery, the fabric mills buildings were, in a sense, giant machines. "In the early Lowell mills, power was generated by water falling through wheels on turbines in the lower level and distributed to machinery by shafts and leather belts. To minimize the distribution distance, production was integrated vertically and one or more separate processes were performed on each floor." [Lowell 77] While distribution of power

may have forced verticality, structural systems and tastes of the day dictated that the machine take the form of a relatively closed box, hiding the workings to a great extent from the outside observer. Breweries built in the past (some still in operation) also took the form of rather tall, closed boxes, divided into layers, with very little spatial or visual connection to/from the outside or from one area to another. In contrast, I'm attempting to make an architecture that not only permits outsiders to observe the process, but that enhances the spatiality of the process. This is not a new idea. Many modern buildings take the opposite position from the Lowell mills and make their "machine-ness" explicit.



Centre Georges Pompidou, Piano and Rogers, 1974-77

Lowell has other desirable attributes as a potential site. Lowell is looking for new industry, has sites left vacant by mill fires, has interesting tradition and history. Like the great beer towns of Milwaukee and St. Louis, Lowell has a long history as a working-class industrial city.

To expand the range of design issues, I included a restaurant and galleries for public tours in the program, somewhat complicating the possible design responses. On the other hand, small brewing operations usually operate barely

on the black side of the profitability borderline, and are therefore forced into available existing warehouse/industrial space. Thus, the concept of a small brewery in new building designed and built for it suggests that this brewery might be the showplace "specialty-beer" brewery of a larger food- or brewing-industry company.

Chapter 2

Site Description

2.1 Brief History of Lowell

Known variously as the "Venice of America," the "Spindle City on the Merrimack," the first planned industrial city in America, and the birthplace of Jack Kerouac, Lowell has a rich cultural and urban heritage. It was originally settled by Pawtucket Indians but began to take its present form with the 1793 charter of the Proprietors of the Locks and Canals on the Merrimack River. Work began on the Pawtucket and Merrimack canals and others soon followed -- all originally designed solely for transportation.

In the 1820s, a group of entrepreneurs recognized the value of the flat topography and extensive waterpower and built the first textile mill in Lowell. Other mills were quickly built, along with elaborate and technologically advanced hydraulic locks. Mill owners had no difficulty recruiting farm girls with a promise of steady income, culture, and education. When the mill girls became disillusioned and more difficult to recruit, the influx of European -- especially Greek and Irish -- immigrants provided a steady labor supply. The city boomed until the mills gradually began to close at the end of the 19th century. The last major mill closed in the 1940s, suffering from stiff foreign competition.

Lowell went through a long period of decline until the early 1970s, when the concerned city officials began discussing an Urban Cultural Park. Since then, the canals and many historic buildings have been granted historic status and the National Park Service has established the Lowell National Historical Park

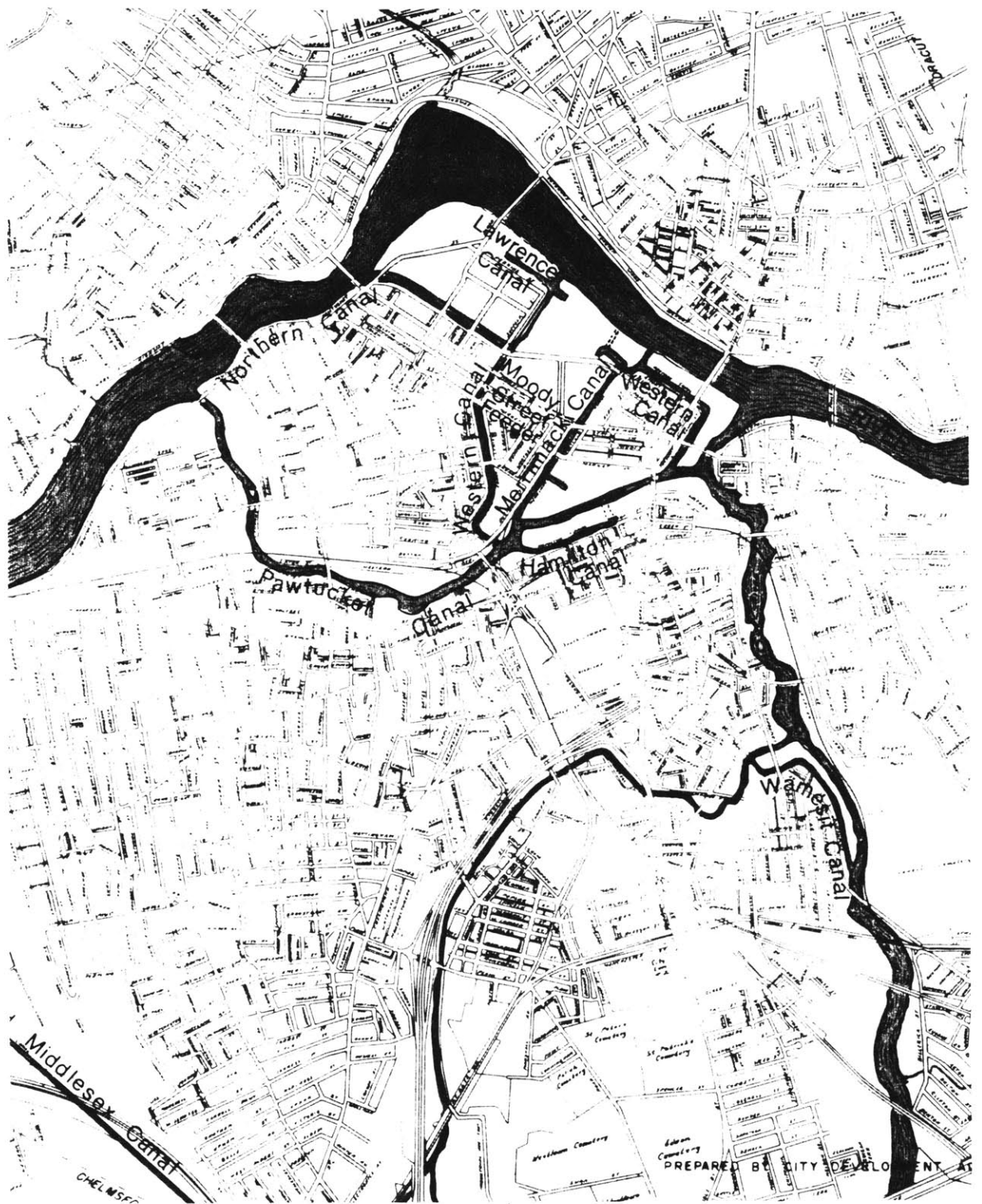


Figure 2-1: Canal system in Lowell

(LNHP). Some of the mills have been rehabilitated into commercial and office space and a number of others are being used for industrial purposes, including some garment-related manufacturing.

2.2 Description of Specific Site

The site I have chosen for the brewery is located along the Pawtucket canal, near the locks where the canal empties into the Concord River. It is separated by a long narrow strip of buildings from Central Street, one of the original downtown thoroughfares and currently one of the busiest routes into town. The majority of the central business district is within a four block radius of the site and the Merrimack River is only seven blocks away. The site is bordered by the major (nearly 100 foot wide) Pawtucket Canal on the north, by the eastern ends of three enormous mill buildings on the west, by Jackson Street on the south, and by the rear of a very continuous two-story commercial block on the east.

The mill buildings on the western side of the site were part of the Hamilton Manufacturing Company mill complex. The site was at one time filled by buildings that comprised the Hamilton Mill Dye Works. Until the establishment of the LNHP, commercial buildings continued along Central Street where it crossed the canal. These are visible in the aerial photograph.



Figure 2-2: *Downtown Lowell, 1"=300'*

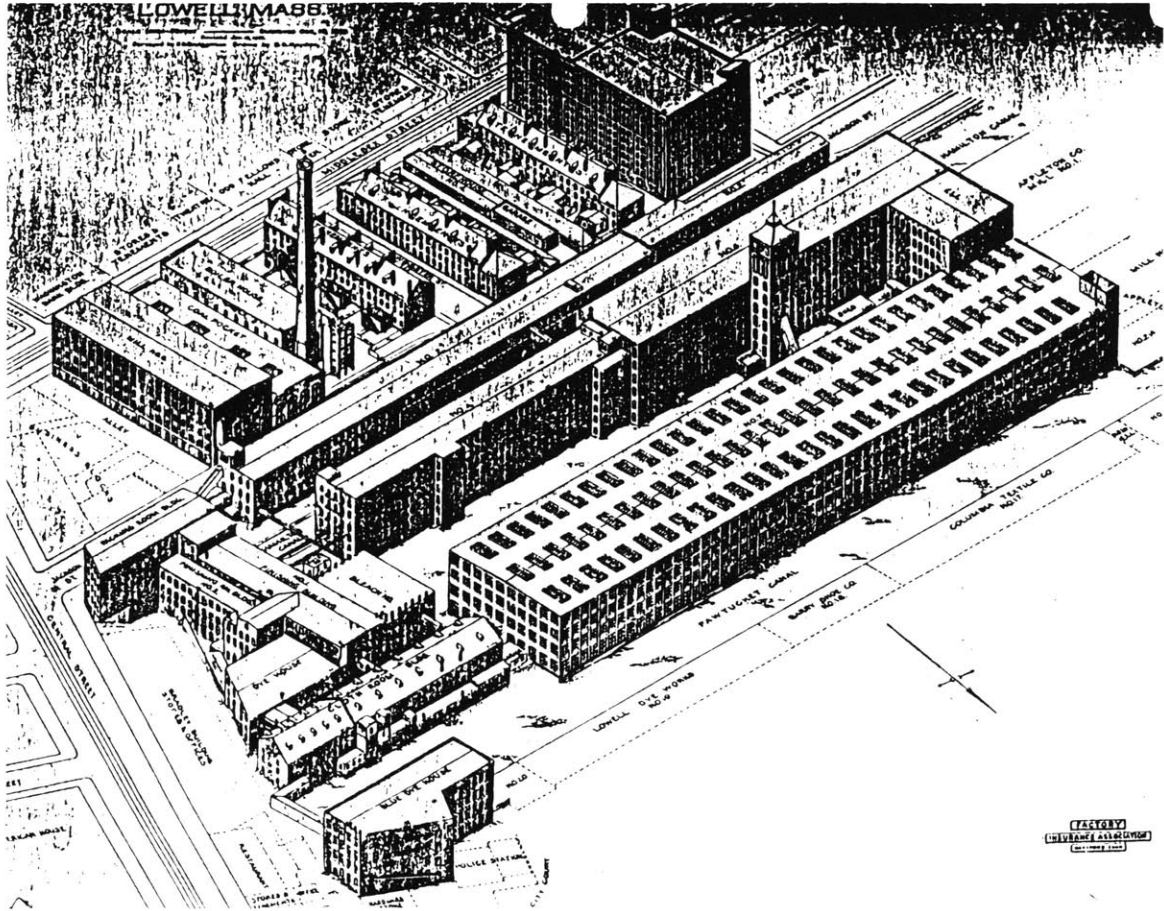


Figure 2-3: Isometric view of the Hamilton Mill Complex, 1920.

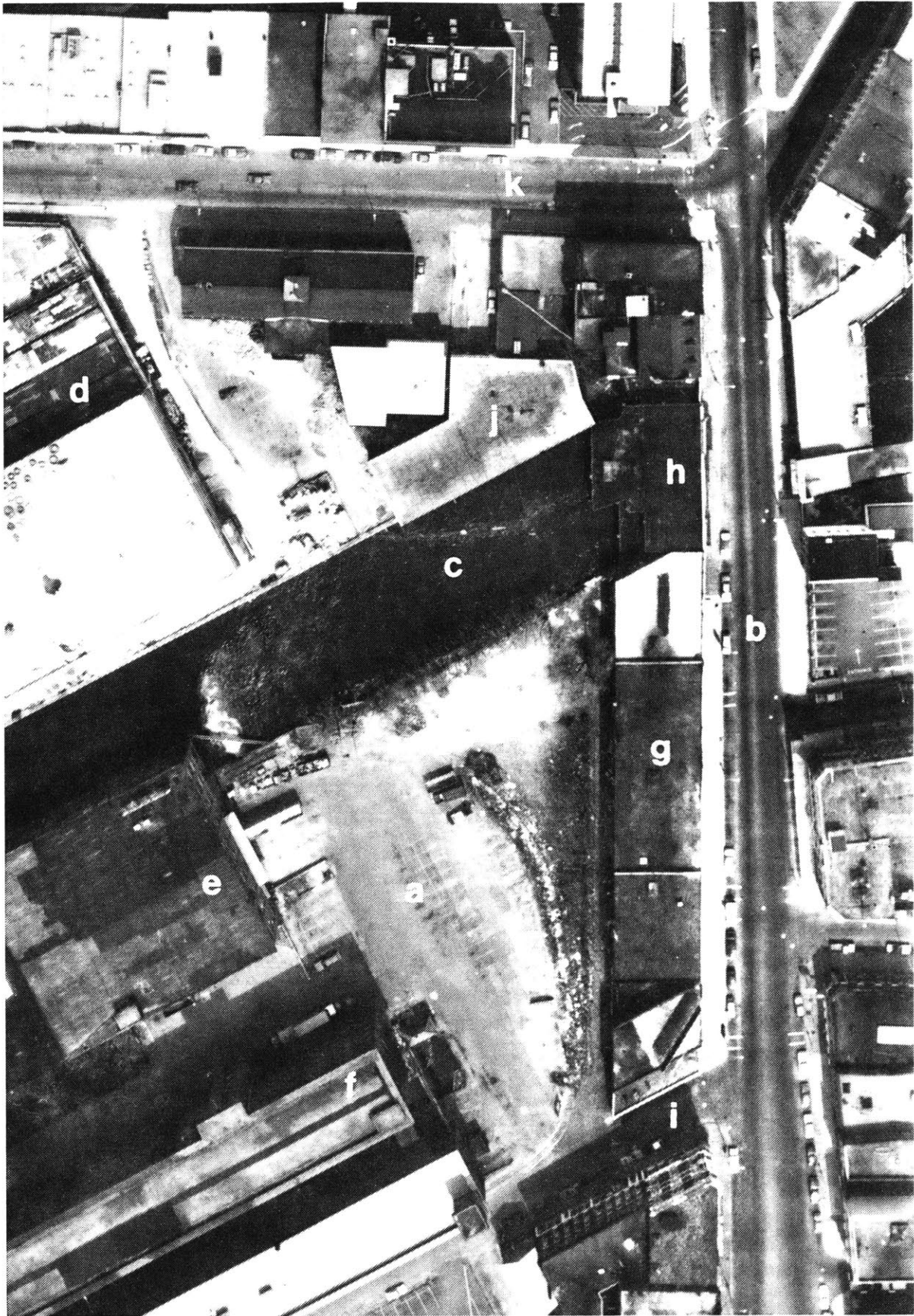
[Shepley 80]

Figure 2-4: *Aerial photograph of site and surroundings, 1980*

1"=100'

Opposite.

- a** Brewery site
- b** Central Street
- c** Pawtucket Canal
- d** Municipal Garage (under construction at time of photo)
- e** Joan Fabrics (Hamilton Mill #7)
- f** Adden Furniture (Hamilton Mill #4)
- g** Saab (Bradley) Building
- h** Building bridging canal (now demolished)
- i** Jackson Street
- j** Lowell Sun Garage (Hamilton Blue Dye House)
- k** Market Street



The site is currently covered by broken pavement, a defunct rail spur, trash, a few scraggly trees (none of which merit saving), and some abandoned cars. It is primarily used for unorganized parking by workers at the Joan Fabric Mill. A makeshift truck dock has been added to the east end of the Joan Fabric Building (see Description of Surrounding buildings, below).



View looking south across site toward Jackson Street.

Except for a depression descending from Jackson Street along the eastern edge of the site (behind the buildings that line Central Street), the site remains relatively level for about half of its north-south depth. Then it descends fairly rapidly toward the Pawtucket Canal along the northern edge.

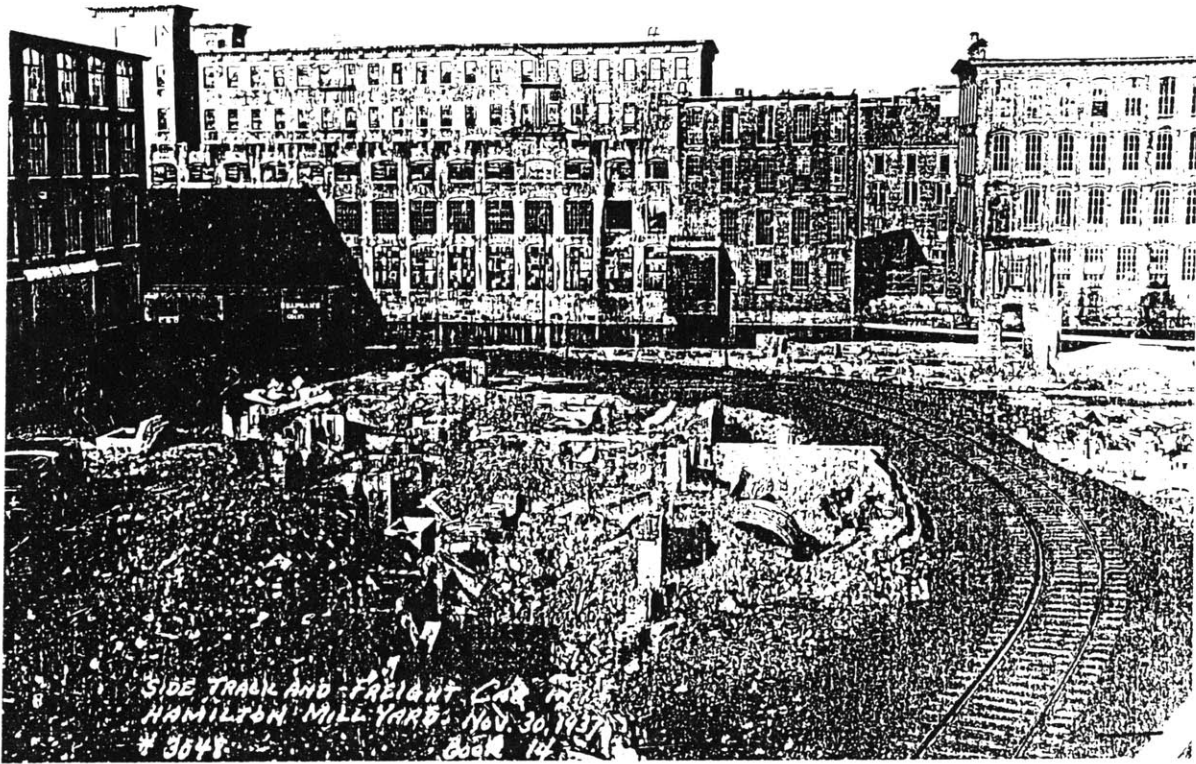


Figure 2-5: Former site of Hamilton Dye Works, 1937.

[Shepley 80]



*View looking north across site from Jackson Street
toward Municipal Garage across canal.*

2.3 Description/History of surrounding buildings

Beginning where Central Street crosses the Pawtucket Canal near the northeast corner of the site, heading south on Central Street, turning right on Jackson Street, and then continuing to follow the border of the site, the following buildings form the physical or visual edge of the site.



Saab (Bradley) Building, 135-187 Central Street

The Saab Building forms most of the eastern edge of site.



*Record Lane, 191 Central Street, and
Ray's Sandwich Shoppe, 201 Central Street*

Record Lane (originally the Hamilton Manufacturing Packing Room Building) and Ray's, on the northwest corner of the intersection with Jackson Street, continue the firm street and site edges begun by the Saab Building.



*Fiske Building, 219 Central Street, and
Unnamed buildings, Jackson Street*

The Fiske Building is on the southwest corner of the intersection with Jackson Street, across from Ray's Sandwich Shoppe. While the actual site boundary only reaches south to the north side of Jackson Street, the Fiske Building is the end of the row of buildings on the south side that forms the southern visual boundary to the site. Just west of the Fiske Building on Jackson Street, one smaller and one small building complete the southern visual boundary.



*Hamilton Manufacturing Company Storehouse,
Jackson Street
(Mill #4 is visible to the right of the Storehouse)*

The Hamilton Manufacturing Storehouse is flanked on its southern edge by Jackson Street and on its northern edge by the narrow Hamilton Canal. Immediately across the canal is the Hamilton Mill #4. The eastern end of the Storehouse is the southernmost of the three mill ends that form the western edge to the site.



*Adden Furniture (Hamilton Mill #4), 26 Jackson Street
(Mill #7 is visible on the right)*

Mill #4 is across the Hamilton Canal from the Hamilton Storehouse building and between the Hamilton Canal and Mill#7 on the western edge of site. At six (large) stories, Mill #4 is one of the tallest buildings in Lowell and by a significant margin the highest border to the site. (Although the Storehouse sits between Mill #4 and Jackson Street, Mill #4 predates the Storehouse and therefore has a Jackson Street address while the Storehouse does not.)



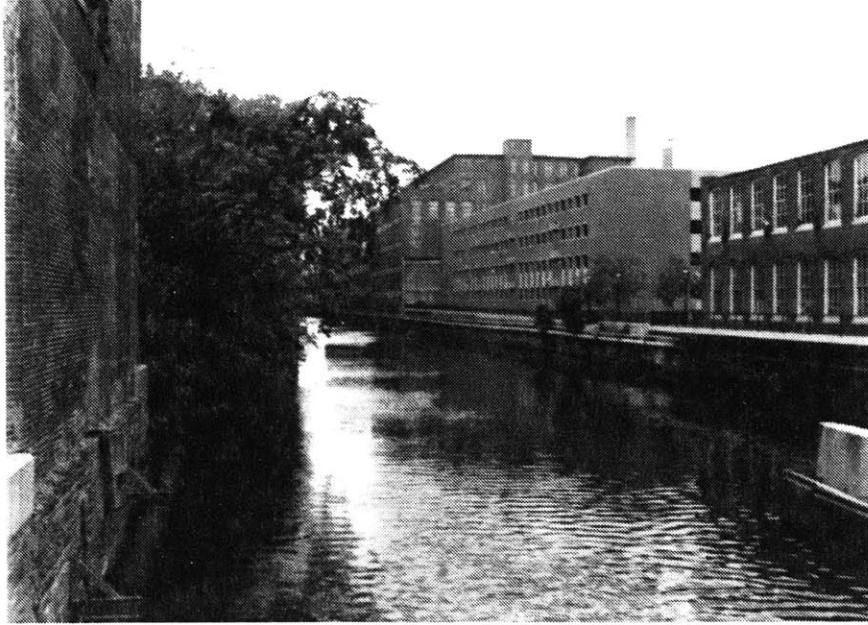
Joan Fabrics (Hamilton Mill #7)

Mill #7 is along the Pawtucket Canal at northwest corner of site. Its end is considerably wider than those of the Storehouse and Mill #4 and the entire building extends many feet over the Pawtucket Canal.



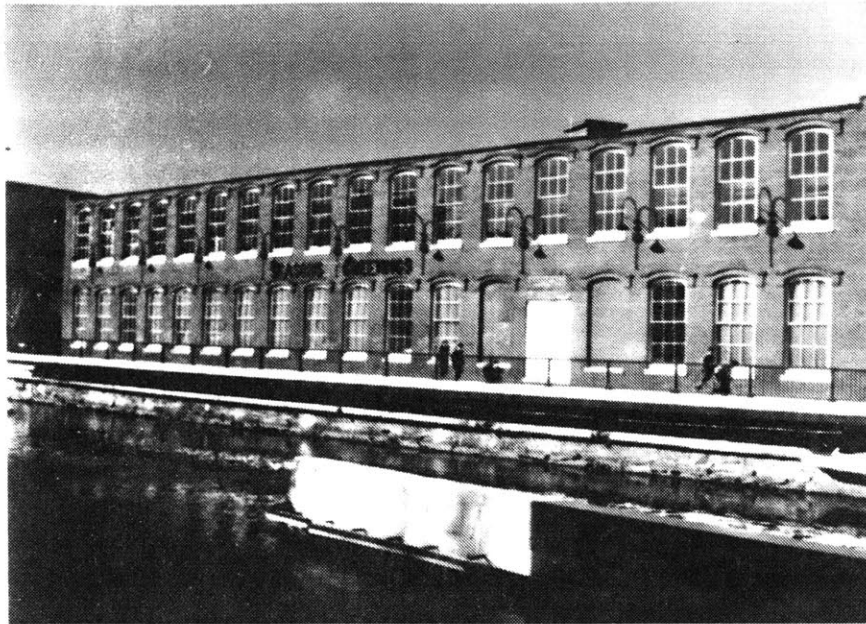
135 - 201 Central Street, rear

The rear sides of the Saab Building, Record Lane, and Ray's Sandwich Shoppe form the eastern border of the site.



*Lowell Municipal Garage, Market Street
(Hamilton Dye House is visible in
the foreground on the right)*

While the Pawtucket Canal forms the entire northern border of the site, the visual space extends across the canal to the buildings on its northern side. Of recent construction (approximately 1980), the large garage serves much of the area surrounding the site, where there are surprisingly severe traffic problems and parking shortages. The garage forms the visual stop from the site looking northwest.



*Lowell Sun Garage (Hamilton Blue Dye House),
30 Market Street*

East along the northern side of the Pawtucket Canal from the Municipal Garage, the Blue Dye House is directly across the canal from the site and is the most prominent element in its northern edge.



*Gemarde Jewelers (Mansur Building),
101 Central Street*

The Mansur Building is opposite the Pawtucket canal from Saab Building and completes the loop around the site. The pedestrian way along its side drops down to a small courtyard a few feet above water level.

Chapter 3

Program

3.1 Brewery

3.1.1 The Brewing Process

Brewing is an ancient and reasonably straightforward practice. There are three primary ingredients: water, malted barley, and hops. (Some modern beers also contain "adjuncts" such as wheat, corn, and/or rice, and even starch extracted from other sources such as potatoes. In Germany, the much-touted purity laws forbid any ingredients besides the three primary ones. Beers produced without adjuncts are referred to as "all-malt," for obvious reasons.)

Barley grains are steeped in water until they swell and then drained and allowed to begin germinating. The onset of germination creates enzymes to digest the starchy portion of each grain which is its energy source. At this point the grain is thoroughly dried to stop germination and to suppress the action of the enzymes. The dry result is malted barley (usually referred to simply as "malt"). Each step can be varied in duration and temperature to produce different types of malt. Most malting is done by "maltsters" or malt-houses, but some brewers like the control they can have over their malt by doing it in-house.

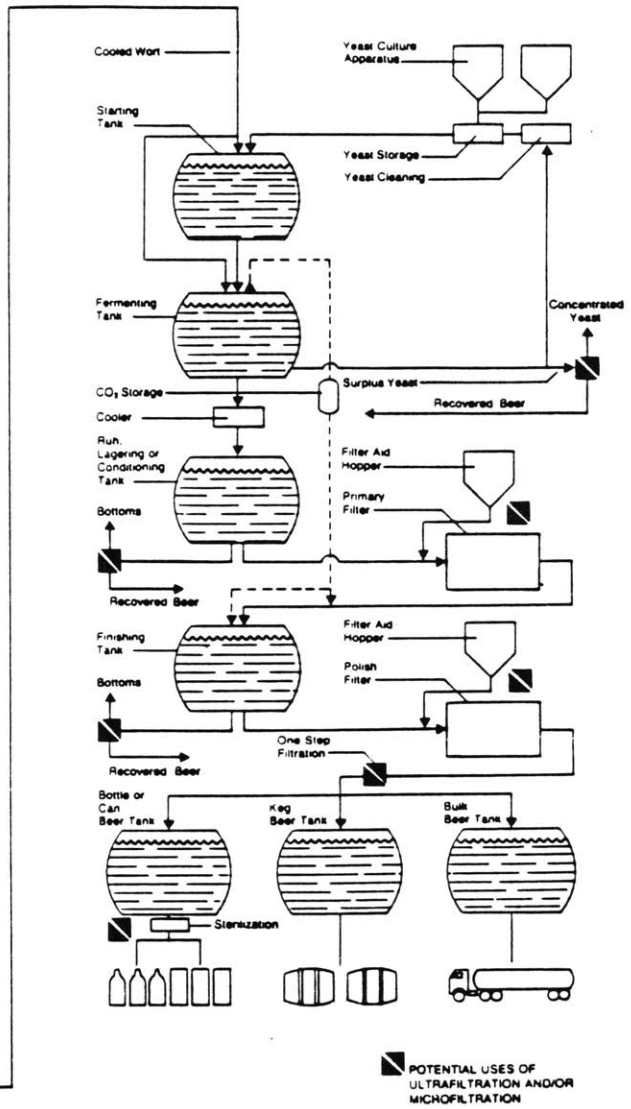
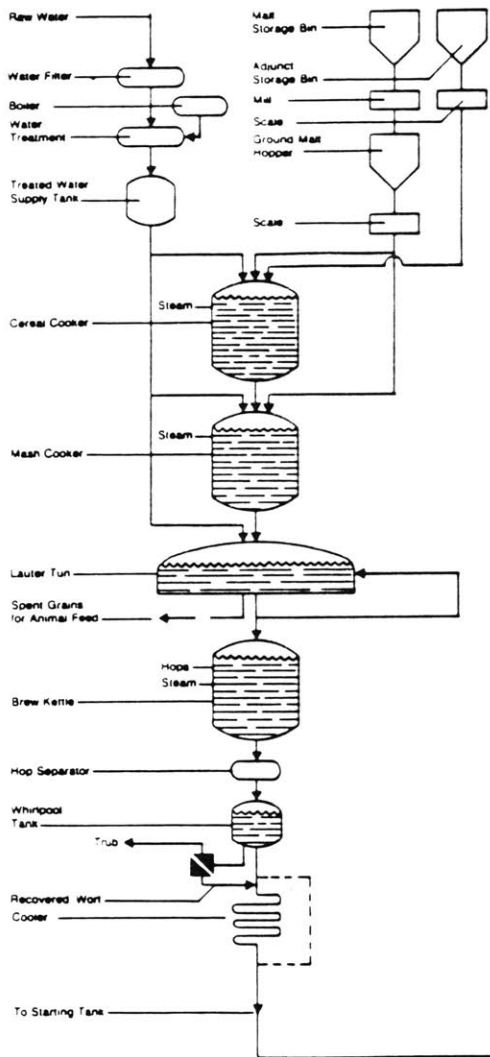
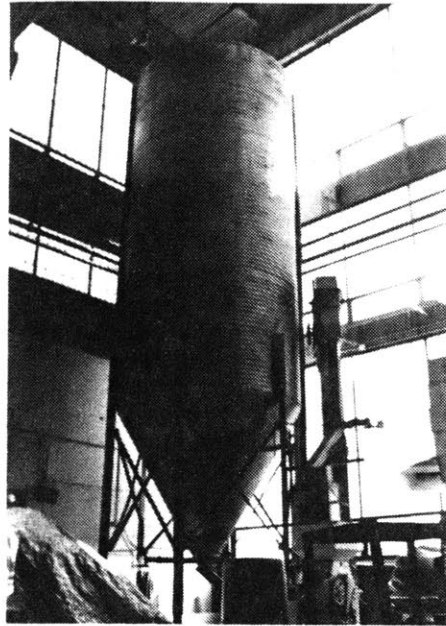
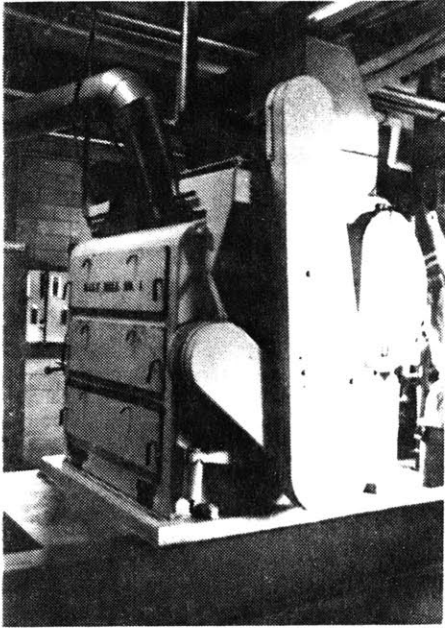


Figure 3-1: Generalized steps in beer production



Small malt storage silo

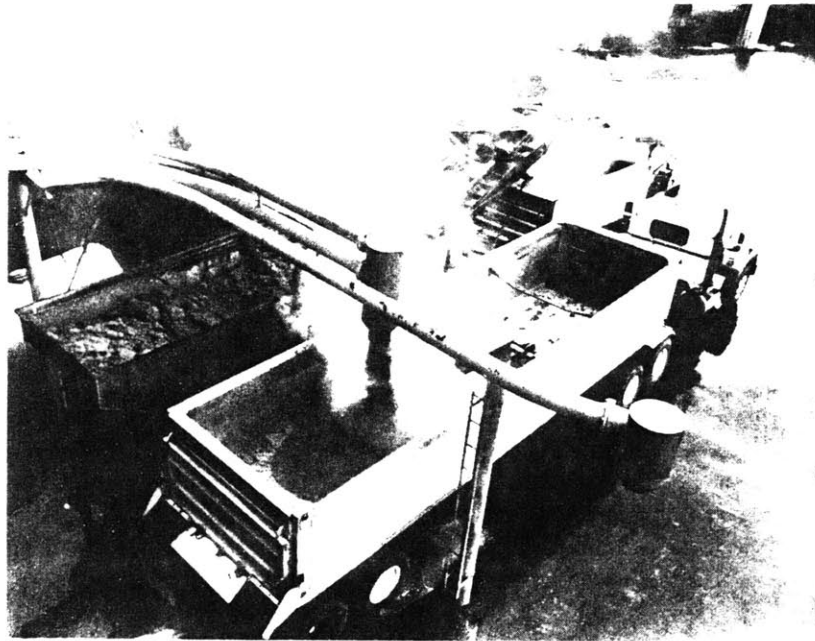
Malt is next milled into a "grist." The whole malt is fairly sturdy and can be transferred by screw-conveyors or blown through pipes, but the grist is delicate and must slide into its next destination -- the mash tun -- by gravity. In the mash tun -- usually a cylindrical tank with domed top and vent pipe -- the grist is mixed with hot water; the mixture is called "mash." During mashing, a large portion of the starch is converted by the enzymes into sugars which dissolve in the water.



*Malt mill (left), very small
grist hopper and mash tun (right)*

After several hours, the mixture is transferred gently -- preferably by gravity -- to some sort of "wort separator" (the wort is the liquid portion of the mixture after mashing).

The most common type of separator is a large, shallow, closed circular tank know as a "lauter tun." In the lautering process, the wort is separated from the depleted grain (known as "spent grain"). The spent grain is usually given or sold to farmers as fertilizer or feed.

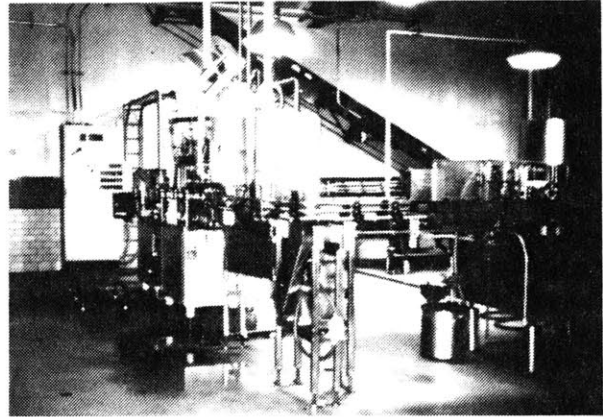
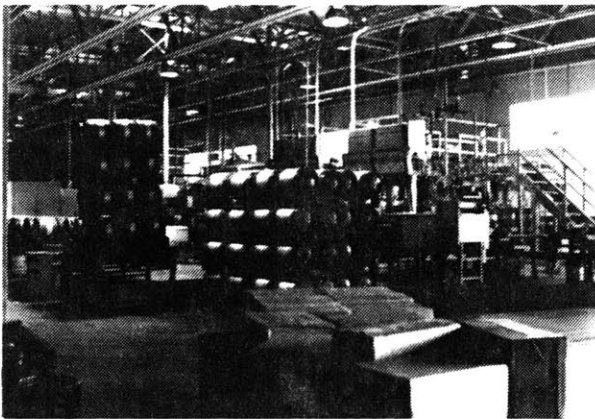


*Spent grain being transferred to trucks
[Broderick 77]*

The "sweet" (unfermented) wort is transferred to a vessel very similar to the mash tun called the kettle. Here the wort is boiled to destroy remaining enzymes and to kill any wild yeasts that may have infected the wort. During boiling, hops are added to give the final product its bitter tastes. (Hops are the dried blossoms of the hop vine.)

Together, the mash tun, lauter tun, and kettle are referred to as the brewhouse. After the completion of brewing, the wort is passed through a hops-separator and then cooled as rapidly as possible. Yeast is then added and the mixture put in special tanks to ferment. Fermenting takes from as little as 4 days for some ales up to about 10 days for some lagers; in both cases this is much longer than the brewing process, so many fermentation tanks are needed. After fermentation, the "green" (un-aged) beer is aged or "conditioned" for two to three weeks in either the same or a different set of tanks.

At this point the beer is ready for packaging in kegs and bottles. Some brewers filter and clarify the beer through various methods first, some think that the suspended particles of yeast and malt are essential to the character of their product.



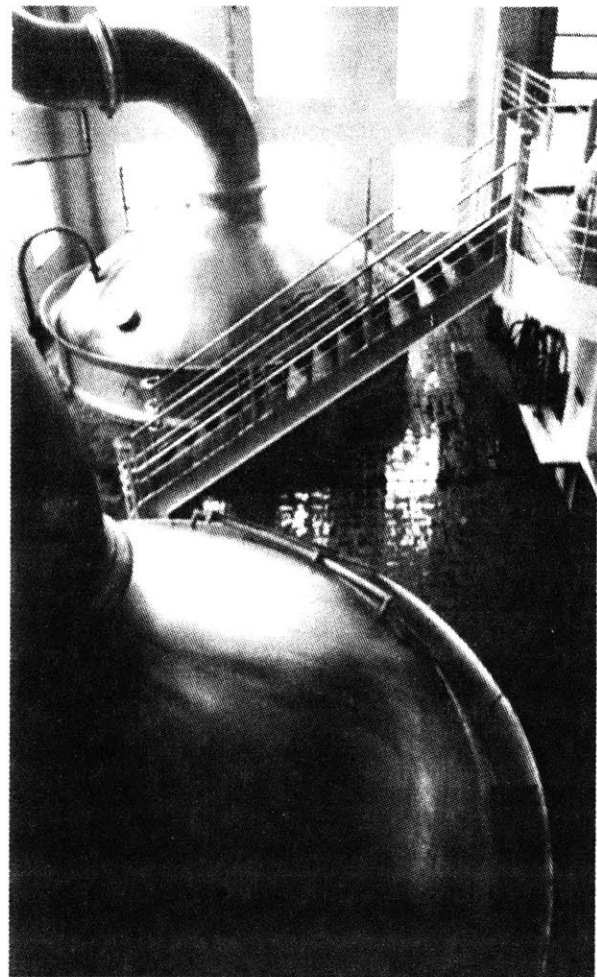
Kegging and bottling areas

3.1.2 Character of the Lowell Brewery

As suggested in the introduction, the Lowell Brewery will produce specialty beers and ales, the popularity of which has caused many "micro-breweries" to spring up around the country. The definition of a **microbrewery** varies somewhat depending on the state or the authority, but it is generally considered to be a brewery equipped to produce no more than 15,000 barrels of product per year (a beer barrel is 31 gallons). There is a great deal of consensus among brewers that, in the long run, a brewery must grow to produce at least 50,000 barrels per year to remain economically viable. (Many mass-market beer breweries such as

Miller and Anheuser-Busch, produce *millions* of barrels per year.) Since the Lowell Brewery is no passing fad, I sized it to produce approximately 50,000 barrels per year.

Brewery equipment is very carefully finished to make it easy to clean; as a result it is often very attractive and sculptural. This is particularly true of the mash tun and kettle, which are often made of copper and have elegantly curving vent pipes crowning them.



Given the sculptural nature of the equipment and the desirability of its organization to be very three-dimensional, the brewery can and should be an exciting architectural landscape that can be enjoyed by employees and visitors.

3.2 Restaurant & Pub

As results of the decision that the Lowell Brewery was to be a showplace (and thereby a marketing tool) and of the proximity of the site to the center of Lowell, it seems appropriate that the complex should include a restaurant and pub for sampling the products and enjoying the internal landscape. While safety and comfort (not to mention the necessary adjacencies of the brewing equipment) limit the extent that the restaurant and/or pub can meander through the brewery, they should do this to the extent possible, giving many views of different steps in the beermaking process.

3.3 Canalwalk and Viewing Galleries

Since the Lowell National Historical Park was established, Lowell has been working very hard to rediscover the history of its mills and canals and to make this history accessible. A network of walkways along and between the different locks and canals is an important element in the urban design strategies being pursued by the City and the National Park Service. The location of the brewery site along the Pawtucket Canal, near the heart of the downtown area, provides an opportunity for the eventual extension of the canalwalk network along and/or through the brewery. The design should respond to this possibility.

3.4 Program Summary

The projected required areas are summarized in the table, following.

BREWERY		17,925
Process-water tank	80	
Barley storage silos	2000	
Malthouse		
Scalper/separator	200	
Steep tank(s)	150	
Germination bed(s)	450	
Malt storage	1800	
Malt milling	100	
Brewhouse		
Mash tun	650	
Lauter tun	575	
Kettle	650	
Hops storage	100	
Hops separation	150	
Hot wort whirlpool	200	
Wort cooling	100	
Laboratory	250	
Fermenters	750	
Conditioning cellar	800	
Filter/holding tanks	250	
Packaging	800	
Empty package storage	1050	
Full package storage	1050	
Utilities	300	
Employee spaces		
Tasting	250	
Restroom(s)	120	
Lounge	200	
Locker room(s)	250	
Lunch room	350	
Exercise/Rec room	300	
RESTAURANT (150-200 seats)		6900
Dining	2400	
Kitchen	1000	
Storage (ambient,cold,frozen)	250	
Arrival/waiting	250	
Patron restrooms	200	
Receiving dock	100	
OTHER		
Observation galleries		
Waste disposal		

Preliminary Program Summary (all figures in sq.ft.)

Chapter 4

Site Analysis

4.1 Major elements/objects

The area around the site is very large-grained. The mill buildings are very regular rectangular solids hundreds of feet long. The canal, while less prominent in the visual field, is a very firm northern edge. The commercial buildings between the site and Central Street, while much smaller, are built as a continuous form.

4.2 Directions/axes

Two sets of axes converge at the site. Certainly, the predominant set is that defined by the three mill buildings and the Pawtucket Canal, all running parallel to one another. Jackson Street and the buildings across it to the south also follow this direction, as do the buildings on the northern side of the Pawtucket. The subordinate axes are defined by Central Street and the buildings that separate the site from Central Street.

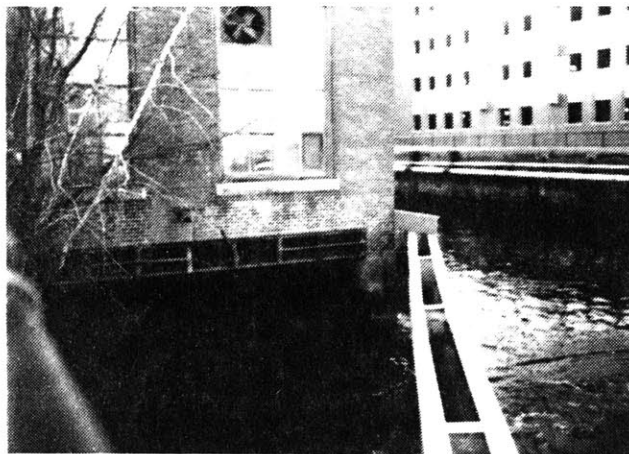
4.3 Access

- **Vehicular.** The only access for vehicles to the site is from Jackson Street on the south, where the site is much narrower than it is further north. A rail spur that comes down Jackson Street from the west turns into the site where it has been partially paved-over.
- **Pedestrian.** There is currently no pedestrian access to the site

except from Jackson Street. As there is little pedestrian traffic on Jackson Street other than workers walking from their cars, a more direct pedestrian connection to Central Street seems desirable.

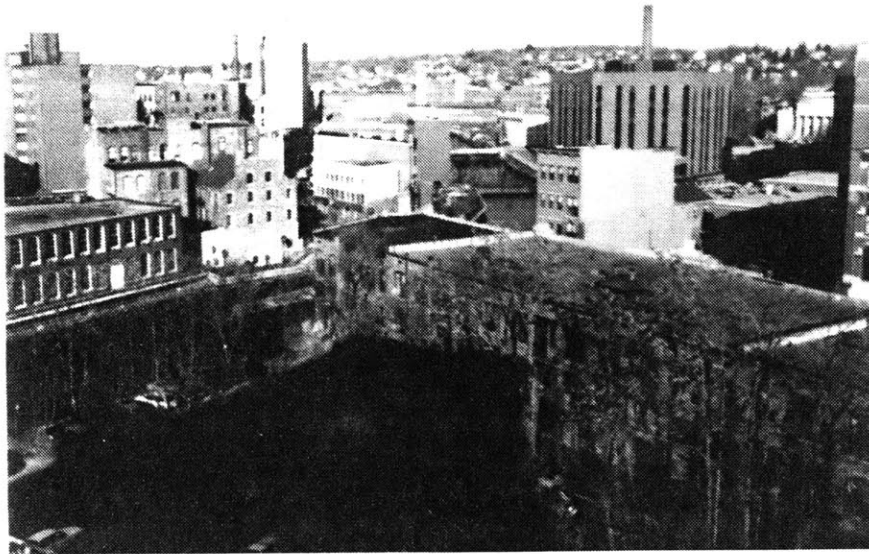
4.4 View

The fact that Mill #7 extends over the Pawtucket Canal eliminates most of the potential view from the site westward along the canal. Now that the buildings that bridged the canal with Central Street are gone, it is possible to see quite a distance toward the locks at the Concord River and beyond.



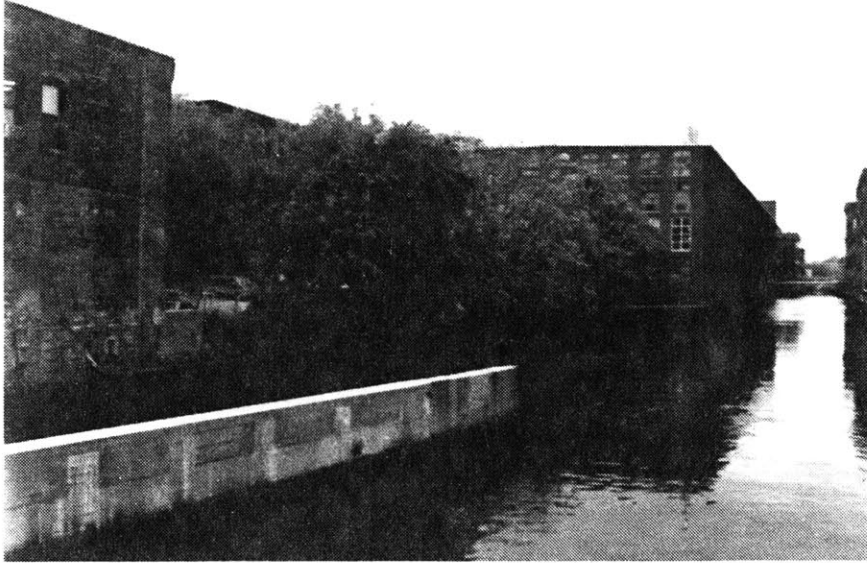
Extension of Mill #7 over the Pawtucket Canal.

If a portion of the brewery can get out over the canal, it could take advantage of this view. In other directions, the immediately surrounding buildings effectively block any further view at grade level. The view from the roof of Mill #4 is unobstructed in nearly all directions and is quite spectacular. Views outward from tall portions of the brewery would be possible, but at lower levels the views would have to be primarily internal.

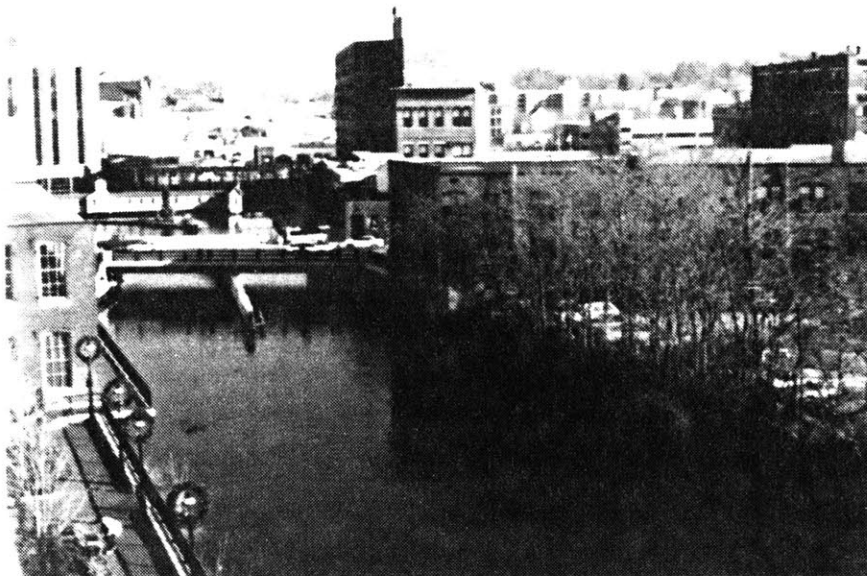


View from the roof of Mill #4, looking northeast.

Views toward the site are from Market Street, from the Central Street bridge, and from Jackson Street. The former two are somewhat upward views, as the site rises toward the south. The latter is really over the site and canal to the buildings along Market Street (because there is currently nothing built on the site). Important features of the brewery should orient themselves toward these views of the site.



View toward site from Central Street bridge



View down the Pawtucket Canal from the roof of the Municipal Garage. Site is behind trees on the right.

Chapter 5

Constraints

The site and program present a number of demanding/difficult problems. These formed the jumping-off points for the design.

5.1 Physical

- Access for large trucks must be maintained/replaced to Mill #4 and provided to the brewery. Large trucks require a lot of maneuvering space. These constraints tend to restrict the territory available for the brewery to the northern portion, along the canal.
- Garbage trucks must have access to rear of the Saab Building. This requires an unbuilt swath along the eastern edge. This constraint coincides with the desirability of not blocking daylight from reaching the windows along the rear of the Central Street buildings.
- Pedestrians neither want to enter where trucks do, nor would the majority of them be approaching from that direction (Jackson Street). Pedestrians will be coming from Central St. or across the canal. A dual approach is required.
- It would be difficult and costly to build over submerged wasteways or (much) over the canal.
- The brewery will require bulk deliveries of barley by rail. Major relocation of the existing rail line should be avoided.
- Parking on site for other than employees is not a realistic possibility, so this is not an important constraint.

5.2 Programmatic

- The portions of program with mechanical transfer (rather than fluid) turn out to require a lot of space and, unlike much of the program, work better if kept on a single level. In particular, the packaging lines need to be as close to the (empty and full) package storage as possible. The package storage, in turn, needs to be as close to the truck dock as possible. This tends to pull the packaging and storage areas to the southern side of the building, and the grade significantly constrains the elevation of this level.

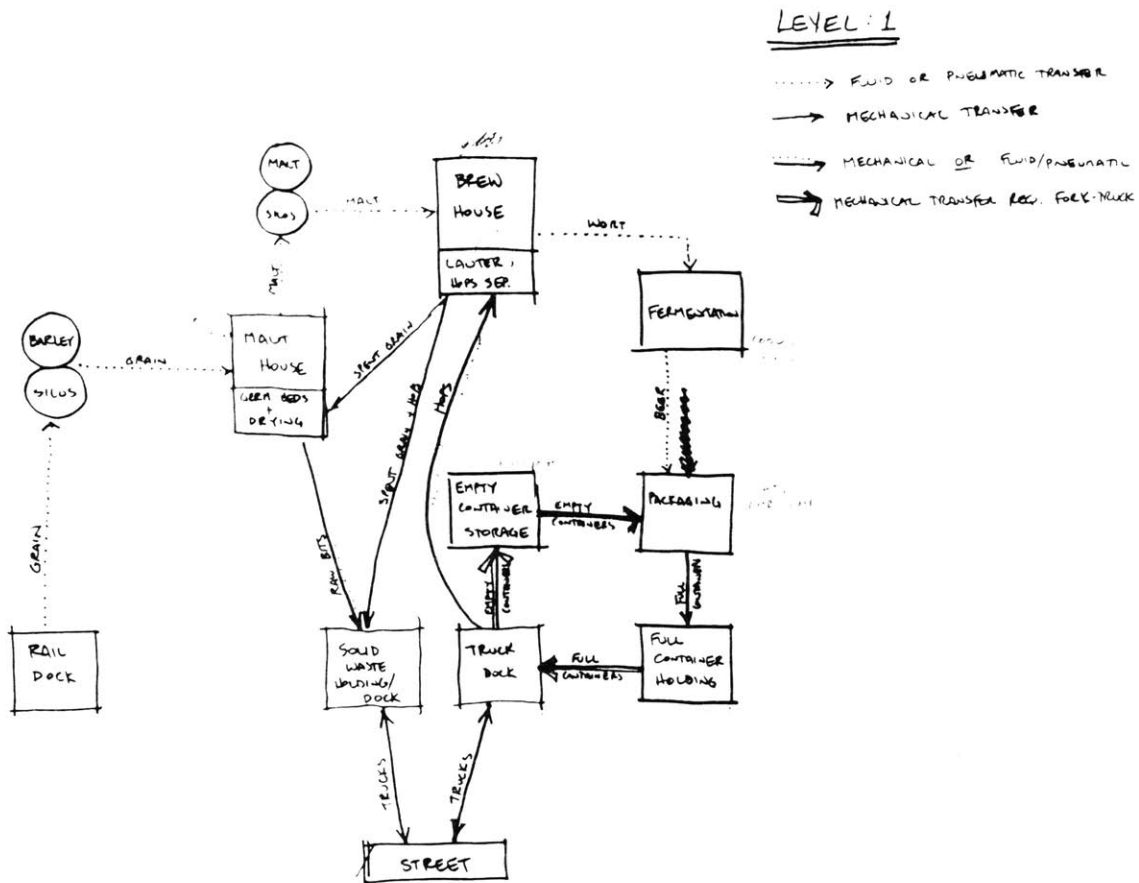


Figure 5-1: Required adjacencies in packaging/storage/shipping

- The restaurant wants to finger in amongst brewing as much as

possible for view. Since the process gets up quite high to take advantage of gravity transfer, the restaurant needs to be multistory or up high for view. Since a multistory restaurant is very difficult for food service, positioning the restaurant as high as is practical for access is desirable.

Chapter 6

Design/Drawings

6.1 Design Considerations



Canalwalk Network. Part of the development plans for the National Historic Park involve creating a network of pedestrian routes along the canals as well as using the canals for sightseeing barges. The Pawtucket Canal in general and the area where it crosses under Central Street in particular have major roles in these plans.

The location of the site along an important portion of the Pawtucket canal gives the opportunity to extend the developing canalwalk network. The canal edge of the site has attractive views and views into the brewery would enhance its interest. At some time in the future, the Hamilton Mill buildings may be redeveloped for non-industrial uses (for example, Mill #7 could be converted into housing, offices, retail space, or a mixture thereof). When and if this

happens, a walkway from Central Street westward along the southern side of the canal would have an important destination. Until then, it would be likely to suffer as a dead-end. To avoid this, I have proposed a pedestrian bridge across the canal from the western end of the site to the space on the north-side canalwalk along the Municipal garage.

In addition to mitigating the dead-end problem and providing easy access for brewery/restaurant visitors to parking, this bridge gives pedestrians a choice of paths. The existing pedestrian walks along the Pawtucket Canal switch from the north side west of Central Street to the south side east of Central Street. To follow it, one must cross the canal on the Central Street bridge, which is not particularly pleasant or interesting. The ability to cross from the north-side canalwalk or the garage to the activated south-side walk, thereby avoiding much of the traffic congestion along Central Street, would be a welcome opportunity.

- **Access.** Access is required for people (brewery employees, restaurant employees, restaurant patrons, tour visitors) and for vehicles delivering and/or picking up materials (barley delivered by rail, beer bottles/kegs delivered and picked up by truck, restaurant supplies delivered by truck, brewery and restaurant waste removed by truck).

The entrance for visitors (restaurant patrons and tour participants) should be easily read as a public entrance and should be visible from many directions/locations. Visitors arriving on foot are likely to be coming from the commercial areas along Central and Market Streets. Since there is on-site parking only for employees, visitors arriving by car are likely to have parked in the large municipal garage on Market Street across the canal from the site, arriving at the west end of the complex via the pedestrian bridge. Hence, the entrance for visitors should be along the canalwalk, easily visible

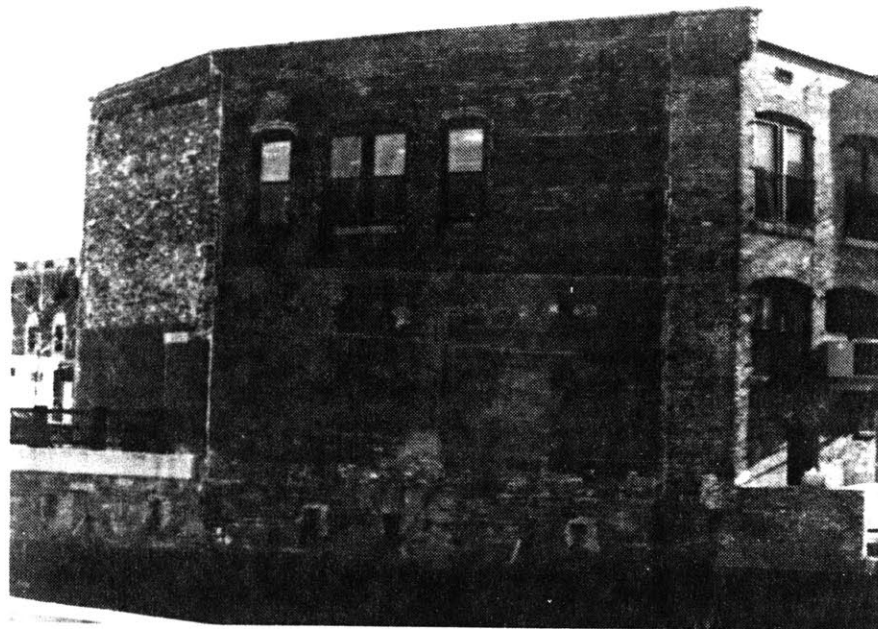
and reachable from both directions. However, given that a pedestrian bridge requires a cooperative effort between the city, the brewery, and perhaps the National Park Service, it is probably unwise to assume its existence. Thus, the entrance should be designed to work whether approach is from both directions or just from Central Street.

Given that the site has no Central Street frontage, where pedestrian access to the brewery/restaurant is a must, I have put a pub serving the brewery products in the storefront at the northern end of the Saab Building and threaded the new canalwalk along the pub, through the canal-edge of the building.



Entrance to Pub and Canalwalk

Window openings in this end of the building were bricked up when adjacent buildings were built that spanned the canal. These openings have not been restored since the removal of the adjacent buildings, but I would reopen them to provide light and view to/from the public passage.



Canal end of Saab Building.

Since this puts the canalwalk under cover (the window openings to the canal would be left unglazed and the closure moved to the edge between the pub and canalwalk), I have given pedestrians the option of staying under cover for the entire length of the canalwalk (except for the pedestrian bridge), making it into a sort of arcade. Since this canalwalk occurs on the north side of the brewery, it is appropriate that it be sheltered from snow and ice. For the winter, some sort of optional closure might be employed. Permanent closure is undesirable because it privatizes and thereby defeats the canalwalk as a public passage.

The entrance for employees should be on south side near employee parking. It probably should be separate from restaurant entrance and doesn't need to be as prominent as the public entrance (because employees will know its location). It should also be reasonably central so that paths to work areas won't be too long or circuitous. The entrance should permit the employees to enjoy views of the workings of the place.

While elevators are a necessity for moving freight and for carrying passengers to the higher levels of the building, they are expensive investments and the number should be kept to the minimum. A freight lift is needed for the packaging area, but it is reasonably inexpensive and simple. If the restaurant or kitchen are not at packaging dock level, the kitchen will need an elevator for supply delivery and/or getting the prepared food to the dining room(s). If it is not practical (in terms of distance/adjacencies or in terms of conflicts of use) for the restaurant kitchen to use the freight lift, it will need some sort of elevator also. Both these uses should be separate from the elevator normally used by patrons and employees. The "people" elevator needs to go to higher levels and should be a glass-enclosed observation variety to provide riders an opportunity (indeed, another way) to experience the internal space/landscape.

Site constraints force truck and rail access to separate points. Beyond this, it is desirable to collect as many truck access requirements as possible to single docks so that a single employee can monitor deliveries and shipments. Clearly, however, it is less critical that waste pickup be located with shipping/receiving since it is unlikely that theft would occur.

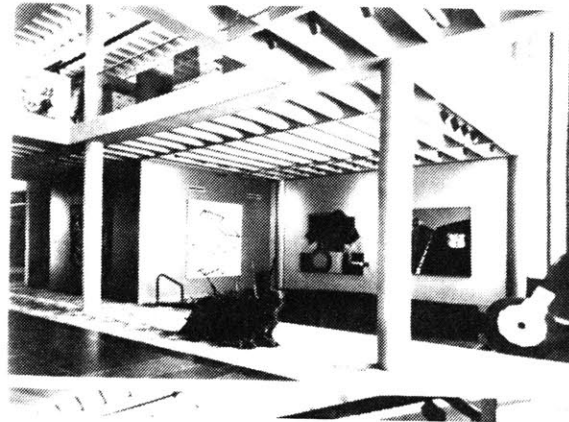
I concluded that due to significantly different sized trucks and potential conflicts of use, the restaurant and brewery should have separate docks. Accordingly, all shipping and receiving for the brewery is collected at a 2-bay dock with "semi" access, while the small delivery dock for the restaurant is located as near to the kitchen as possible. Special access for trucks to pick up the "spent grain" from the brewery is provided directly under the lautering area so that the waste can be dropped from the lauter tun into a waiting truck or into a holding tank.

- **Volume.** In order to make the brewery a landscape, the elements

that comprise it must exist in space. In my design studies, I found that the metaphor of a valley was easy to make, the brewing machinery rising up on receding mezzanines that make the walls of the valley and define the volume of space. Building a valley has structural ramifications. Either there must be a long-spanning roof or a very open jungle-gym framework which gets sparsely inhabited by equipment.

- **Structure.** There are problems in providing paths through a continuous framework for moving large pieces of equipment. In addition, I found that it was difficult to keep a continuous framework open enough to permit easy views. Therefore, the long-spanning roof was the better option. The stepping-back mezzanines that form the valley could then build in from the roof supports. To have a sort of system, I wanted the addition of mezzanine(s) to be completely optional in any given location; therefore, the supports for the spanning roof members needed to be quite rigid. I chose to begin with groups of four columns, connected and braced to one another. Ultimately, some of these groups became simple pairs at places where the opposing support could provide enough rigidity on its own. In other places, firestairs substitute for entire column groups. While the auxilliary columns that build the mezzanines out from the groups must align with the columns of the groups, they can be positioned at will in the other direction, subject only to the practical length of beams.

Since the floor loads in many areas of the brewery are quite high and since they need to withstand cleaning with strong chemicals and mechanical wear, I chose to use a one-way, site-cast, concrete slab and joist structural system. The beams run perpendicular to the valley so that the mezzanines can step out and back at will (if the beams ran parallel to the valley, the slab would never be able to stop short of the supporting columns).



Example of one-way joist and slab [Sorkin 81]

While the floor- and roof-support structure is concrete, the roof structure in general did not need to be able to support unusual loads. To reinforce the feeling of lightness and space, of an architectural valley (and not a cavern), it was important that the roof have a light internal appearance. Various forms of open steel trusses or spaceframes were the most obvious choices. I ended up using three-dimensional trusses (triangular in cross-section) because I wanted the ability to move the roof support structure up and down (spaceframes can fold and turn, but they tend to become rather amorphous if they're manipulated very much) and because they would provide a periodic visual element by which to gauge distance (whereas a spaceframe is rather continuous). The three-dimensional trusses are also robust enough to provide suspension support to mezzanines and catwalks below; suspension was sometimes required to keep areas free of columns where they would obstruct equipment.

The internal dimensions of the column groups were chosen so that the groups would define space that was useable (e.g., for stairs) or inhabitable as private spaces such as office or bathroom. The

distances between groups of columns was chosen so that the structure extending laterally out from the groups could generate a range of spans. The distance between the closest columns from two groups was established at 16 feet since the loads in some areas require closely spaced supports. The distance between the farthest columns from two adjacent groups is then 32 feet, a more typical span for lighter loadings, which can be utilized for the offices, tour galleries, and other lightly loaded areas.

An important consideration in determining the structural system was my intention that parts of the building reflect each of the two sets of axes that define the site. Hence, the specific proportion of the column groups was determined by the two sets of axes: the rectangular groups of columns are aligned with the principal axes of the site and the diagonal defines (or rather, was determined by) the subordinate site axes. This permits the groups to serve as supports for beams on either set of axes.

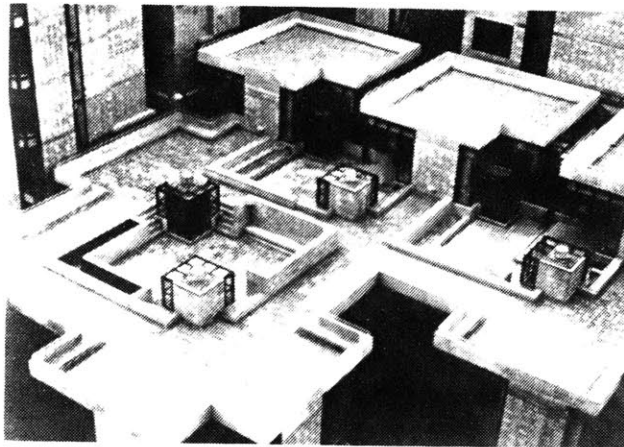


*Two sets of axes combined in a single structural system
[Sorkin 81]*

- **Intersection/Joint.** I began by making the public part of the program -- the restaurant -- an extension of the pedestrian world,

following the subordinate axes of the Central Street buildings and by making the manufacturing part -- the brewery -- an extension of the industrial world, following the primary axes of the mills and canal. Later, I purposely broke this guideline to build an exchange between the pedestrian and the industrial. In the process, the hearts of both parts -- the brewhouse equipment of the brewery and the entrance lobby and ascent to the restaurant -- converged to a joint between the two sets of axes.

- **Massing.** Keeping the main valley along the canal and arranging the packaging (which stays fairly horizontal) on the south side for truck access allows the roof levels to step down to the site. This stepping down on the south gives possibilities for inhabitation of the lower roofs as balconies/terraces/patios.



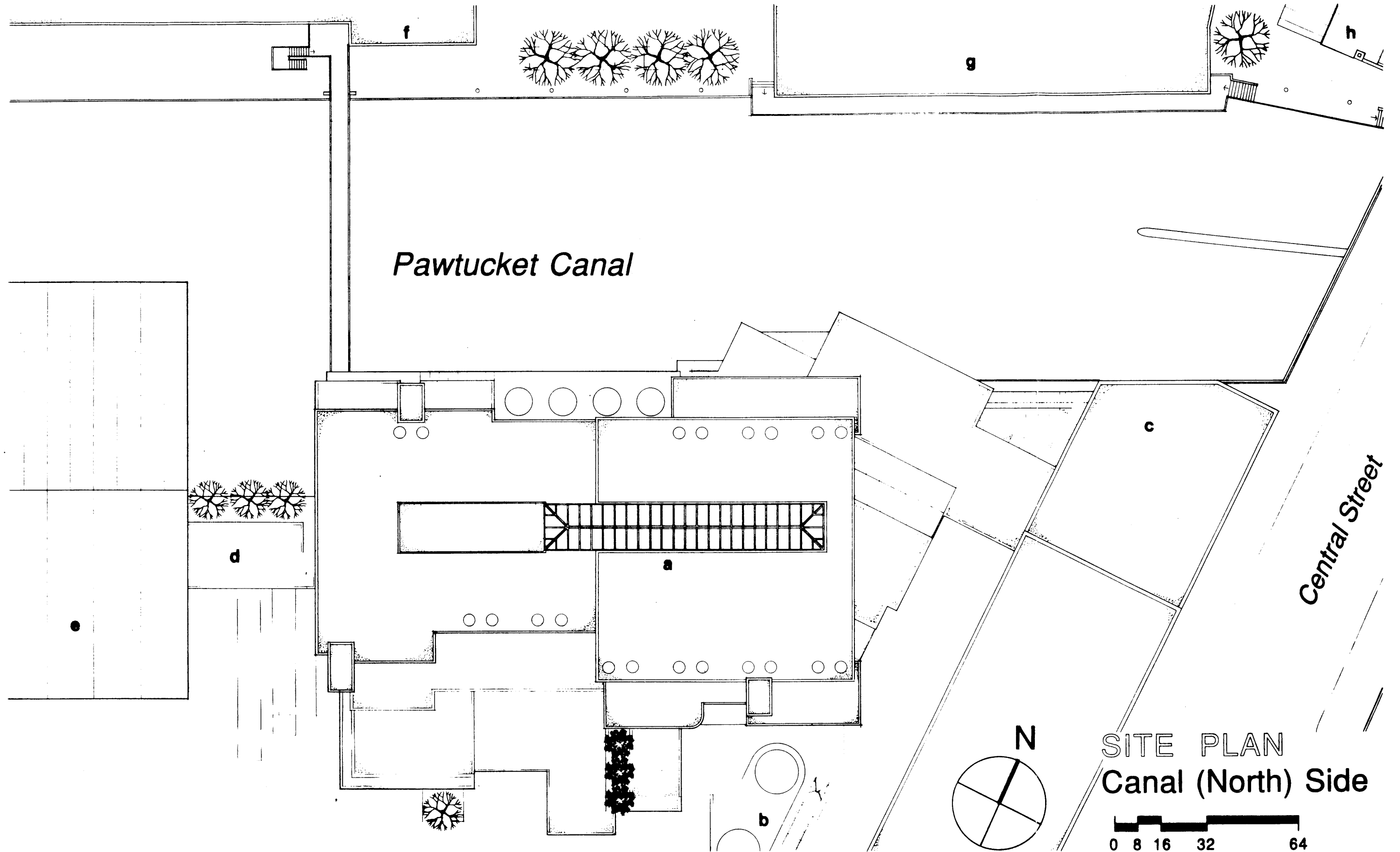
Use of roof as terrace. [Luchinger 87]

The highest roof crowns the brewhouse equipment (because it has the most demanding height requirements) which reinforces the joint between the two sets of axes.

6.2 Drawings

**Figure 6-1: *SITE PLAN, North (Canal) Side
Opposite.***

- a** Lowell Brewery
- b** Barley silos
- c** End of Saab Building occupied by Pub
- d** New dock for Hamilton Mill #7
- e** Hamilton Mill #7
- f** Municipal Garage
- g** Hamilton Dye-House (now Lowell Sun garage)
- h** Mansur Building



Pawtucket Canal

Central Street

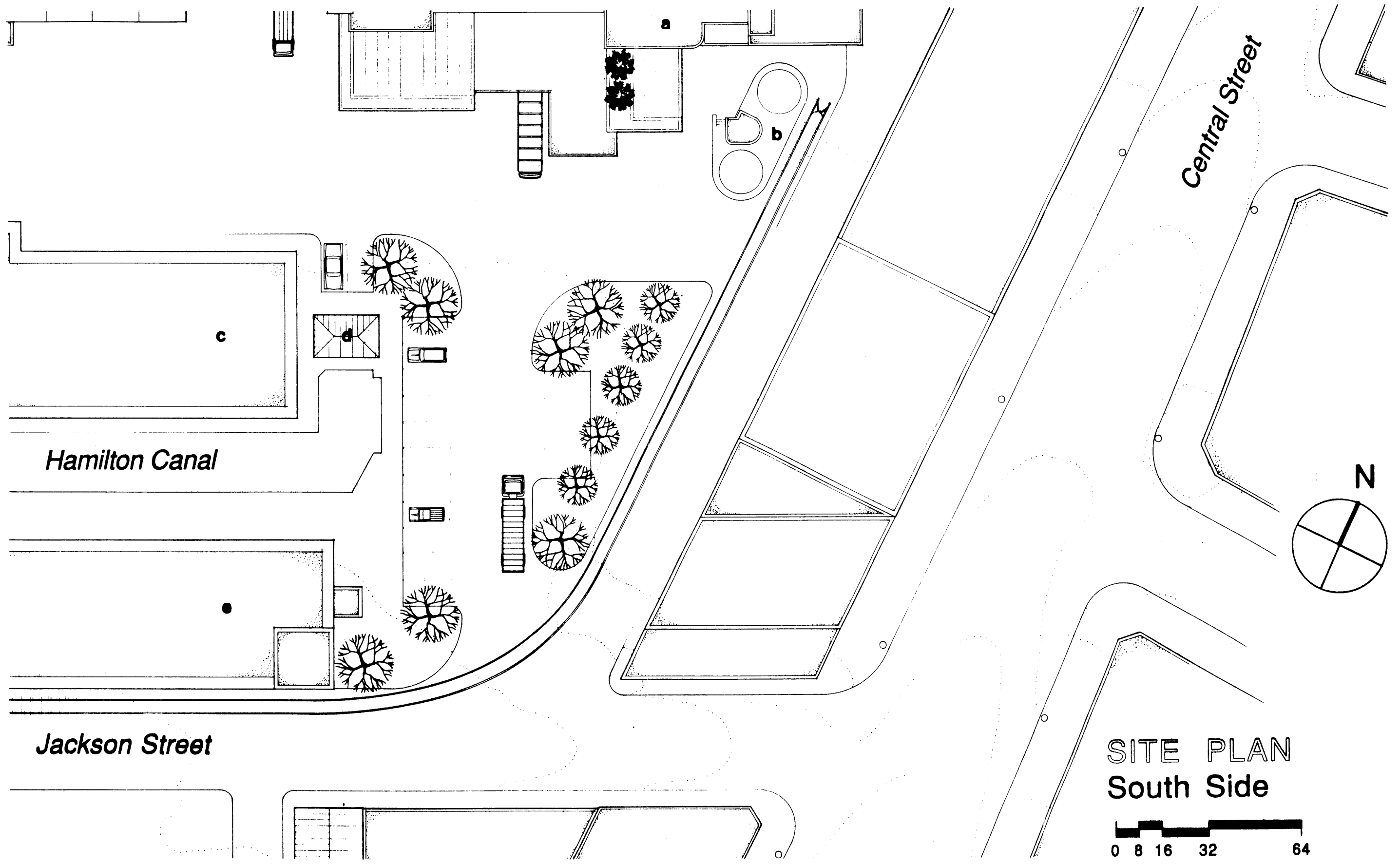
SITE PLAN
Canal (North) Side

0 8 16 32 64

Figure 6-2: *SITE PLAN, South Side*

Opposite.

- a** Lowell Brewery
- b** Barley silos
- c** Hamilton Mill #4
- d** Hamilton Canal Wasteway Gatehouse
- e** Hamilton Storehouse Building



Central Street

Hamilton Canal

Jackson Street

c

a

b

d

N

SITE PLAN
South Side

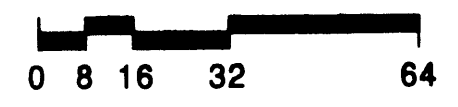
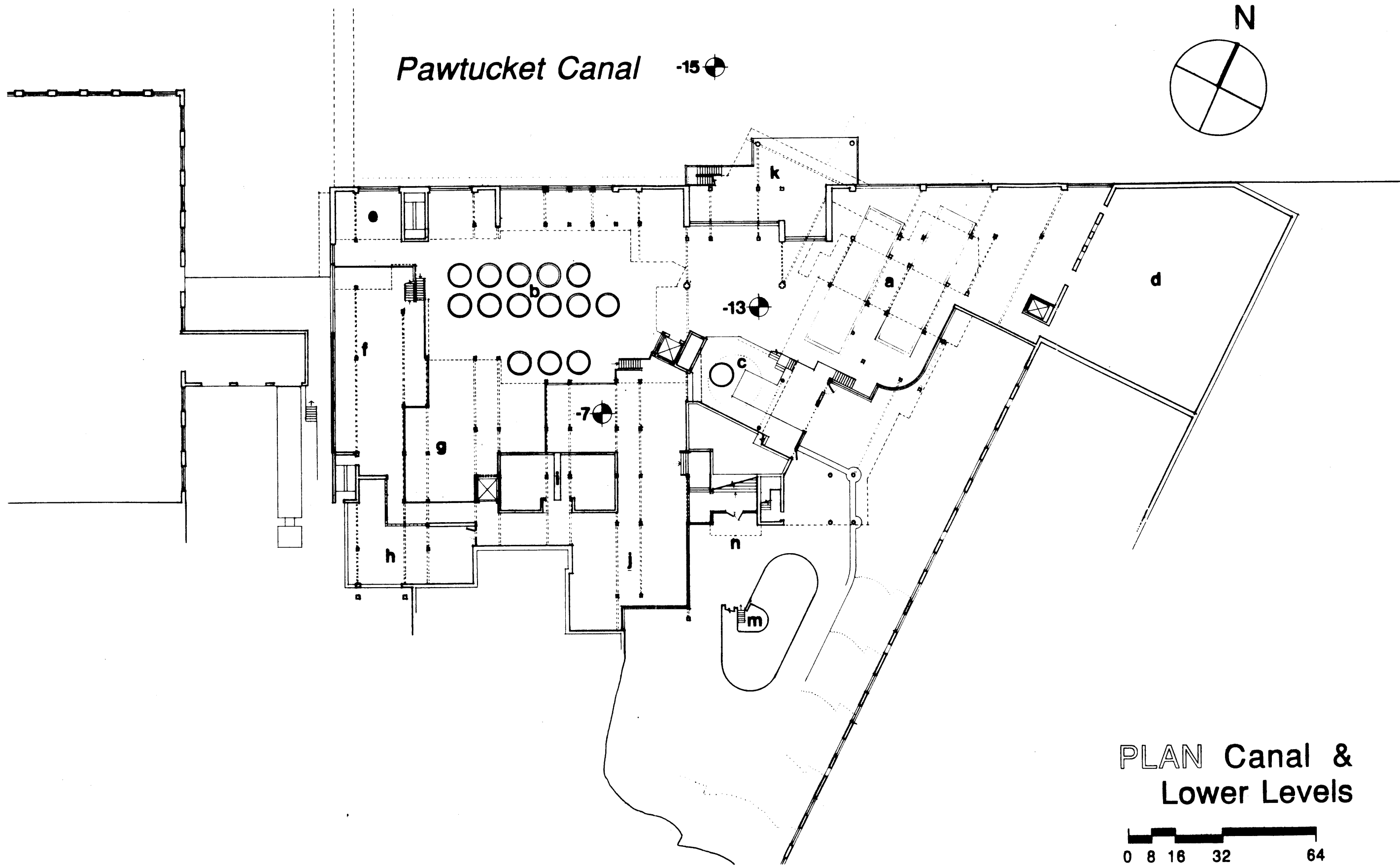


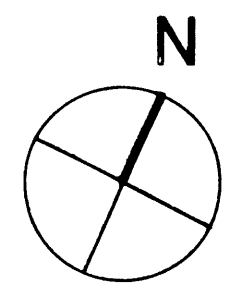
Figure 6-3: PLAN, Canal and Lower Levels

Opposite.

- a** Barley germination/drying beds
- b** Unitank fermenter/conditioners
- c** Spent grain dock
- d** Storage (existing basement of Saab Building)
- e** Utility equipment
- f** Shop area (plumbing, carpentry, etc.)
- g** Equipment storage
- h** Employee fitness area
- i** Locker rooms
- j** Lunchroom
- k** Boat dock for tour barges
- m** Mechanical room for grain blowers
- n** Employee entrance



Pawtucket Canal -15



PLAN Canal & Lower Levels

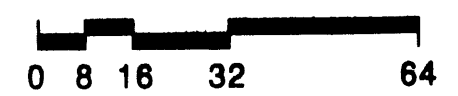


Figure 6-4: PLAN, Canalwalk and Entry Levels

Opposite.

- a** Entrance to canalwalk and pub
- b** Pub
- c** Storefronts
- d** Restaurant delivery dock
- e** Canalwalk
- f** Restaurant lobby
- g** Pedestrian bridge to garage
- h** Kegging and ambient storage
- i** Cold storage
- j** Truck docks
- k** Bottling and ambient storage
- l** Brewery lobby
- m** Lauter tun
- n** Observation elevator
- p** Steep tanks
- r** Hamilton Mill #7 truck dock
- s** Barley silos
- t** Hamilton Canal Wasteway Gatehouse
- u** Hamilton Mill #4
- v** Hamilton Mill #7

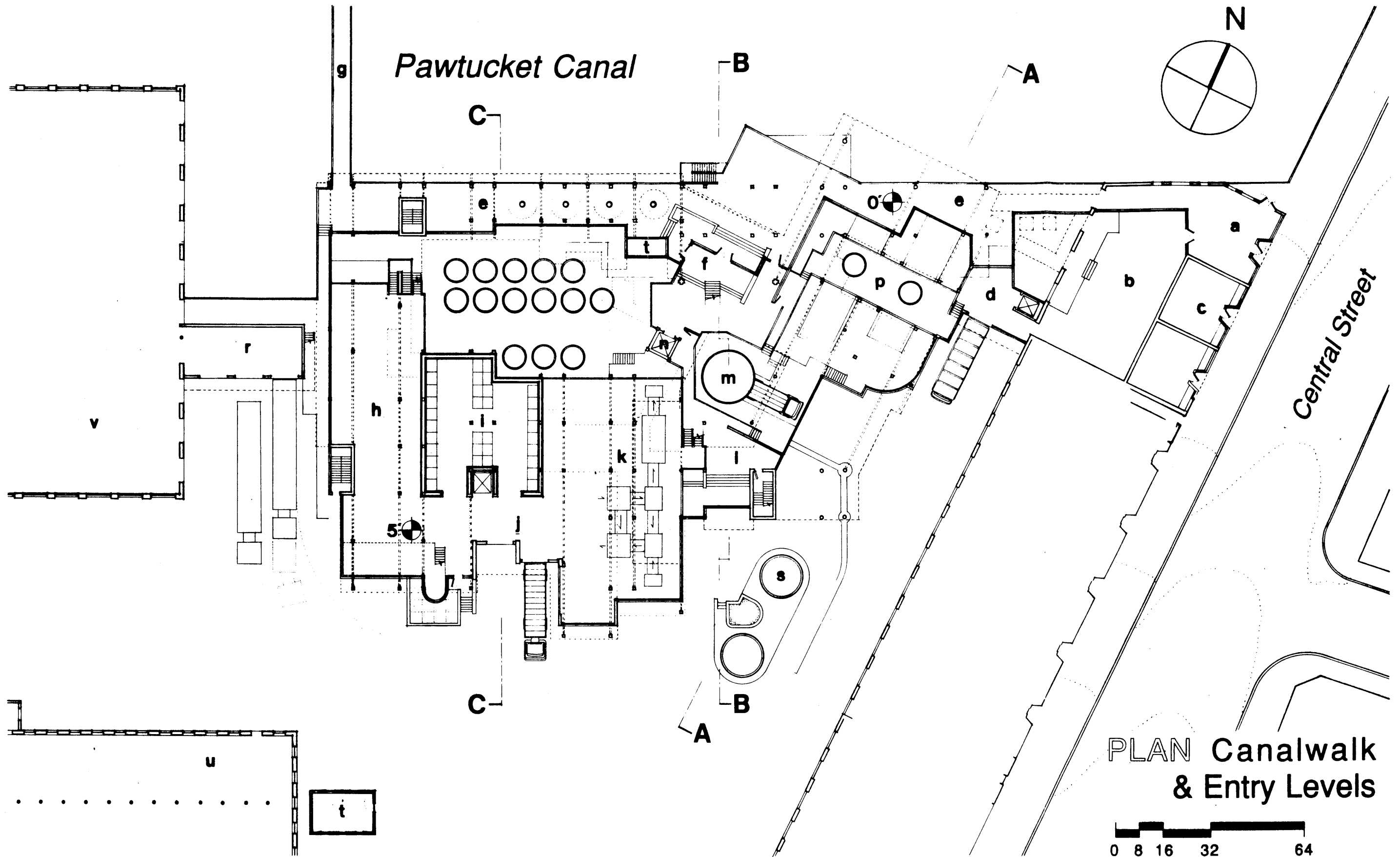
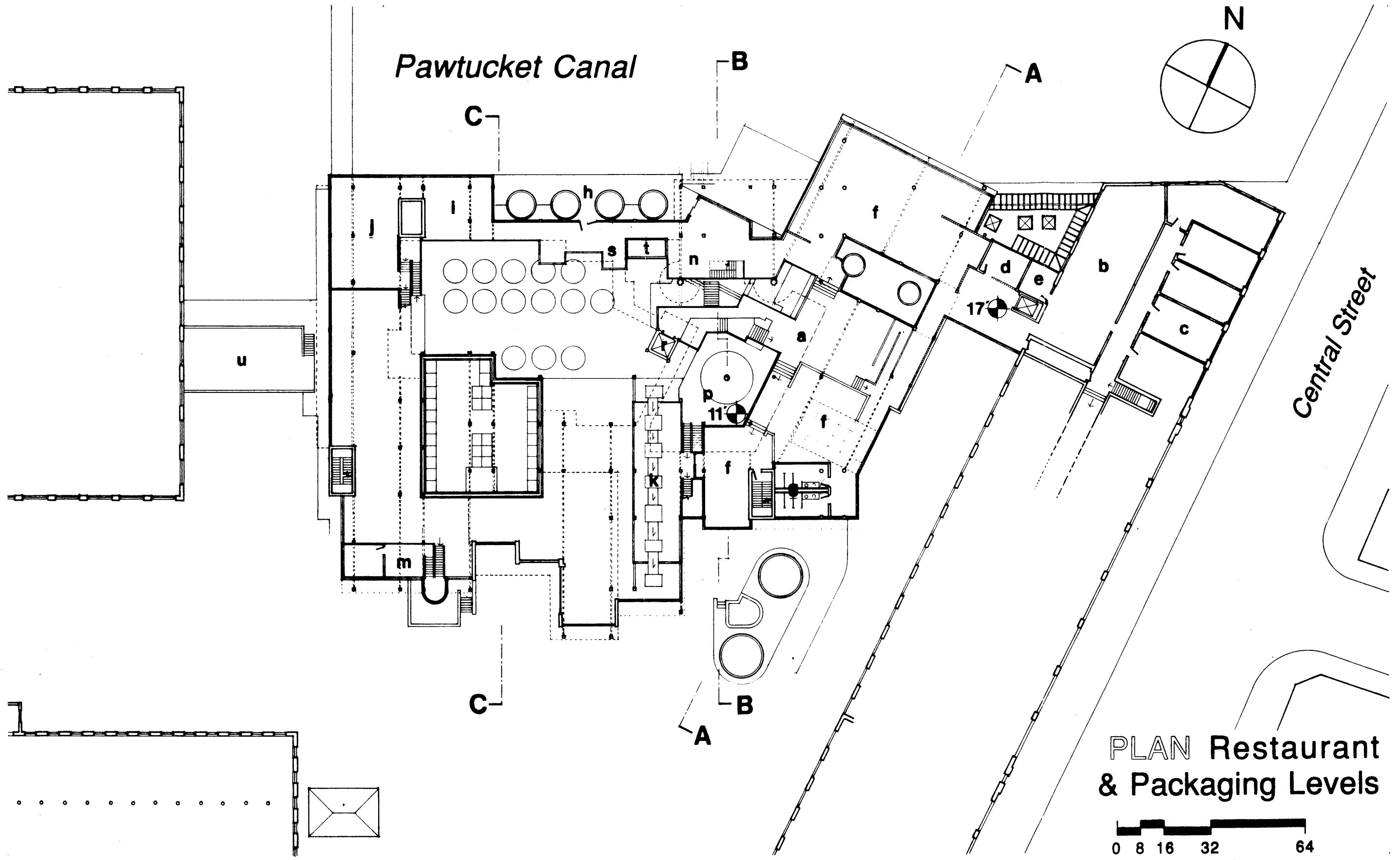


Figure 6-5: *PLAN, Restaurant and Packaging Levels*

Opposite.

- a** Restaurant arrival and bar area
- b** Kitchen
- c** Existing offices
- d** Restaurant manager's office
- e** Kitchen manager's office
- f** Dining rooms
- g** Restrooms
- h** Malt silos
- i** Tour observation point
- j** Tour tasting area
- k** Bottling mezzanine
- m** Shipping/receiving office
- n** Hops separator
- p** Lauter area
- r** Observation elevator
- s** Observation platform
- t** Wort cooling
- u** Roof of Mill #7 dock



PLAN Restaurant
& Packaging Levels

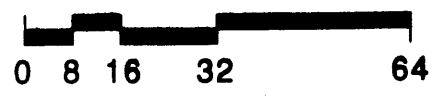
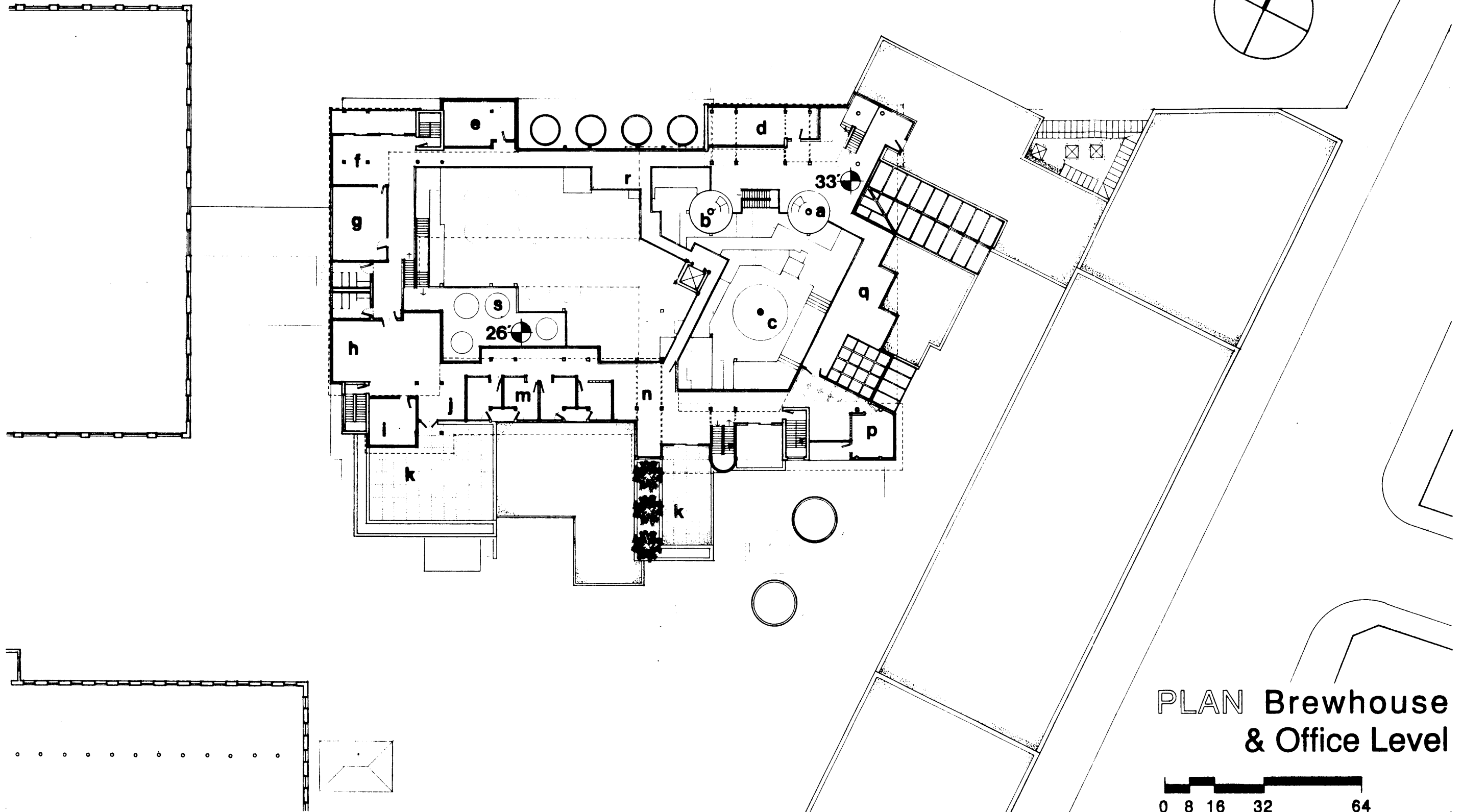
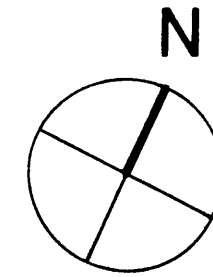


Figure 6-6: PLAN, Brewhouse and Office Level

Opposite.

a	Mash tun
b	Brew kettle
c	Lauter tun
d	Control room
e	Lab
f	Tasting area
g	Conference room
h	Open office area
i	Meeting room
j	Lounge
k	Roof patio
m	Offices
n	Reception/open office area
p	Executive office
q	Ventilation equipment
r	Whirlpool tank
s	Finished beer holding tanks

Pawtucket Canal



PLAN Brewhouse
& Office Level

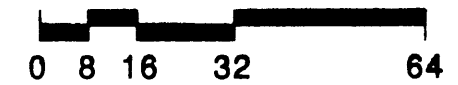
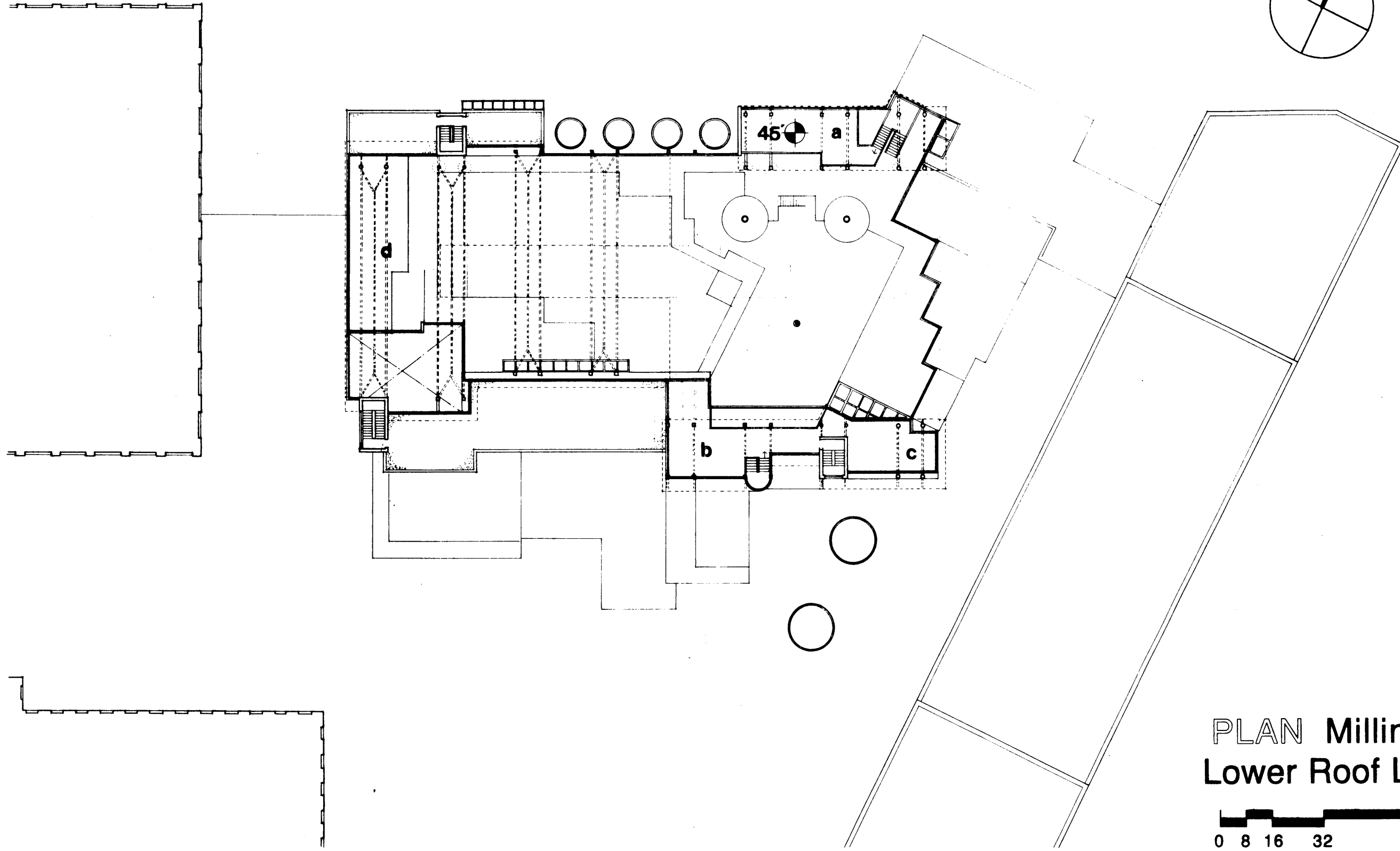
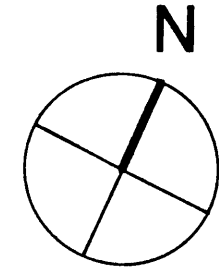


Figure 6-7: *PLAN, Milling and Lower Roof Levels*

Opposite.

- a** Mill mezzanine
- b** Office/meeting area
- c** Office/meeting area
- d** Mechanical loft

Pawtucket Canal



PLAN Milling &
Lower Roof Level

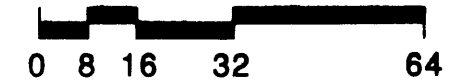
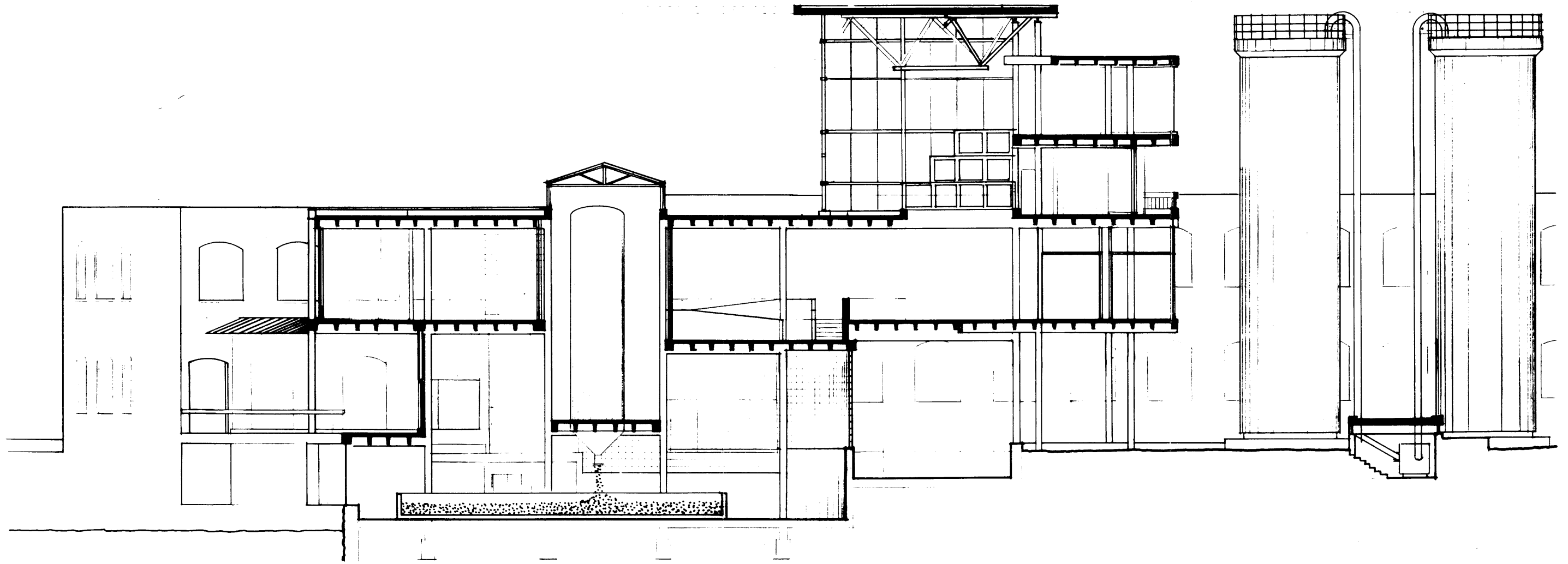


Figure 6-8: SECTION A-A

Opposite.

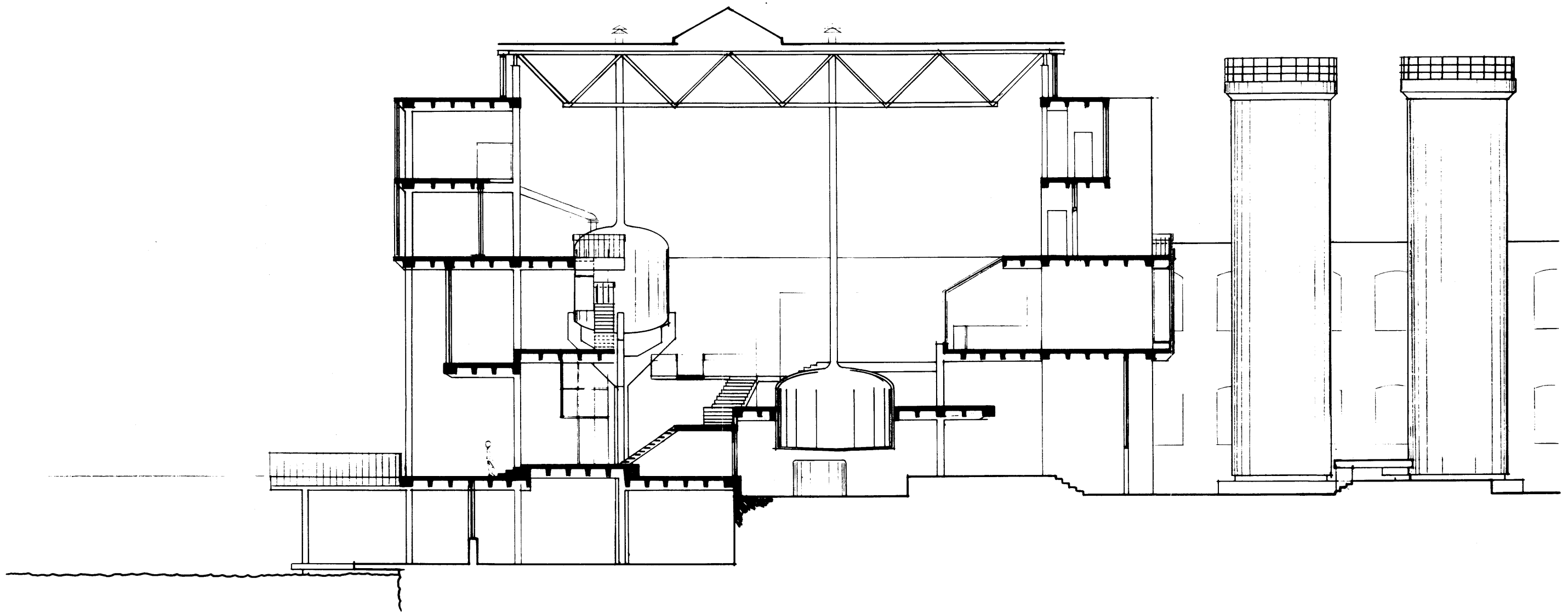


SECTION **A-A**



Figure 6-9: SECTION B-B

Opposite.

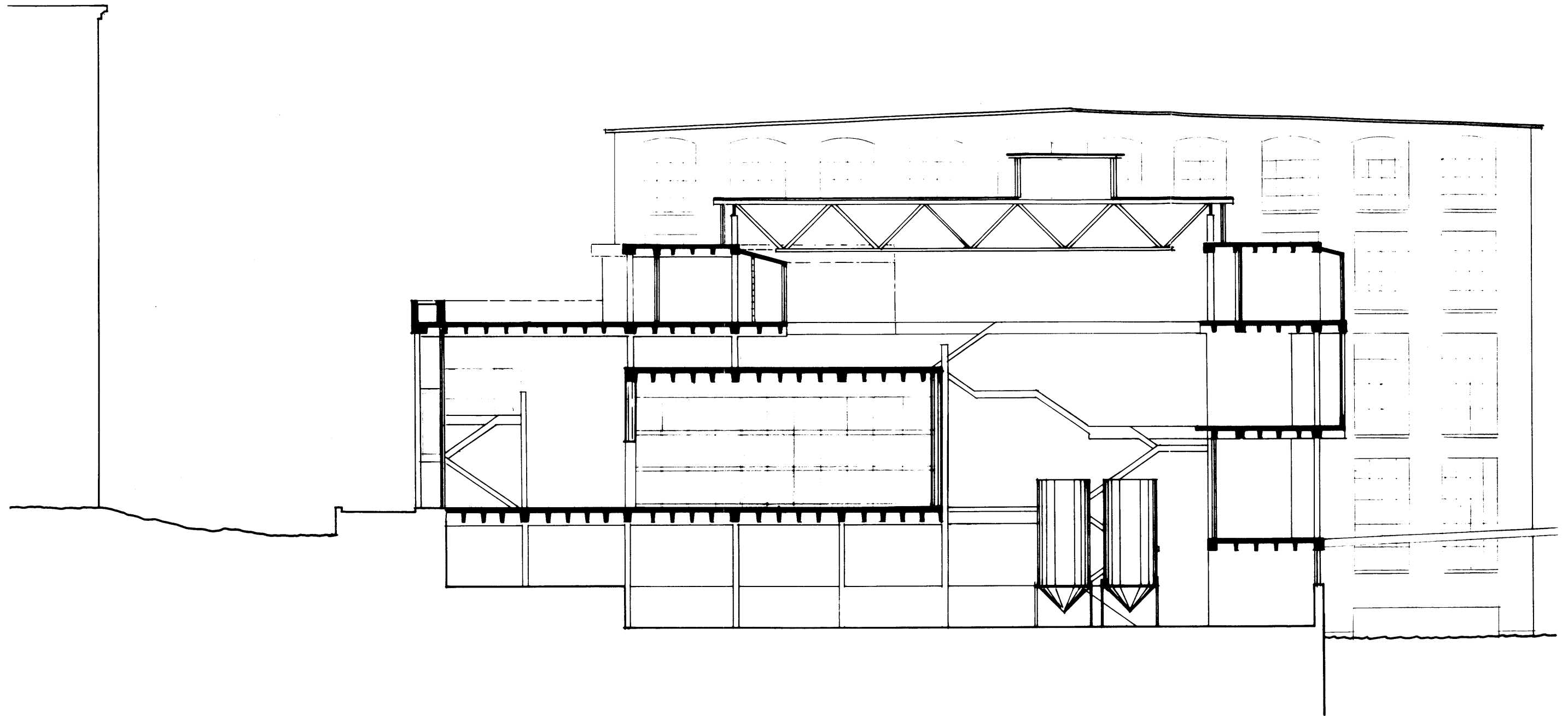


SECTION **B-B**



Figure 6-10: SECTION C-C

Opposite.



SECTION C-C

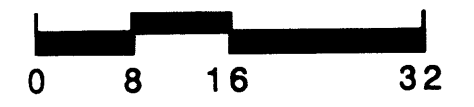
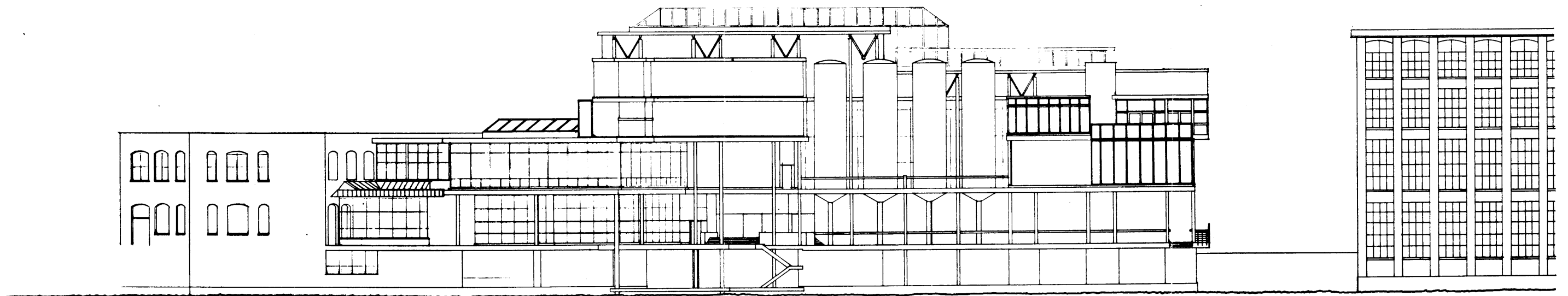
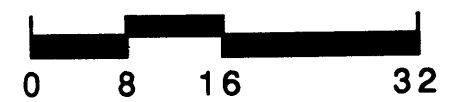


Figure 6-11: ELEVATION, North

Opposite.



ELEVATION
North



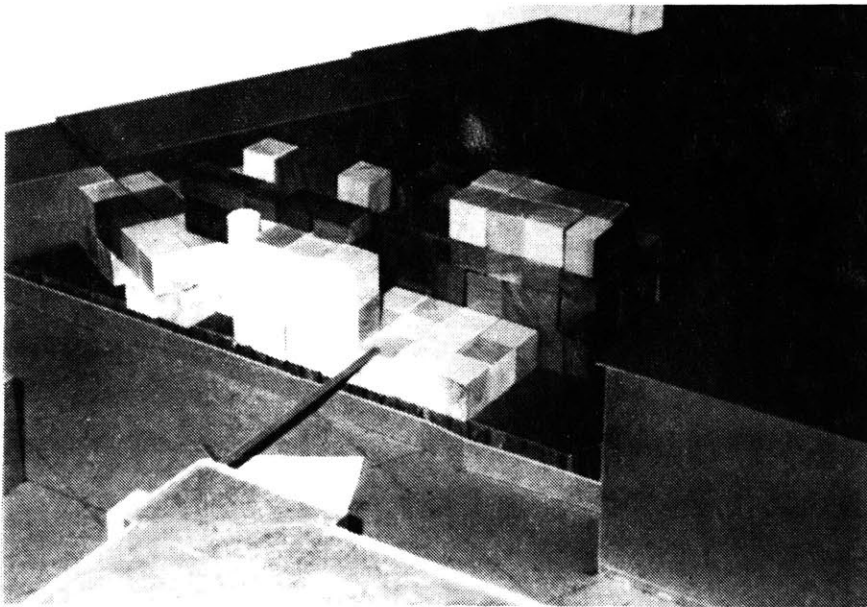
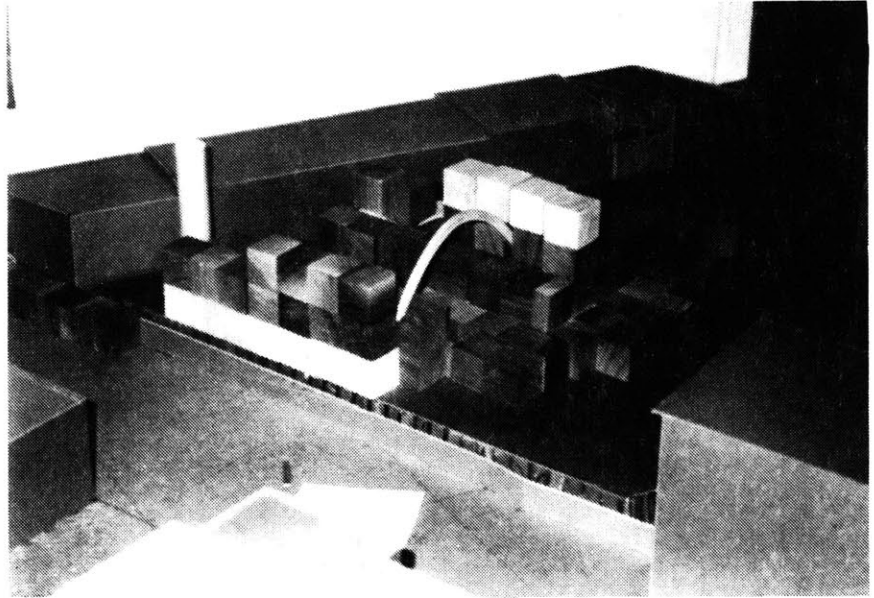


Figure 6-12: *Photographs of massing model*

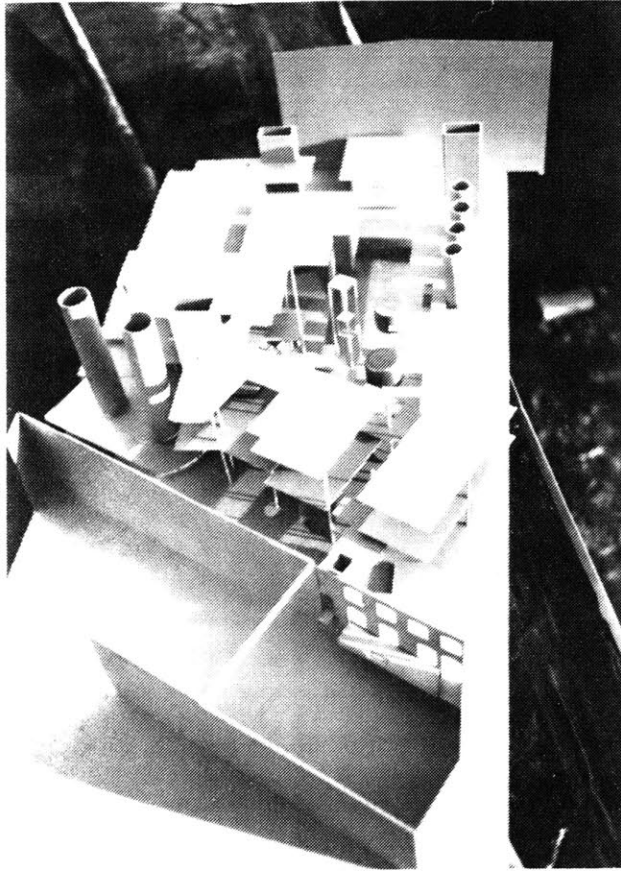


Figure 6-13: *Photograph of study model, looking west*

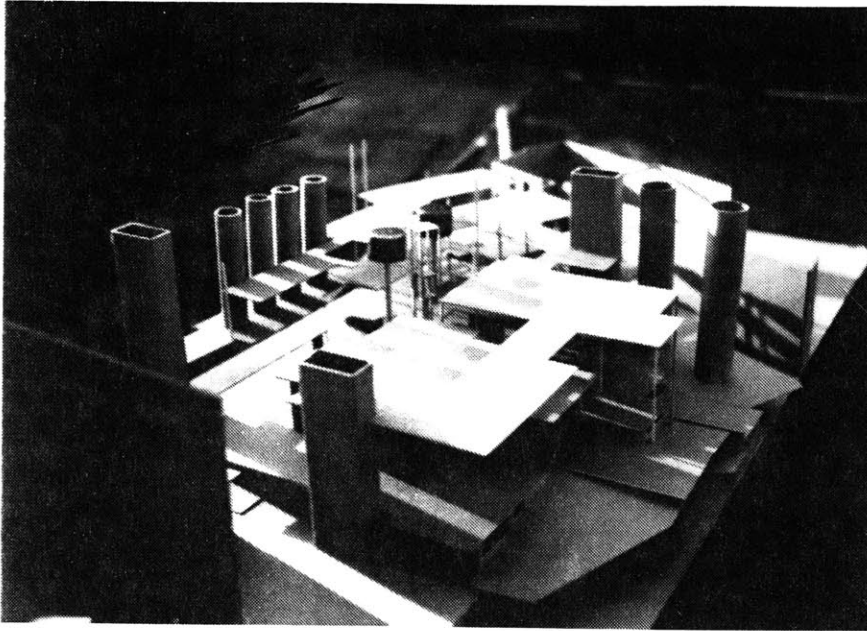


Figure 6-14: *Photograph of study model, looking east*

References

- [Allen 85] Allen, Edward.
Fundamentals of Building Construction: Materials and Methods.
John Wiley and Sons, 1985.
- [Broderick 77] Broderick, Harold M. (editor).
The Practical Brewer: A Manual for the Brewing Industry.
Master Brewers Association of the Americas, 1977.
- [Hardman 76] Hardman, Michael.
Beer Naturally.
Bergstrom + Boyle Books Ltd., 1976.
- [Human 73] Lowell Urban Park Development Program.
Human Services Corporation Report.
1973
- [Institute 87] The Institute for Fermentation and Brewing Studies.
Microbrewers Resource Handbook and Directory
Second edition, Association of Brewers, Inc., 1987.
- [Lowell 77] Lowell Historic District Commission.
Lowell Massachusetts: Report of the Lowell Historic Canal District Commission to the Ninety-Fifth Congress of the United States of America.
US Government Printing Office, 1977.
- [Luchinger 87] Luchinger, Arnulf.
Herman Hertzberger: Buildings and Projects, 1959-1986.
Arch-Edition, 1987.
- [Massachusetts 74] A Proposal for an Urban State Park in Lowell, Massachusetts.
Massachusetts Department of Natural Resources, Office of Planning Publication.
1974
- [Molenaar 83] Molenaar, J. and Geurst, J.
van der Vlugt, Architect 1894-1936.
Delft University Press, 1983.
- [Moon 84] Moon, William Least Heat.
A Glass of Handmade.
The Atlantic Monthly, November, 1984.

- [Schodek 80] Schodek, Daniel.
Structures.
Prentice-Hall, 1980.
- [Schoepp 88] Schoepp, Scott (editor).
American Brewer.
Bill Owens, 1988.
- [Shepley 80] Shepley Bullfinch Richardson and Abbot.
*Lowell National Historical Park and Preservation Project
Cultural Resources Inventory.*
Technical Report, Division of Cultural Resources, National
Park Service, 1980.
- [Sorkin 81] Sorkin, Michael.
Hardy, Holzman, Pfeiffer.
Whitney Library of Design, 1981.
- [Whitney 88] Whitney, Dori (editor).
Brewers Digest.
Siebel Publishing Company, 1988.