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BOZEMAN

THE DESIGN OF A BATHING FACILITY

for

Bozeman Hot Springs, Montana

By Stephen B. Sewall

Under-graduate Thesis
for

the partial fulfillment of requirements
for a Bachelor of Architecture Degree

Montana State University

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INTRODUCTION

This book deals with the development of an architectural environment for Bozeman Hot Springs. This environment is to be one of uniqueness and relaxation to fully amplify the use of the natural hot water located on the site.

Much of what is in my book is the result of long thought and evolution of my design process. The present building located at Bozeman Hot Springs, in comparison to Norris Hot Springs, has little gratification other than the soothing hot water of its pools. I am going to attempt to create a building suitable for such a unique natural attribute.

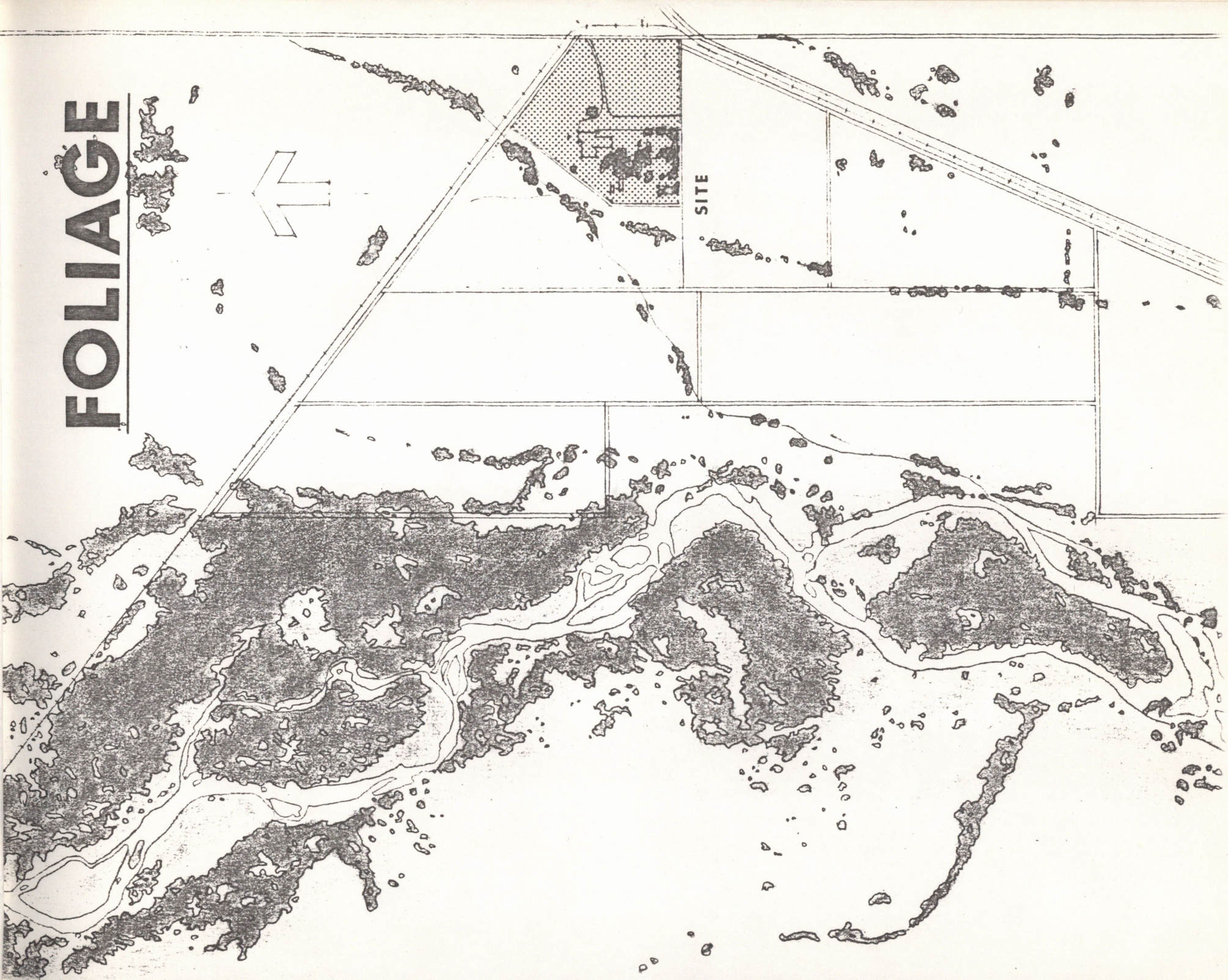
THESIS STATEMENT

An architectural enviroment developes through the
understanding of a buildings needs.

To illustrate my thesis statement, I have chosen to investigate a bathing facility for Bozeman Hot Springs. I feel there is a need for a building to house the now present function which would reflect the unique natural attribute of the site.

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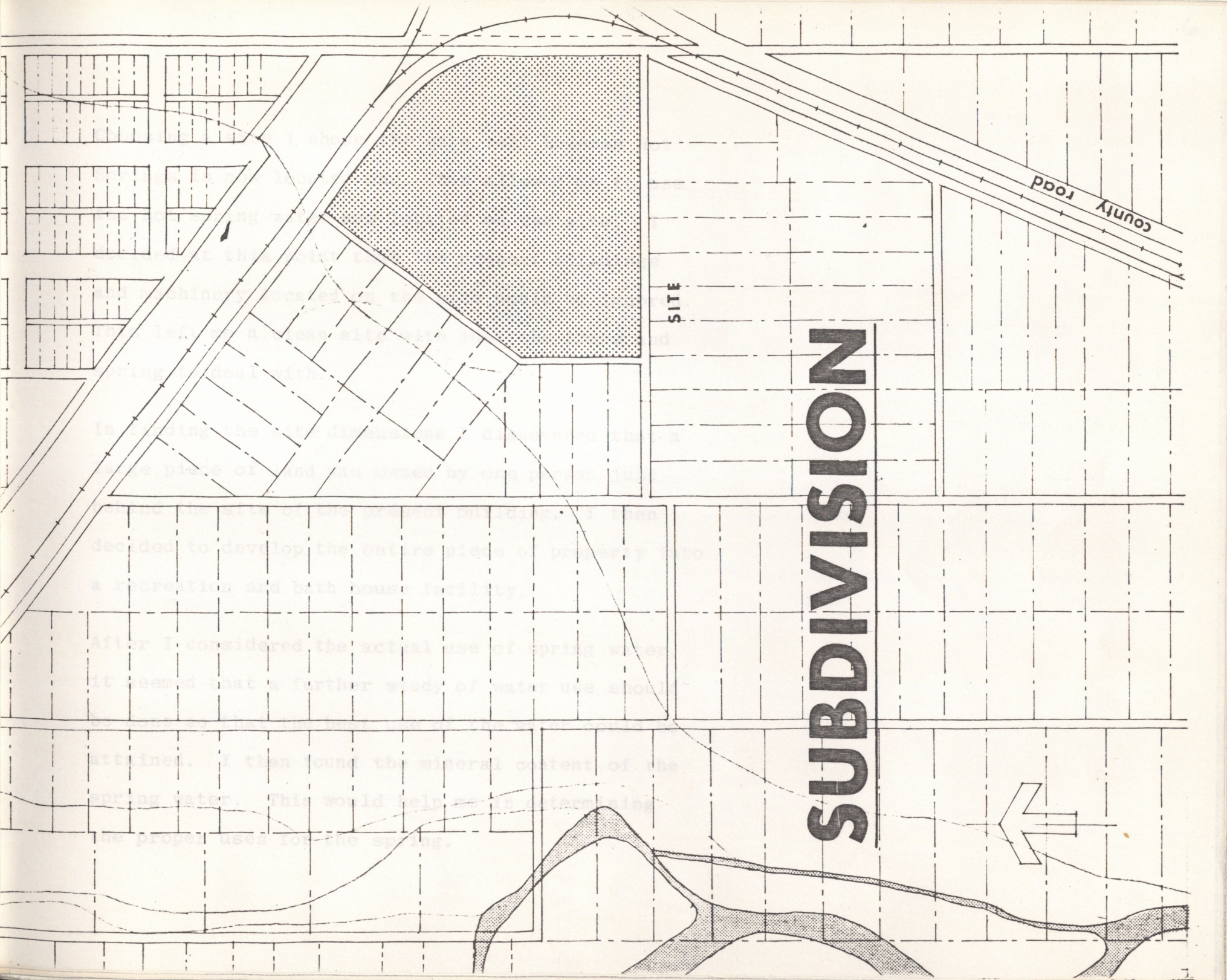
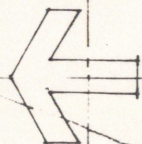
FOLIAGE



SUBDIVISION

SITE

County Road



Choosing a site I chose the site that Bozeman Hot Springs is now located on. This allowed me to use the hot spring water now located on the site. I decided at this point that the present buildings and machinery located on the site would be ignored. This left me a clean site with just the trees and spring to deal with.

In finding the site dimensions I discovered that a large piece of land was owned by one person just behind the site of the present building. I then decided to develop the entire piece of property into a recreation and bath house facility.

After I considered the actual use of spring water, it seemed that a further study of water use should be done so that the best use of the water could be attained. I then found the mineral content of the spring water. This would help me in determining the proper uses for the spring.

BOZEMAN HOT SPRINGS

Sodium Chloride

Sodium Sulphate

242.0

Sodium Carbonate

52.0

Sodium Bicarbonate

Medical classification - weak total mineralization

Magnesium Bicarbonate

Calcium Bicarbonate

This is a moderately mineralized, sodic, sulphated, alkaline-saline water, flowing at the rate of 600 gallons per minute, possessing laxative and tonic properties.

Ferric Oxide & Alum

Silica

Waters have been endorsed by the profession and used with success in the treatment of gout, rheumatism, diseases of the liver and kidneys.

MEDICAL ANALYSIS

Located 4500 feet above sea level

Weak total mineralization

Water level is about 15 feet below surface and does fluctuate during the year.

Springs.

Water temperature is about 141 degrees and must be pumped for use.

PLANT LIFE

Spring water has a Ph of 8.9 which is too high for

watering use. If used the soil will become alkaline

for plant life to live. The water which is pumped

from a well located on the site has a Ph of 7.2. This

water could be used on plant life with no adverse effects.

HYPOTHETICAL COMBINATIONSParts/1000

Sodium Chloride	91.0
Sodium Sulphate	242.0
Sodium Carbonate	52.0
Sodium Bicarbonate	61.0
Magnesium Bicarbonate	Trace
Calcium Bicarbonate	16.0
Ferric Oxide & Alumina	.8
Silica	<u>52.0</u>
TOTAL PARTS	514.8

MEDICAL ANALYSIS

Weak total mineralization compared to most Hot Springs.

PLANT LIFE

Spring water has a Ph of 8.8 which is too high for watering use. If used the soil will become alkaline for plant life to live. The water which is pumped from a well located on the site has a Ph of 7.2. This water could be used on plant life with no adverse effects.

DRINKING USE

The spring water can be drunk and does have a stronger taste and smell than the well water of the Bozeman water supply. The water does have a laxative effect if two quarts are drunk in a day. Because of this children under seven should probably not drink the water.

WASHING USE

The spring water is now being used in pools and for showers in the present building. The water works well for showers and a clean feeling can be obtained. The water is also suited for use in washing machines and does not stain clothes.

HEATING

The spring water now has to be pumped from a well 15' below the surface. The water is in four layers which supply 40-60 gallons per minute for each layer. Just

10

the first layer is now being used and if all four layers were to be pumped there would be a 20-30% reduction in water supplied. The total amount which could be pumped would be about 140 gallons per minute.

A house using a two-circuit, one-pipe forced circulation system with hot water from the spring would use about 12 gallons per minute to heat the houses. With the 140 gallon total from the spring, 12 houses could be heated.

The temperature of the water from the spring 15' below the surface is 141°F. Recommendation by Mechanical and Electric Equipment for Building is:

- Floor piping 140°F water temperature
- Ceiling piping 150°F " "

Piping for the heating system should be non-corrosive so it can be cleaned with acid every 4-6 years to remove mineral deposits.

BUILDING STUDY

In my building study the top three buildings best suited for use of the hot spring water were (1) a bath house; (2) a greenhouse; and (3) an agricultural building producing crops year around. In my solution I would like to try and incorporate all of these buildings into one complex where their function could all work together.

My initial concept was to use the entire piece of property. After some consideration it may be better to just use the site on which the present building is located. I was going to use the land for recreation which would not bring in any income for the owner other than those which would be drawn to the site for recreation and then use the bath house. This would be quite minimal. The better solution may be to sell the land which is already sub divided for revenue which could then be used to build the new

bath house. Then any large recreation facility could be built and financed by the community once it had a chance to get started. At the present time there are not enough people in the subdivision to really justify a recreation park as I was planning. I feel this plan would be a much better proposal.

In my building study it turned out to be a bath house which would best use the water and serve the public. I know am going to look at the bath houses which were done in Rome.

These buildings were used as training facilities for wrestling, boxing, racing, jumping, etc. Poets and philosophers also used these buildings where their works could be read to the public.

The use of these baths was part of the daily routine and there was a small fee or some were free. Both men and women used the baths, usually in the afternoon.

Plans were focused around a central hall from which other halls and rooms grew. Spaces on both sides of the hall were used for baths with men using one side of the building and women on the other. They usually had a large staff of people which were slaves.

The building was usually raised on a platform with an enclosing wall underneath where the furnaces for heating the baths and building along with rooms connected where services were located. There were three main parts to these buildings:

1.) Main Building

Dominant central hall which all rooms were built around.

2.) Large Open Space

In this space were trees, fountains, statues, etc. Part of this area was used for a stadium with seating for spectators.

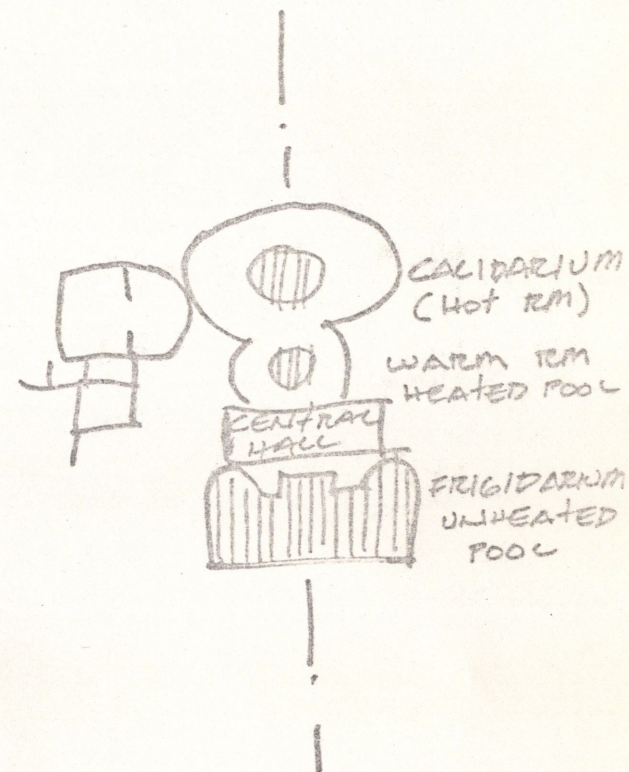
3.) Outer Ring of Apartments

These were used by slaves who worked in the complex. Colonnades served to protect these buildings from the sun.

A large reservoir bed by a special aquaduct supplied all water needed for the baths, apartments, fountains and miscellaneous purposes.

The platform the building sat on was usually about 20 feet high. The building had its vistas from its central hall to surrounding rooms using columns for screening.

The frigidarium, which was the large swimming pool in the building, was open to the sun and used in the hot summer months. The interior, not exterior, of the buildings were decorated. They used mosaics in geometric patterns or figures of athletes. Lower walls were colored marble and modeled stucco. Windows were colored glass mosaics and many sculptures were used.



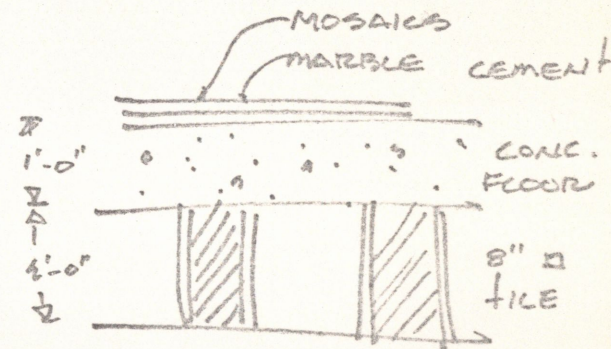
Additional interest was given to interiors by the perpetual streams of running water into pools. Exterior was stucco except at the main entrance where more decoration was added. The entrance was through the surrounding buildings on the Northeast side.

Furnaces stoked and lighted from the interior courts were at a lower level than the floor.

Smoke and heated air passed under the floor to flues located in the walls on the far side of the building.

Flues were made of socket jointed clay pipes 12' in diameter. For rooms requiring exceptional heat, the walls were completely lined with these flues. In

smaller rooms tile tiers were sometimes done away with and the whole concrete floor rested on ledges of the walls permitting the hot gases to go under the entire floor.



Facts prove that the whole design was conceived before construction began. Columns, usually marble, were 38' high and 5'4" in diameter in some buildings. The larger columns supported the vaults and floor structure of balconies overlooking the central hall or forming screens between central halls or rooms. Then all structural halls and courts were all paved with marble mosaics in diverse patterns, with figures of gladiators, athletes, tritons, and geometric designs and borders. The baths were all lined with white marble. The walls were lined with marble of various colors up to a certain height then white marble was used up to the springing of the vault. The upper portion of the vaults were decorated in stucco with arabesque ornamentation. The walls enclosing the frigidarium were decorated with tier above tier of niches, flanked by columns carrying entablatures and pediments, circular as well as triangular.

Interior decoration in marble and mosaics were most elaborate. There was no attached value to the exterior of the buildings. Exterior walls were covered with fine stucco which was quite durable and resembled marble with its imitation joints of stone to give it a certain monumental character. The same was probably adopted to protect and decorate the concrete walls faced with brick which from the time of Augustus became the favorite method of construction in Rome. The side used as an entrance was covered with marble to contrast with the richness of the granite interior columns.

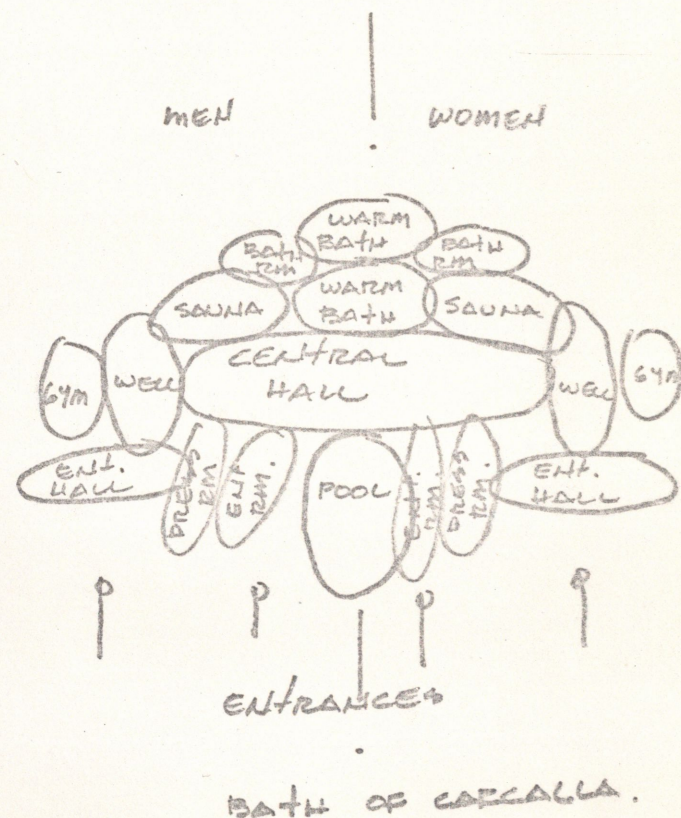
The perimeter apartments, exercise yard and garden setting were used to counter balance the mass of the main building.

The Empire promoted leisure, besides well being.

Everyday life was divided between business and recreation. By tradition the public leisure had come to center itself around the ritual of the bath. The bath building grew into complexes which housed sports grounds, gardens, walls, lounges, lecture halls, libraries, each nobly framed as became its use, all united in a pervasive and compelling symmetry of design. The shape and size of spaces was varied in accord with the use of function of the space. The very nature of the design implied perfect bilateral symmetry, making the most compact and economical use of heated space for the benefit of large numbers.

BATHS OF CARCALLA ROME

It's garden setting and two matching apsidal wings, which contained lecture halls and lounges, counter-balanced the main building with complimentary masses. At the back the stadium flanked by libraries cupped the vista



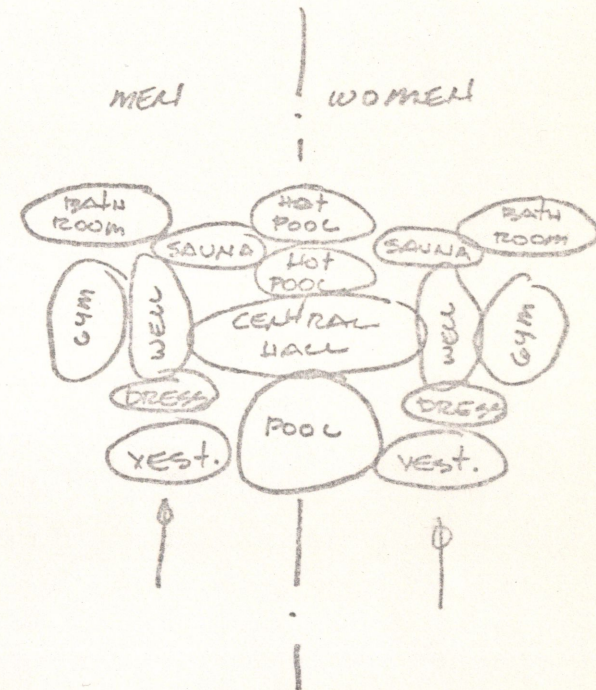
from the tier of hot rooms. The hot bathing room was a vast windowed rotunda, a tranquil eddy of light which centered the movement it brought to a momentary hall: whereas the cold bathing hall with arrest, prompted dispersal by flights of visions down the long axial halls. The whole was fashioned to marshal every man in a common and exhilarating rite or self-purification. The expertly, compact spatial composition with its running counterpoint of cubical and spherical dome and cross of barrel vault, gave compelling unity and urgency to the lesson.

THERMAE OF DIOLLETIAN
ROME

This complex could handle over 3,000 bathers. It resembled the baths of Caracalla in their general distribution. The great central hall 200 feet x 80 feet and 20 feet high was cross vaulted in concrete and supported by granite columns 50 feet high and 5 feet in diameter.

The unbounded license of the public baths, which were resorted to for all sorts of dissipation, brought them under the ban of the early Christians, who held that bathing might be practiced for cleanliness but not for pleasure. Then in the Fifth Century the thermae fell into further disuse and decay owing to the destruction of the aquaducts by the Huns and also to the decrease of the population. Later they served as quarries for Medieval and Renaissance builders.

Affluence and well-being had generated the practice of leisurely care of the body and had given it a pattern of exercise and bathing which took the form which we know as the Turkish Bath. As a fixed public institution it gave rise to an order of spaces answering not only to ritual programs of dressing and undressing, a supply of hot water and cold, variably controlled temperature and separation of sexes. Apart from the exercise grounds and the requisite installations of



Thermae of Diocletian
Rome

radiant heating through floors and walls, furnaces, boilers, plumbing, these earliest solutions of Roman architects were based on the use of barrel vaults in series. Spaces of sizes sorted with their functions were ranked across the line of the fixed sequences of bathing from cool to hot and back again. Their axes at right angles to the progressive movement were established by apses, pools, basins, and windows. Staggered doorways and varied surfaces made each a distinct moment in a chain of separate experiences. Each took place in a cylindrical capsule. The vaults, springing at radius heights and hovering over the participant, had the effect of closing the circle of space about him, restrained only by the flatness of the floor and the verticality of the walls.

After considering what the Roman's had done and how I may apply it to a modern society, I started in on the design of a bath facility. I had chosen to work

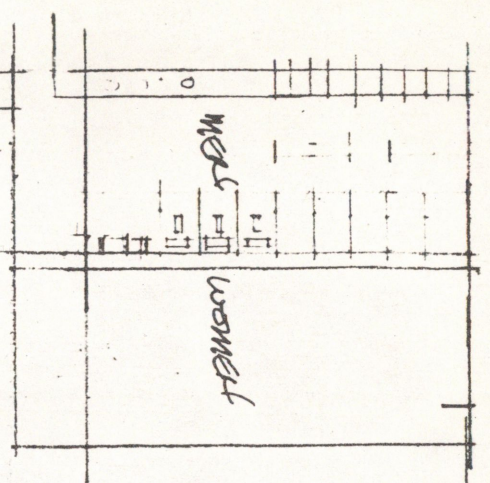
with 5 pools ranging from cold to hot. Starting in the coldest one would be set at swimming pool temperature, working up to the hottest and then back to the cold pool. I feel the order of use would be quite fixed and will consider them in this way. The other rooms which will be connected to the facility will be a storage room, game room, meeting room, sun area, mech room, exercise area, two offices, a desk located at the entry, and a mens and womens locker room and a sauna.

At this time I went to Norris and used the hot pool, which was quite relaxing in appearance and in use. This concept was one of a very commercial use for the water, not one of a religious ceremony which it perhaps has to be.

PHASE I

In this design I had chosen to place the four pools, which were small sitting pools, in a cluster for ease of getting out of one and into another. These were to be located outside as to be a more natural experience. One pool of swimming size was placed inside for year-round convenience. Plant life in this Phase was considered to be used as a decorative feature placed in planters. The total building had a very industrial look and use by the public.

At this time I went to Norris and used the hot pool, which was quite relaxing in appearance and in use. This concept was one of a very commercial use for the water, not one of a religious ceremony which it perhaps has to be.



MEN
WOMEN

BANK ROOM

A

HALL

CORRIDOR

LOBBY

COMMUNITY ROOM

OFFICE

REST ROOM

WOMEN'S LOCKER

MEN'S LOCKER

W.C.

MEN'S LOCKERS

WATER POOL

POOL

PHASE I

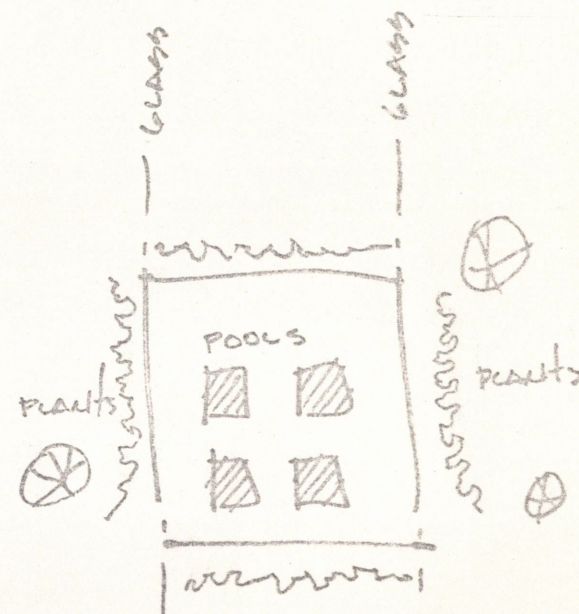
SAUNA

OUTDOOR POOLS

PA

PHASE II

I now reconsidered what a hot pool was and how it should be used. I felt that it had to be a unique experience one of relaxation. The plans I had in Phase I were of a token basis, and now I would like to consider them as an environment for my building. In its early development I kept the pools to the outside of the building but surrounding them with plants which were behind glass. This did not seem to be an honest approach to the problem. The pools either had to be diverse of the building or housed in the plant environment which would have to be protected from the natural Montana climate. I chose to create a totally new environment inside my building in which the pools could happen. I now had to discover a way in which both people and plants could be subjected to each other without destruction of the plants. The plants seemed to be the answer to many of the buildings problems. They could give me functional



separation, sound dampening, a theraputic smell not to be associated with a pool-locker room complex, oasis image, educational value to public and a aesthetic form in which to bath. My building was now a glass house in which bathing took place.

This meant that my building, to a great extent, was controlled by those natural characteristics which would support a glass house. Some of the things to be considered were:

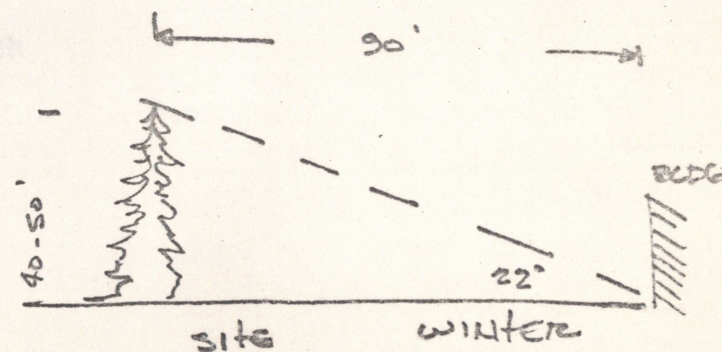
I. Site

A. Climatic Factors

- 1.) Natural Light - direct or difused.
- 2.) Length of light in winter and plants chosen for building.
- 3.) Air Quality (clean or not).
- 4.) Fog - will it block sunlight?

B. Shelter

- 1.) Are winds strong so heat loss is going to be high?
- 2.) Use of windbreaks:
 - a.) Should be far enough away as not to block sun or cast shadows.
 - b.) Medium density screen about 50% permeability is effective to a distance of 10 times their height.



C. Orientation of Building

D. Labor

1.) Two general types

- a.) Highly skilled
- b.) Semi-skilled (weed pickers)

E. Water supply

1.) Should have an adequate supply from a deep well.

- a.) It may be necessary to have a large storage tank for watering purposes.

II. Ventilation

A. A glass house requires ventilation for three reasons:

- 1.) To supply carbon dioxide for plants.
- 2.) To reduce temperature from solar gain.
- 3.) To limit rise in humidity.

There never has to be greater than 40 changes of air an hour. In the summer air is taken in at the bottom of the building and hot air is exhausted through the top.

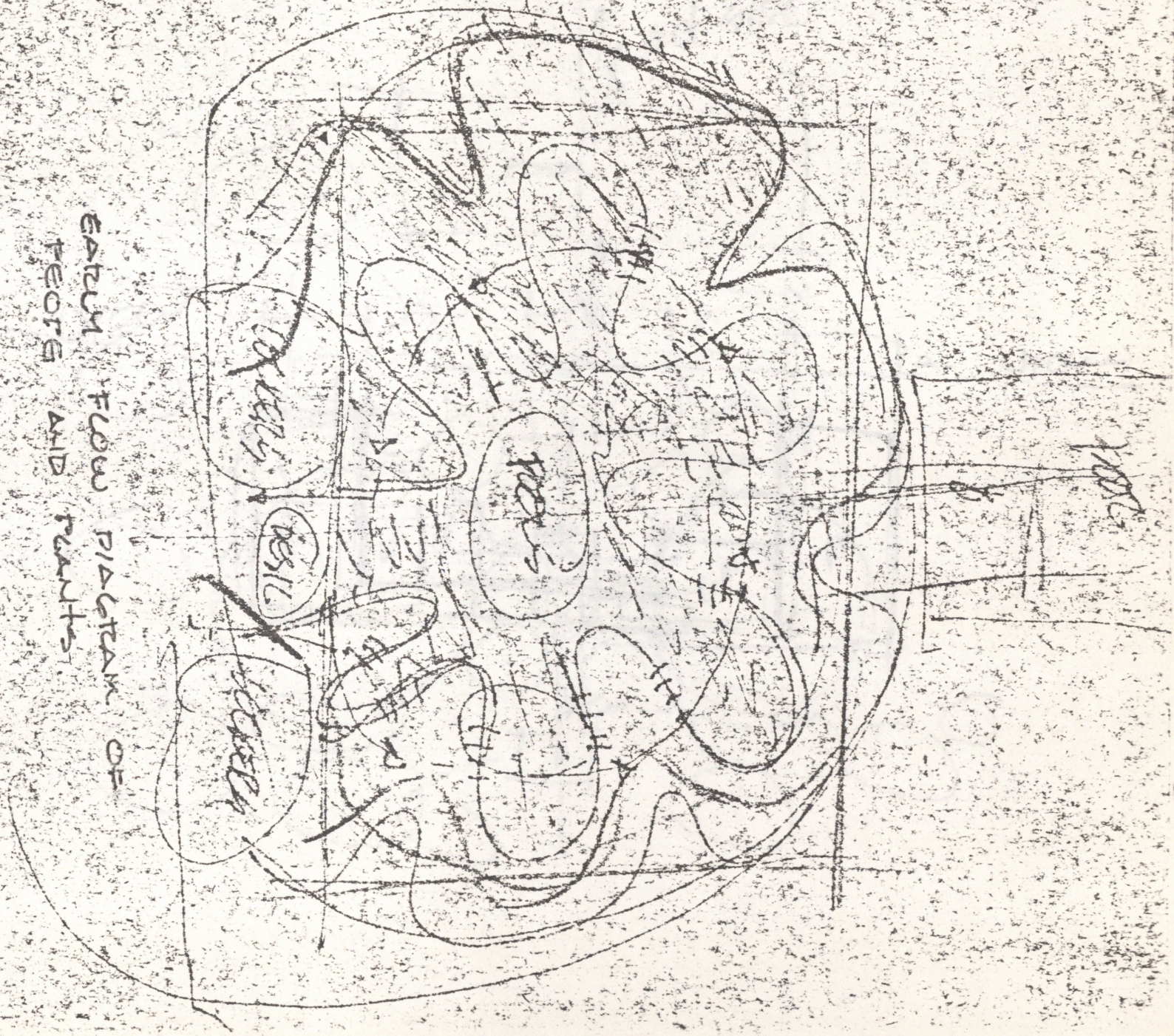
The ideal site should have good light, equable climate and reasonable shelter. It should be level and soil should be well drained loam, free of serious

pests and diseases. There should be an adequate supply of clean water and electricity.

After looking at the necessary requirements to make a glass house work on my site, I feel the construction of an artifical plant environment would work well.

The building was laid out with rooms on the perimeter looking into the large open area where the bathing among plants will be. In this phase, the hot sitting pools were sunken into the ground with plants growing around them. This provided privacy for the bather if people were to just walk around and look at the plants. The large swimming pool was placed at the south end of the building where it could receive sun throughout the day. It was made to pass outside the building so that a swimmer could swim inside or out.

EARLY FLOW PICTURE OF FEORS AND PLANTS



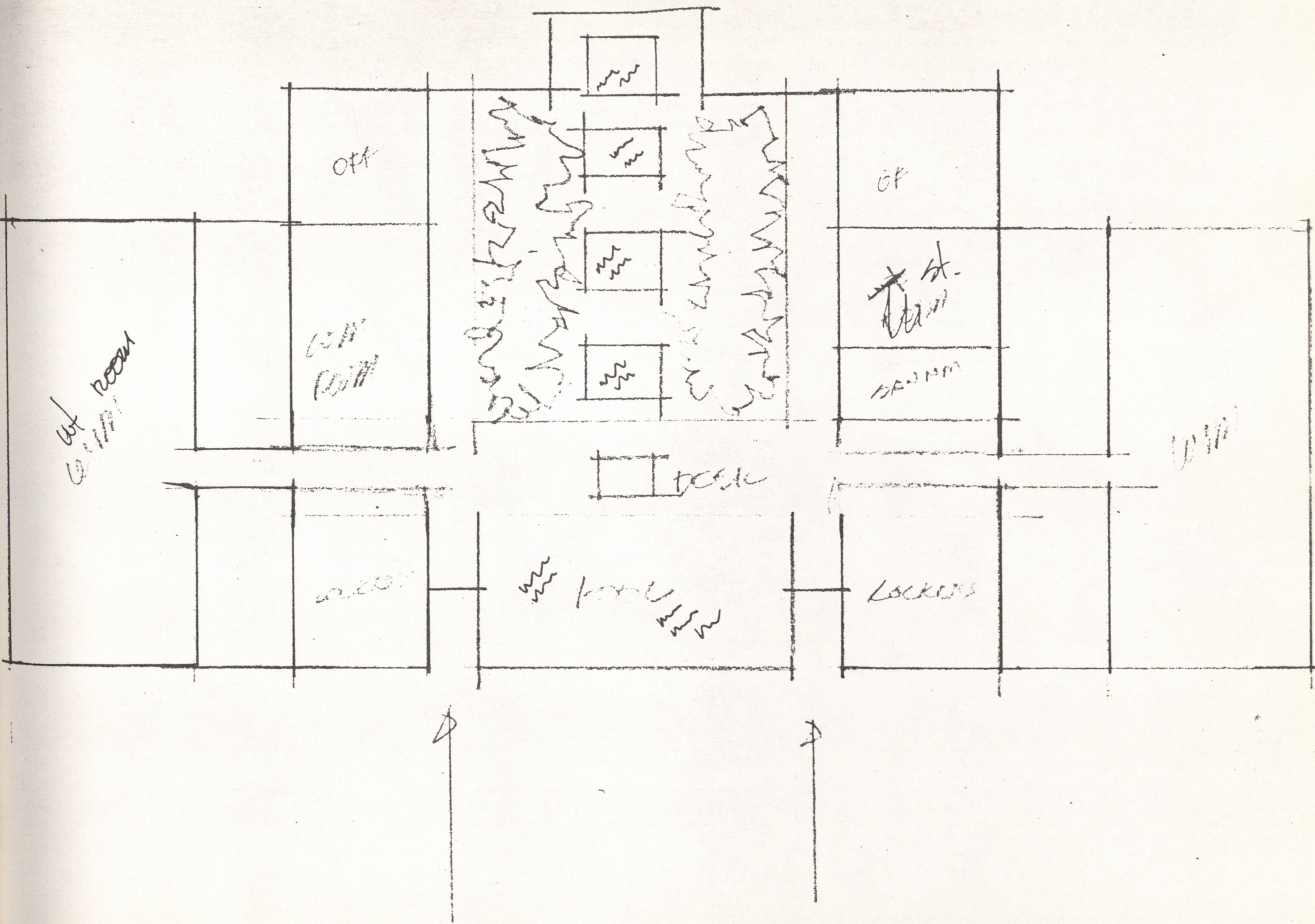
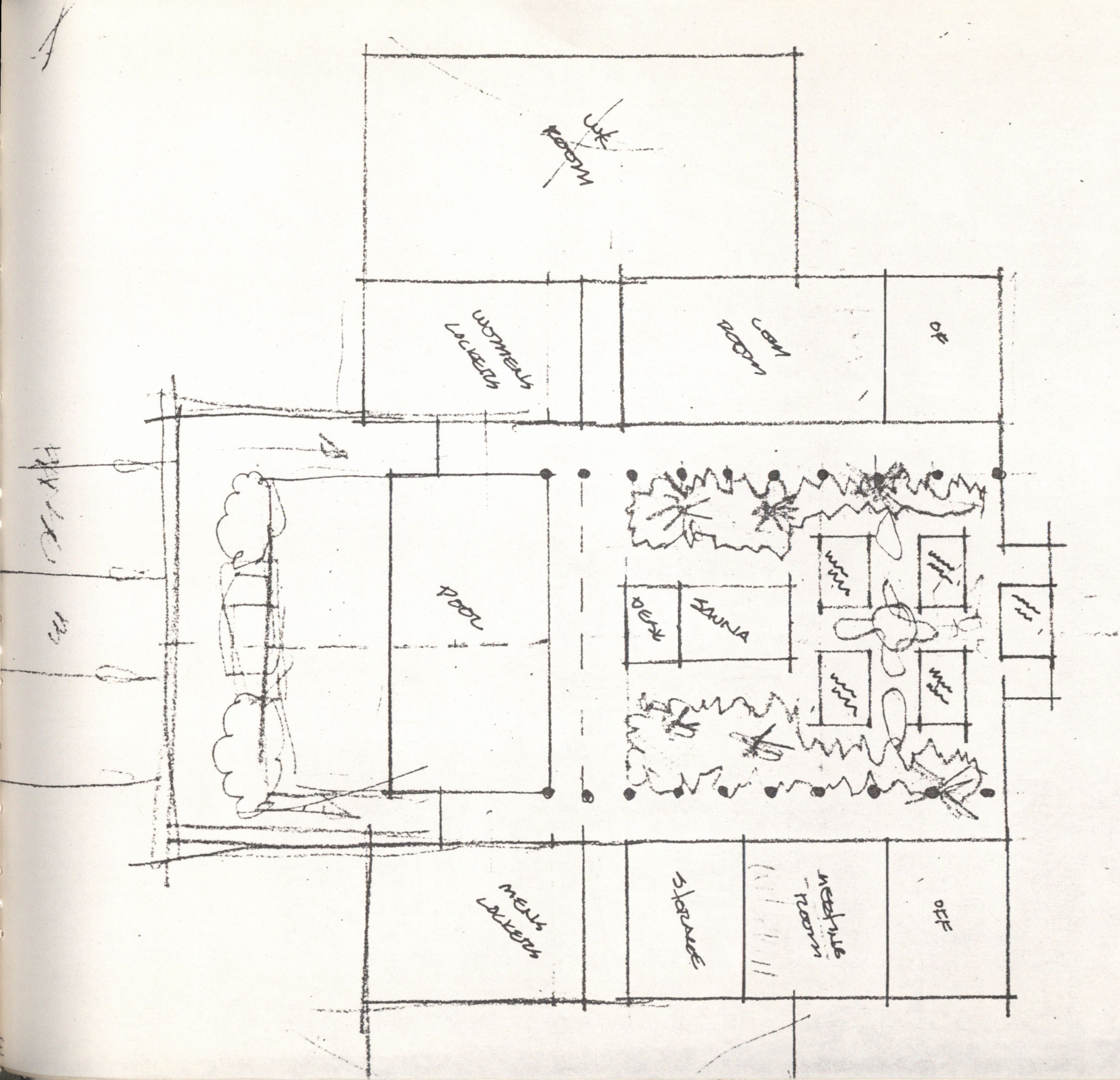


PLATE 2



PHASE III

Because of the need for separation and isolation of

interior functions

1.) Berms as physical separators of

and people from plants

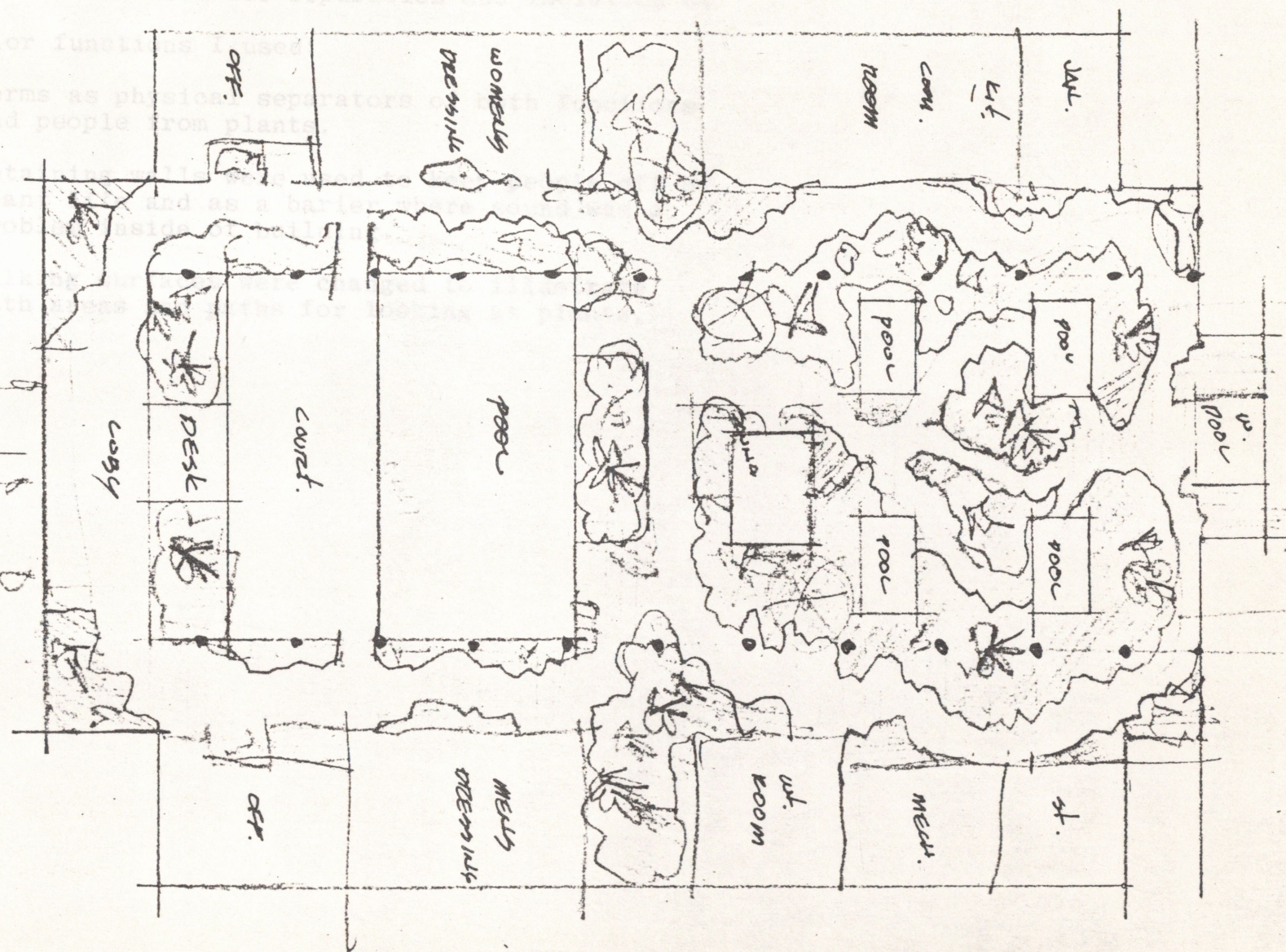
2.) Retaining walls

plan and as a barrier

prob inside

4.) Walkways

bathrooms

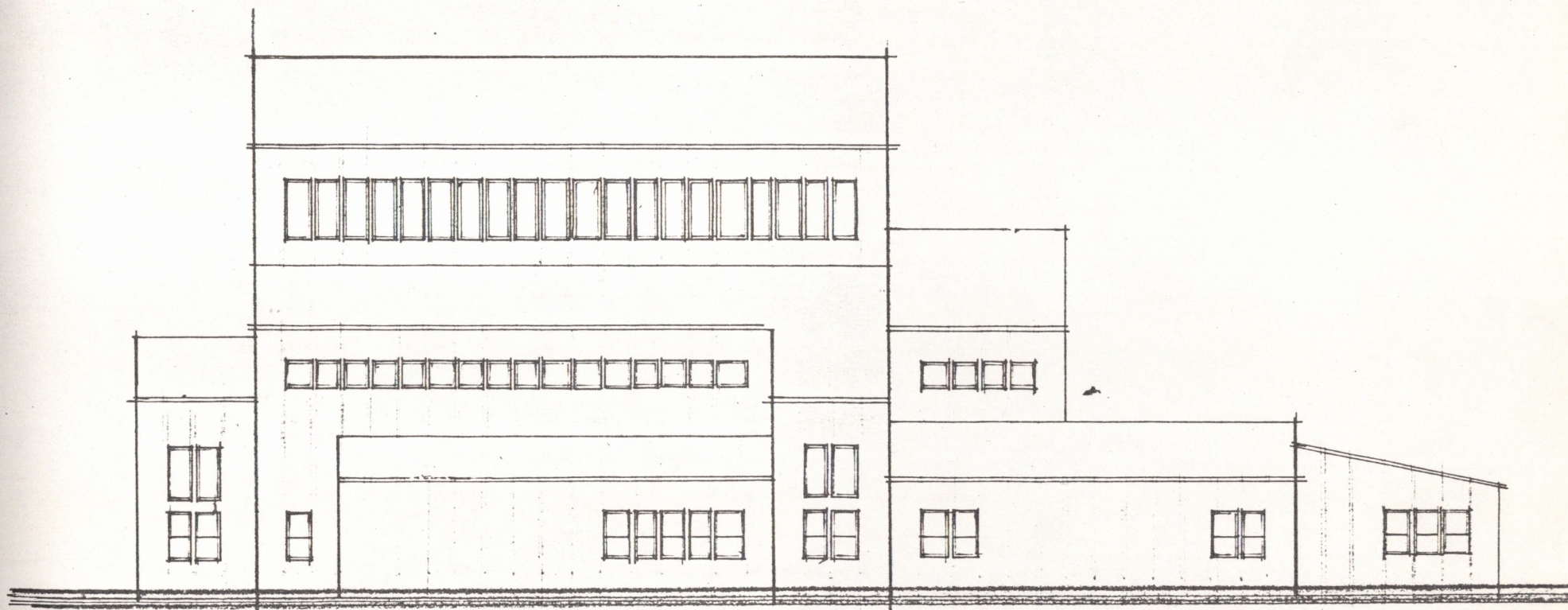


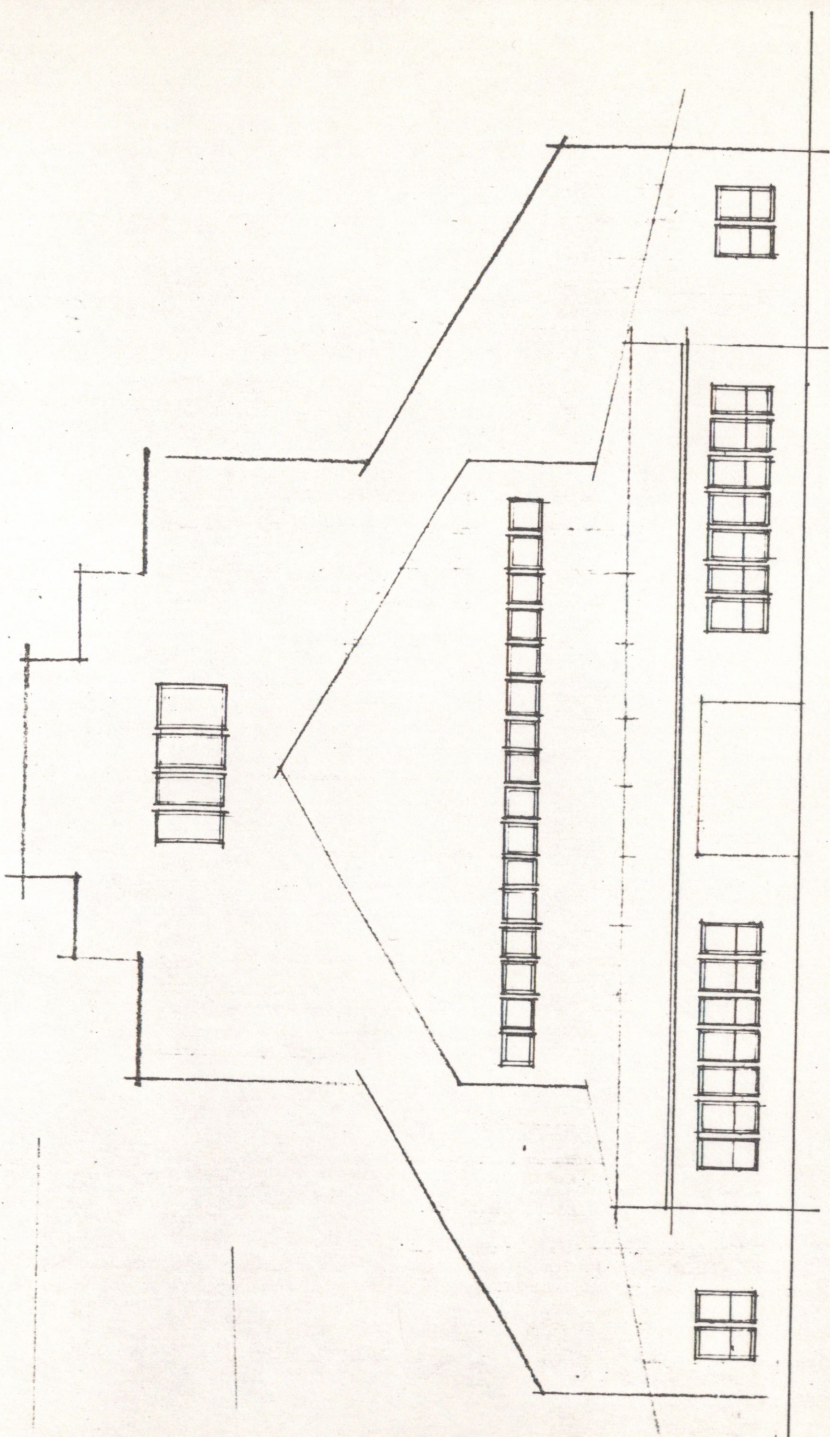
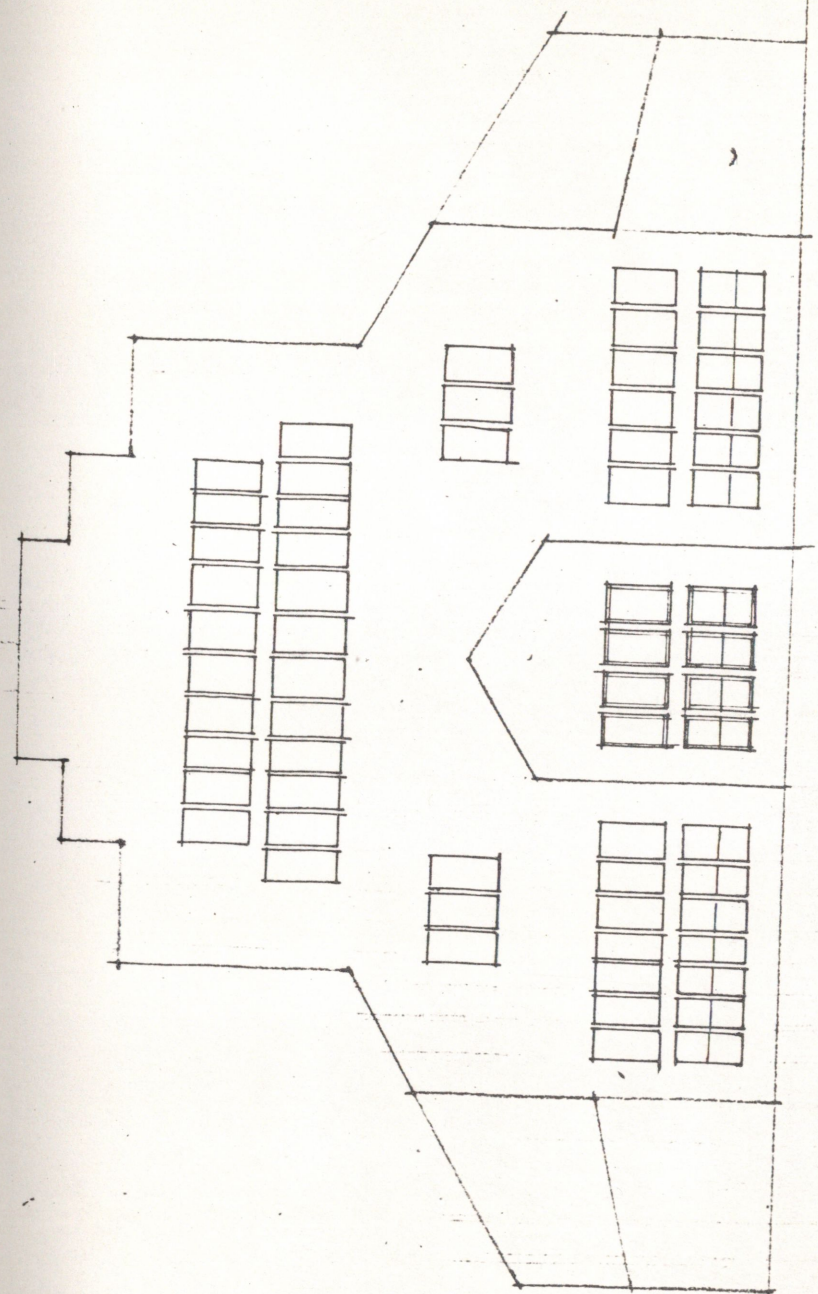
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PHASE III

Because of the need for separation and isolation of interior functions I used:

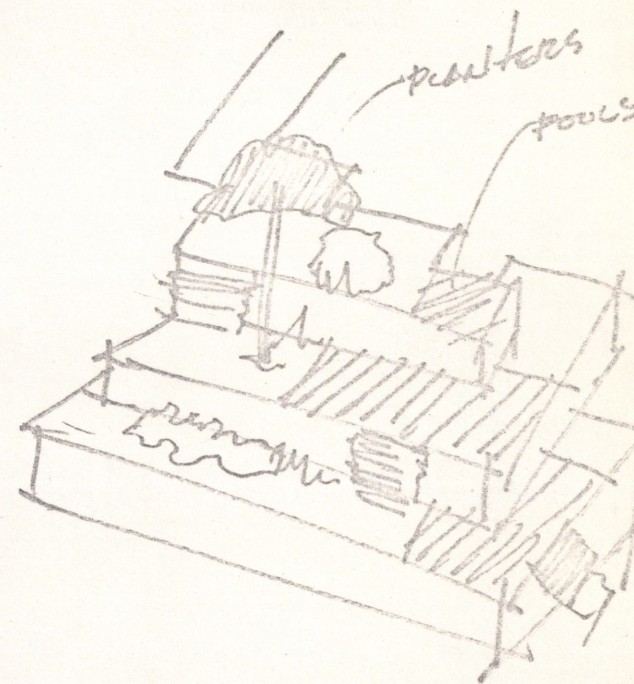
- 1.) Berms as physical separators of both functions and people from plants.
- 2.) Retaining walls were used to keep people off of plant life and as a barrier where sound was a problem inside of building.
- 4.) Walking surfaces were changed to illustrate bath areas and paths for looking at plants.





PHASE IV

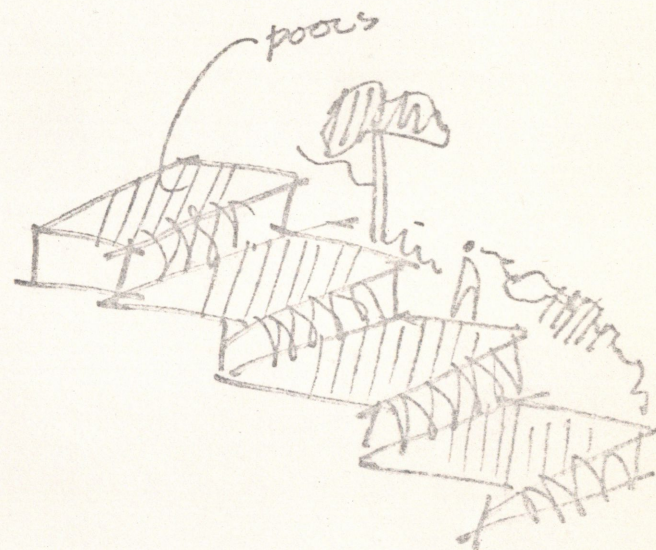
I now reconsidered the four pools which were located in the center of this new plant environment. Because of the sound problem I decided to put the pools on different levels so that falling water could be used as a background noise. It turned out to be made up of boxes which were stacked up; some being large planters and others sitting pools. People could then climb this large mountain as they moved from the cooler pools to the hottest one located at the top. After consideration, this structure seemed a bit too romantic, complex and mechanized to produce a relaxing bath atmosphere.



PHASE V

The building remained as it was in Phase III with more experimentation with the pools located in the center of the building. I was still working with the idea of making them into a water fall but this time they took on a fountain approach. The pools were again stepped but this time in a simpler form. This idea again was rejected as I had done in Phase IV for many of the same reasons.

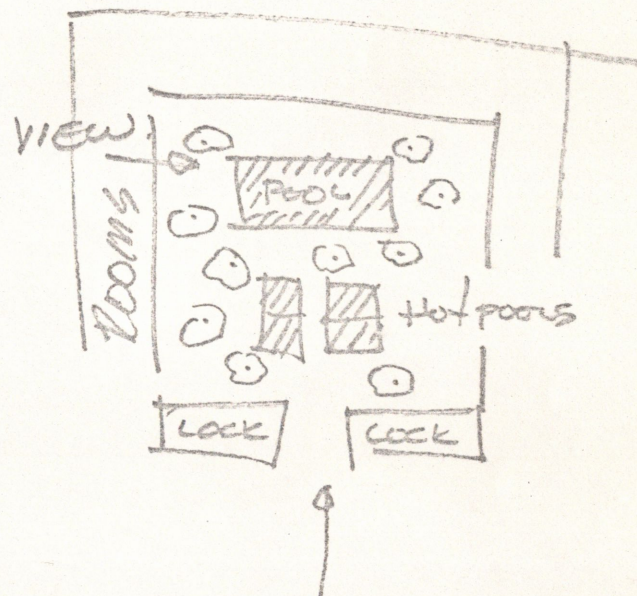
At this point I went back over my thinking about what a hot sitting pool should be. In nature a hot pool would form in a low spot where hot water from the spring had collected. With water flowing in one side and out the other keeping the pool at a constant temperature. These holes were then boarded up on the bottom and sides to make the bath a cleaner experience with boards added above ground to keep people out. This atmosphere is very natural and relaxing to sit in. In

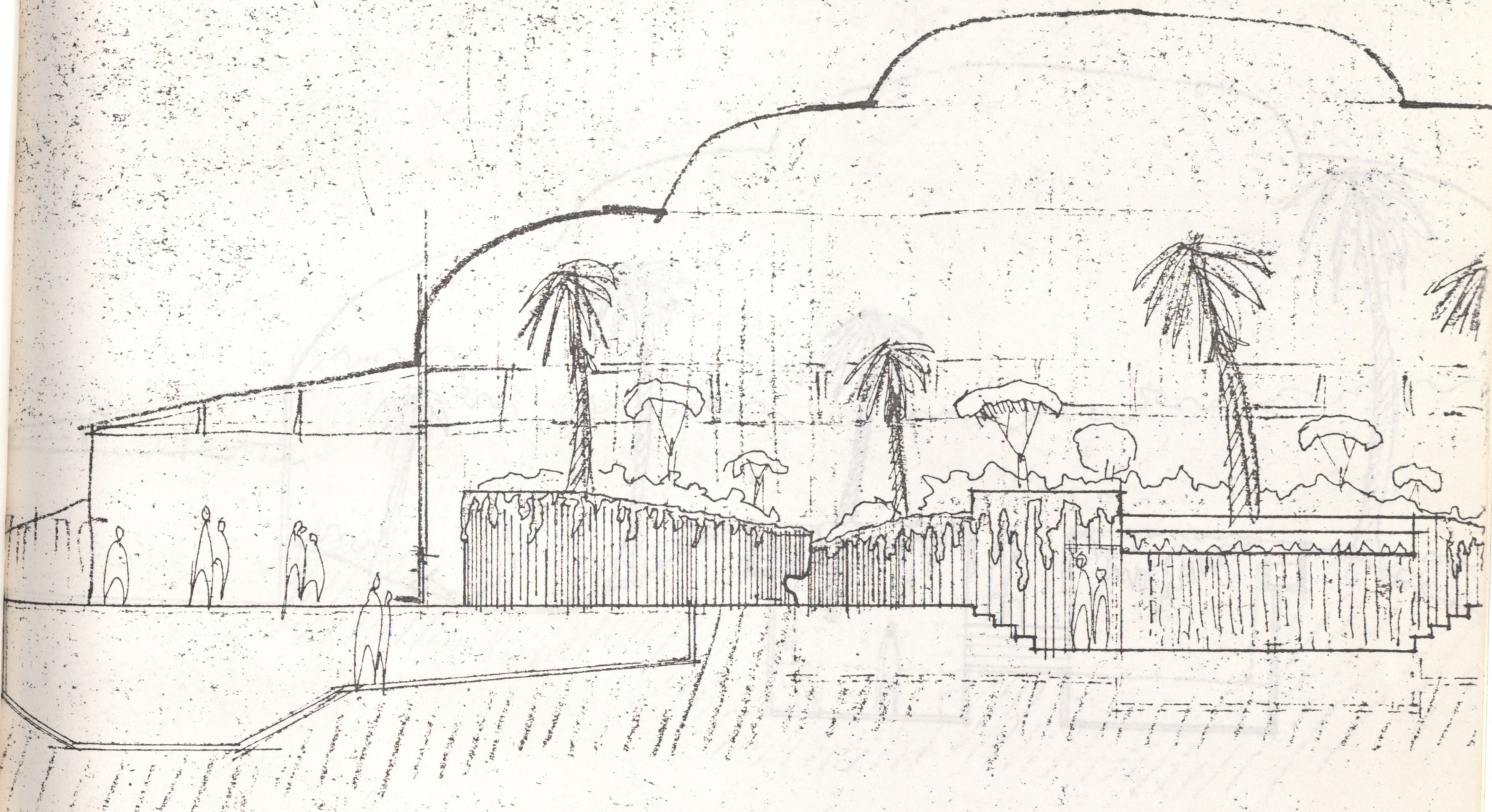


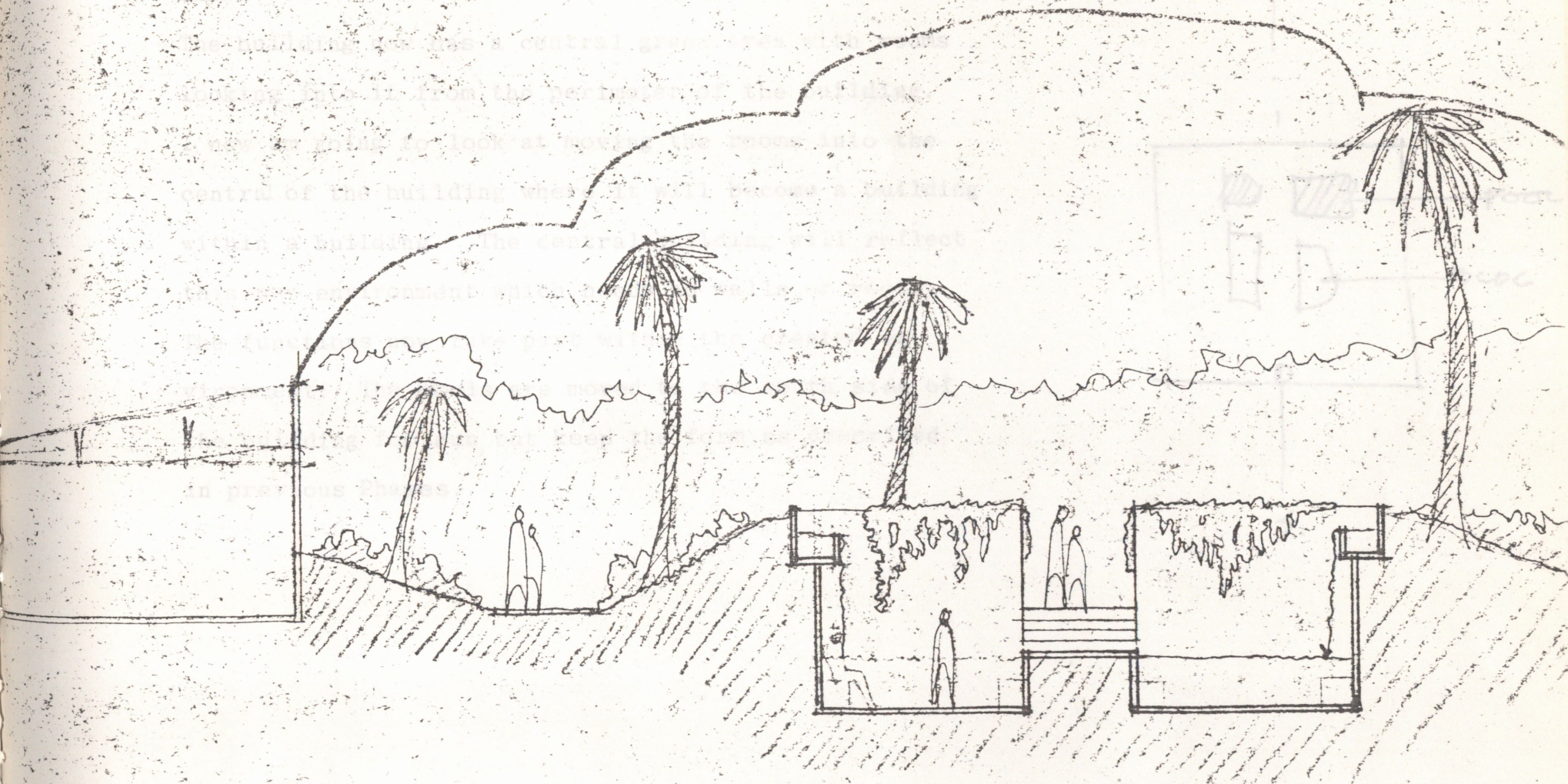
my last Phases of design I have gone through gymnastics which over-used the water. I now realize that my initial concept in Phase II was a correct one where water use was kept simple and straight forward. Water supply has to be done on an individual basis keeping each at its desired temperature. This means an addition of hot and a run-off of water already in the pool. This can be incorporated into the waterfall system I will put on each pool. The falling water will add background noise as well as an aesthetic feature to the bathing process.

PHASE VI

In this Phase I looked at things such as depth of pools; this is both water depth, height of falling water and distance they are sunken into the ground. I also examined the large swimming pool which went from inside the building to outside and decided to bring it inside the building and enclose it into its own glass room for aquistical reasons. The locker rooms were also redone, in that before they were entered from the lobby and had to be existed into the lobby before going to the pools. Now they are entered from the lobby, but when going to the pools you go out through the shower room which work much better functionally. This is the way the building now stands.





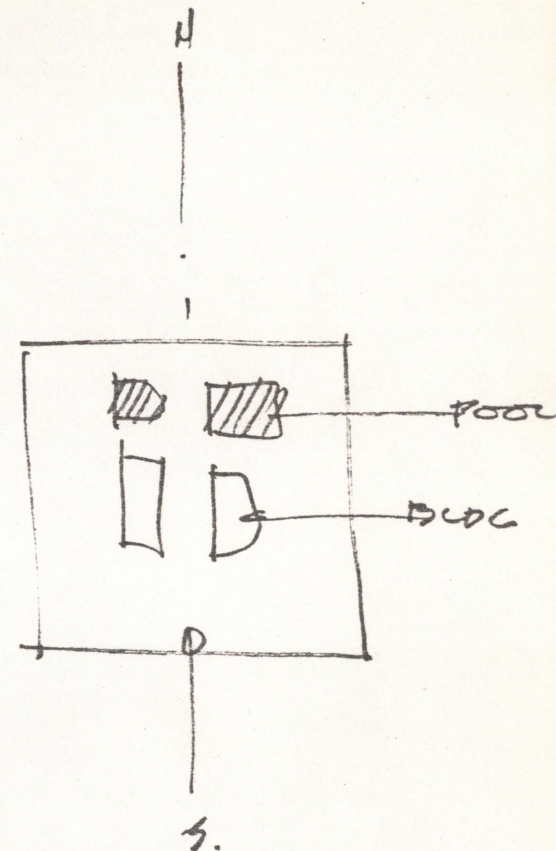


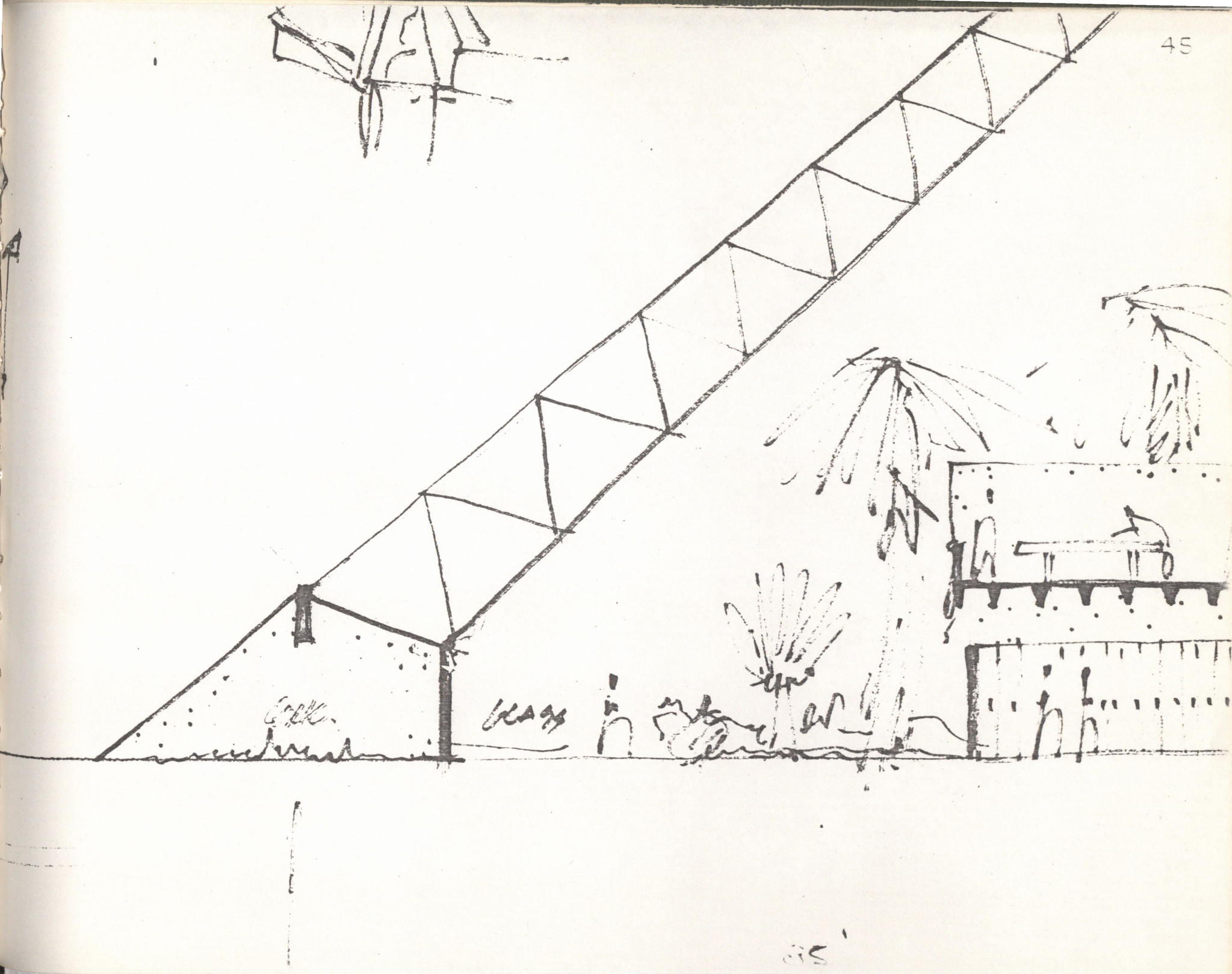
PHASE VII

The building now has a central green area with rooms looking into it from the perimeter of the building.

I now am going to look at moving the rooms into the central of the building where it will become a building within a building. The central building will reflect this new environment which needs no walls or roofs.

The functions now take part within the created environment. The pools are moved to the south side of the building for sun, but keep the form as described in previous Phases.

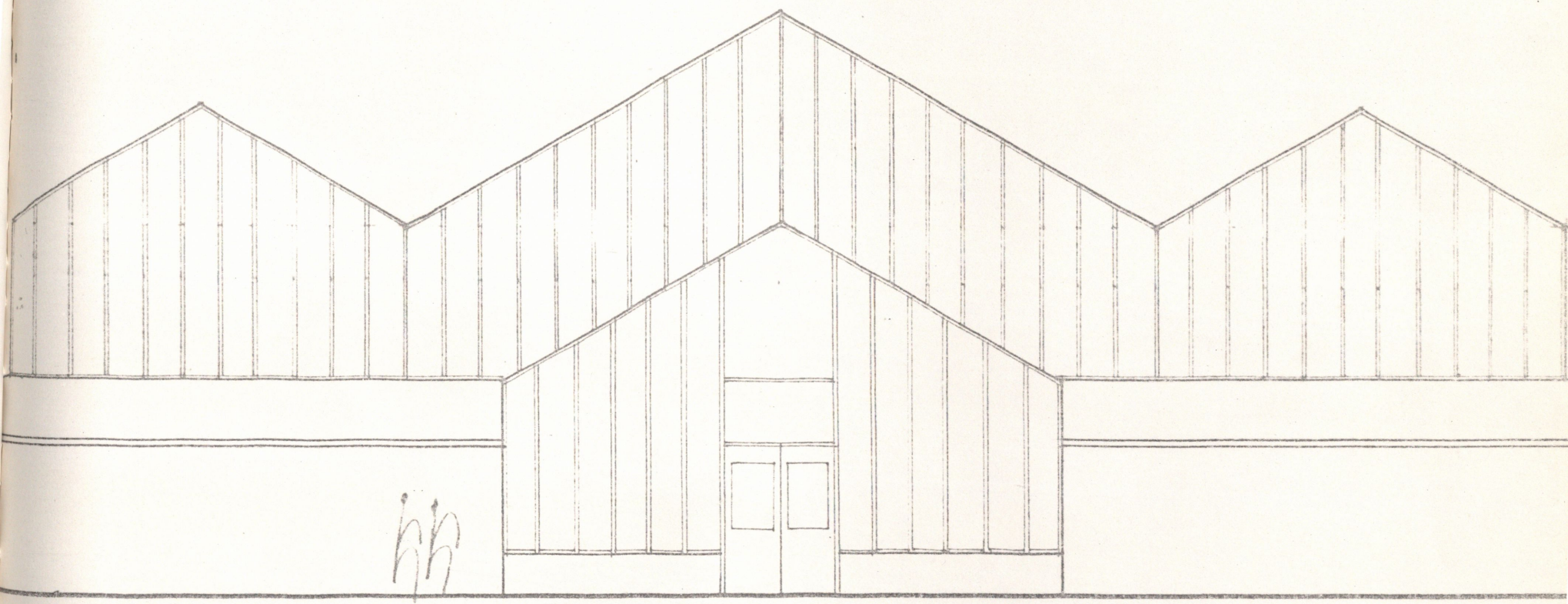




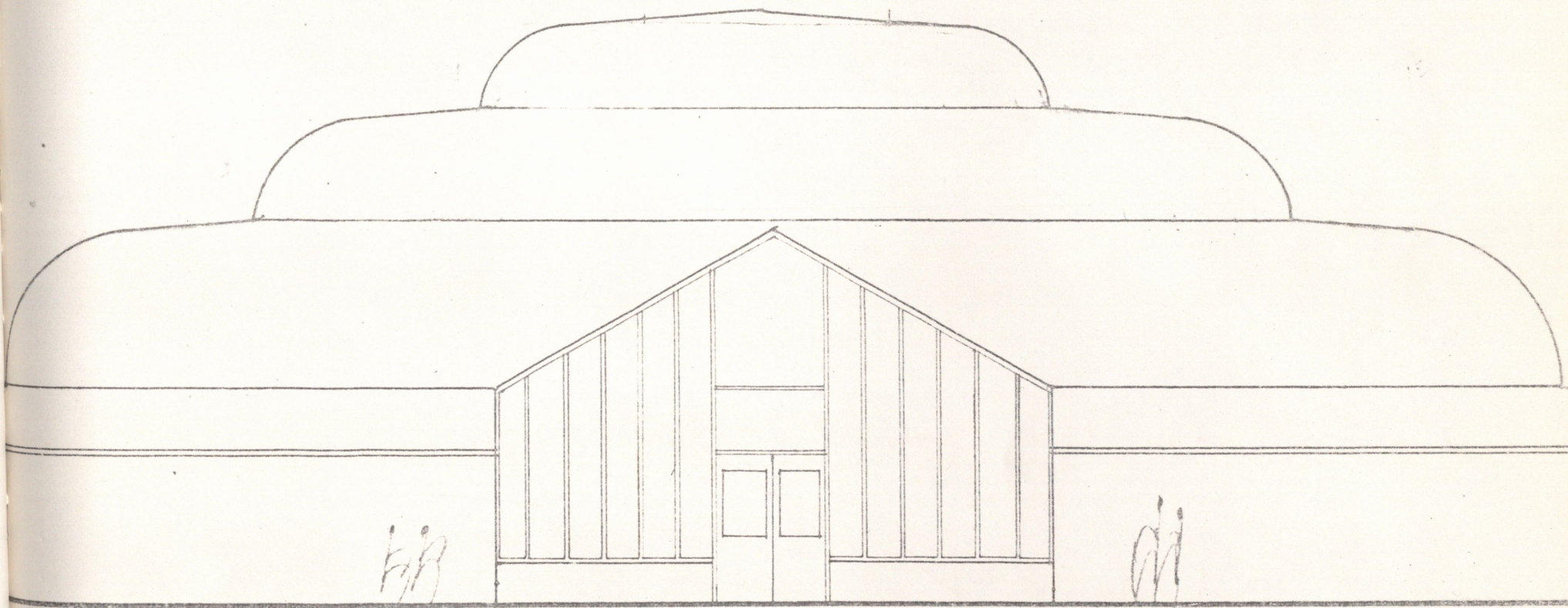
EXTERIOR SHELL OF BUILDING

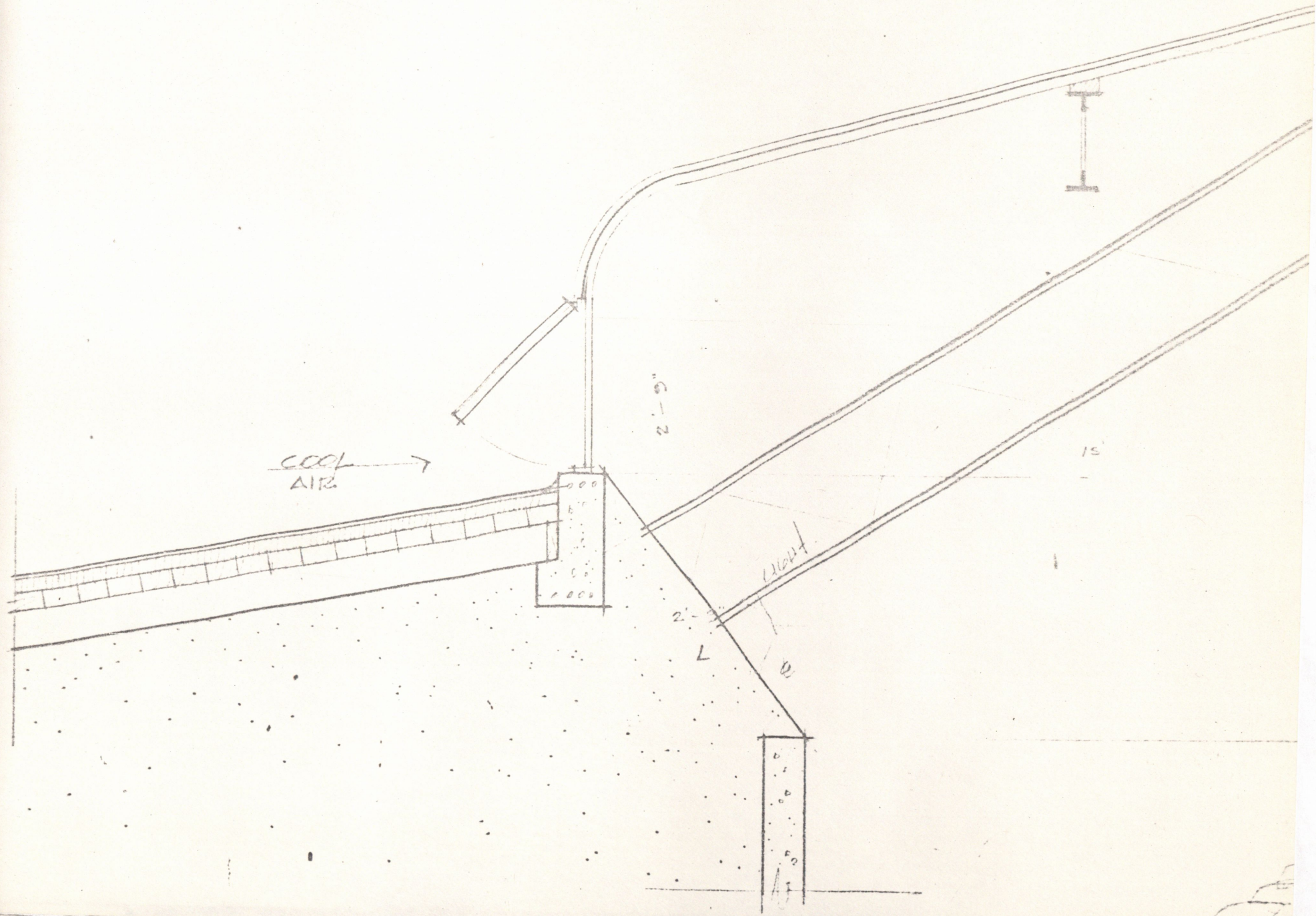
Up to this point I have concerned myself with only floor plans leaving the shell of the building to now be considered. My first attempts were to make the building with grain elevator scoped roofs and industrial size windows, placing windows and massing the building much like a Romanesque Church. This was not the direction I felt the building should go after further consideration. I, then, started looking at a more honest way to house the interior functions. Thus the building took on the look of a large green house which it truly was. But this still was not the answer because this building was not just a greenhouse, it was a special building. The roof then took on this form which is a combination of barrel vaults and arches which captured a ritual looking building which houses its special function.

#1



NORTH





5

I then considered the barrel roof structure and found that it was not self supportive and interior columns would have to be used. It also did not allow a view into the building as you were approaching the building. For these reasons, I then decided to try a pyramidal form of roof structure. This seemed to be the answer. It was self supporting for the 200 feet span, being seven feet in depth and taking on a space frame type of structure. It was a transparent structure expressing the skin of the building much better. The skin would be made of panels which are two sheets of fiberglass laminated to 2" of translucent insulation. These have a heat transmission of .24 as compared to glass at 1.0 as a single pane.

SITE

During the design process the building was set on the site in a north-south direction dictated by the greenhouse that it was to be. Entry was from the north,

leaving the south end free for glass by which a large part of the interior sunlight will come. Parking was placed off the north end of the building for pedestrian access to the north wall of the building. After looking at the site and what the building was, I decided to turn the building 45° so that it did not line up with the formal N-S orientation of Bozeman. The buildings then took on its own meaning not associating itself with other building which it is so different from. The parking, too, was changed so that the cars parked and faced the building as almost to worship it. I later decided to pull them away and have them park still facing the building but now partially hidden in a row of trees which encompass the building, playing their scale with that of the buildings. Because of the nature of the building the trees have to be kept at a distance so the sun can shine on the interior plants. The trees thus define a courtyard in which the building sits.

BUILDING EXTERIOR

The bottom part of the building is going to be poured in place concrete with the upper roof structure of glass and aluminum. The building is going to sit on the site with no landscaping around it or berming up to it. In this way it will express its distinction with its natural surroundings.

INTERIOR

The interior concrete walls will be white stucco with pool areas tiled in white. Walks from locker rooms to pools are tile, other walks are slate.

CONCLUSION

The final building is an artifical environment in which the building functions and bathing take place. It is a building expressing itself and relating to the environment created by the membrane which is placed over it.

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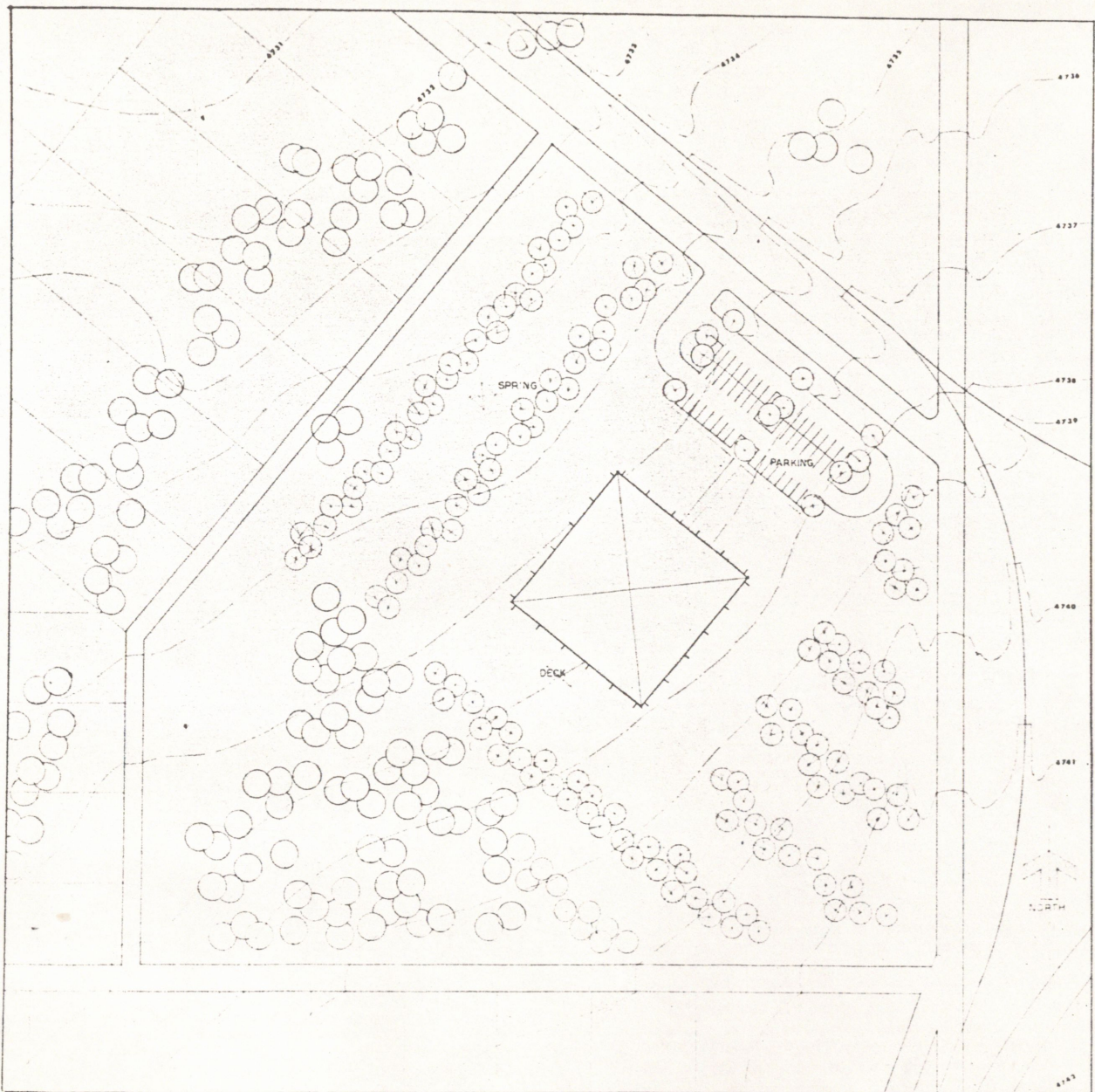
Architectural Record, (August 1967), 112-113

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HOT SPRINGS BATHING FACILITY

BOZEMAN HOT SPRINGS

BY STEPHEN B. SEWALL

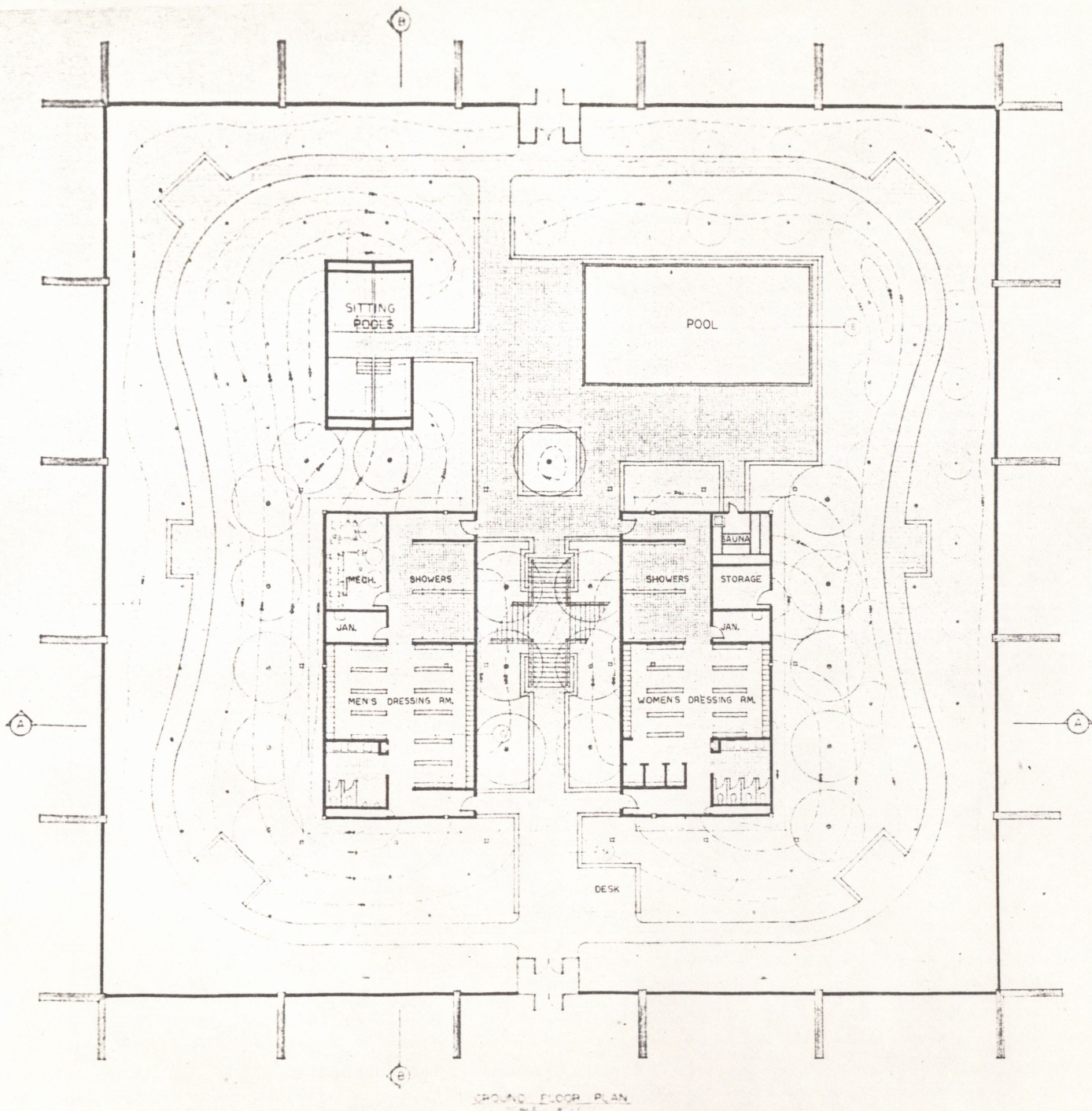


SITE PLAN
SCALE: 1" = 50'

HOT SPRINGS BATHING FACILITY

BOZEMAN HOT SPRINGS

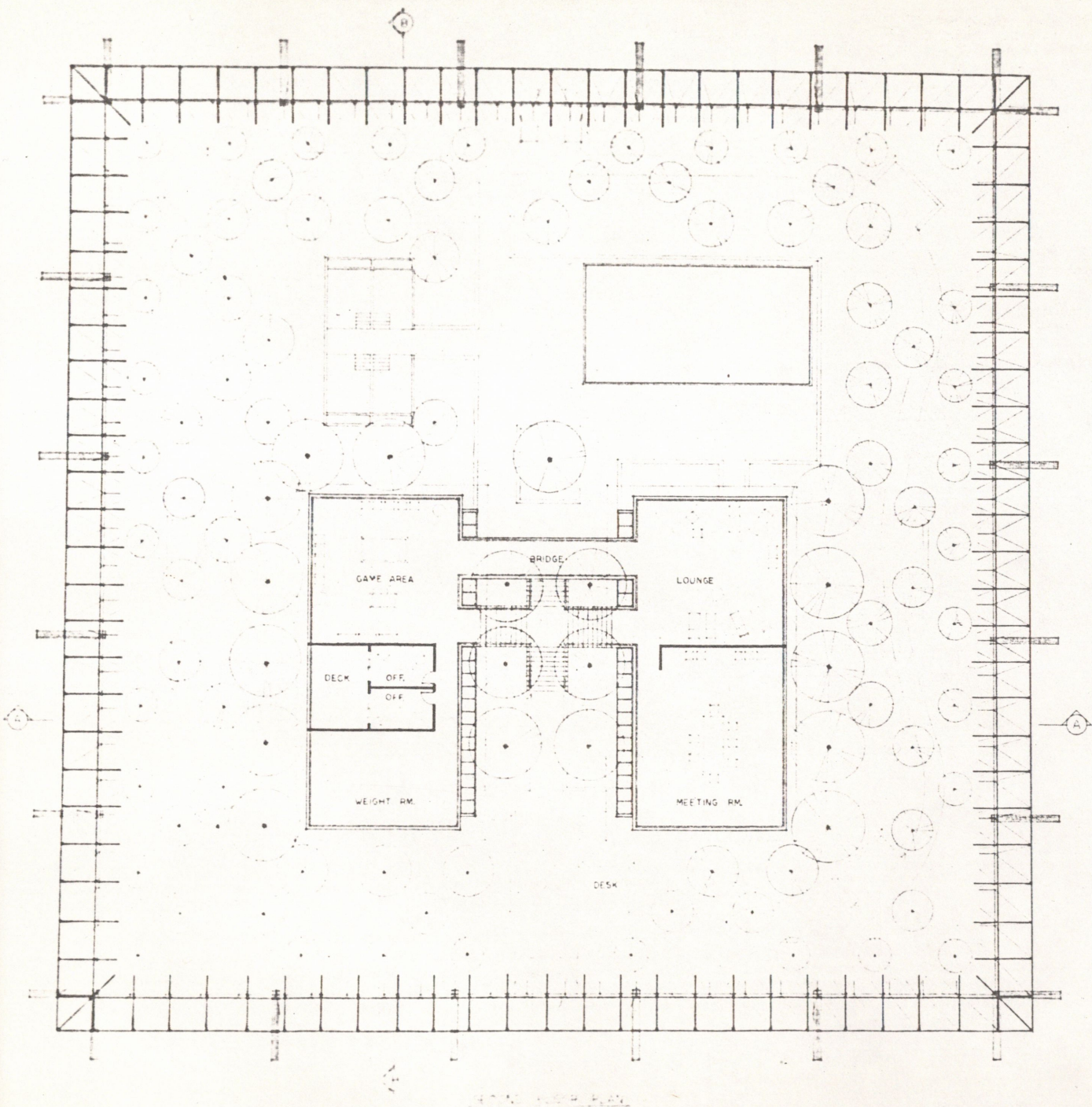
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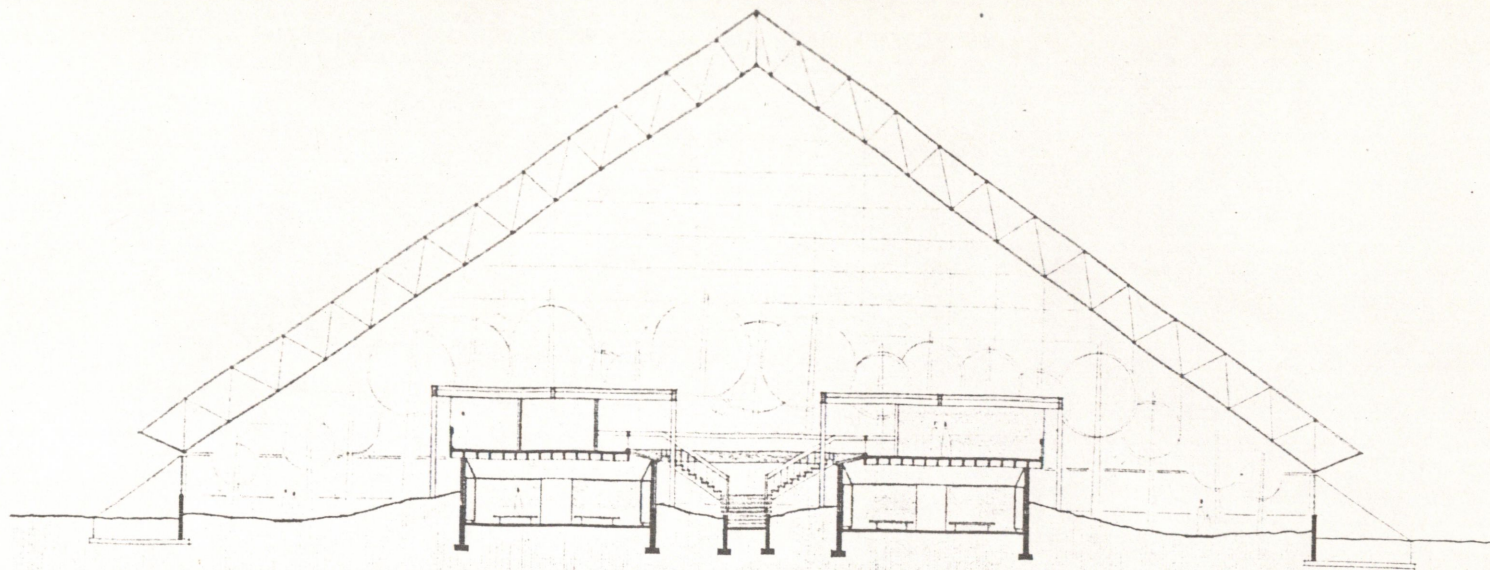
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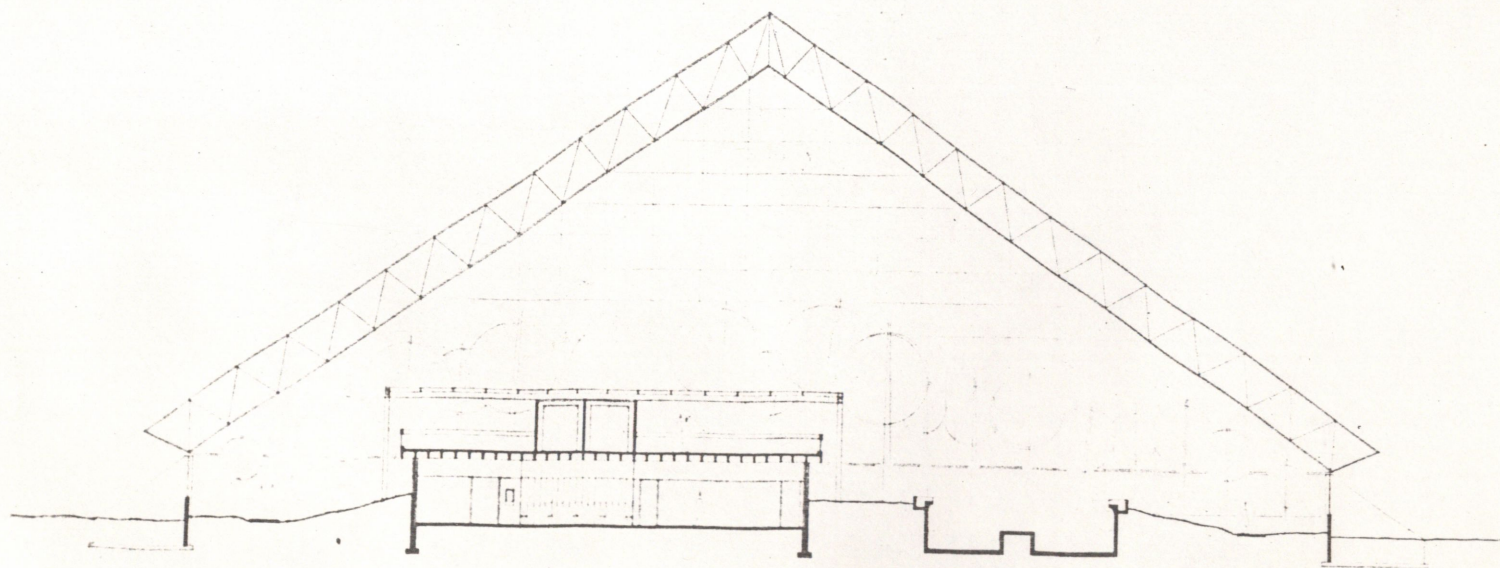
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SECTION A
SCALE 1/8" = 1'-0"

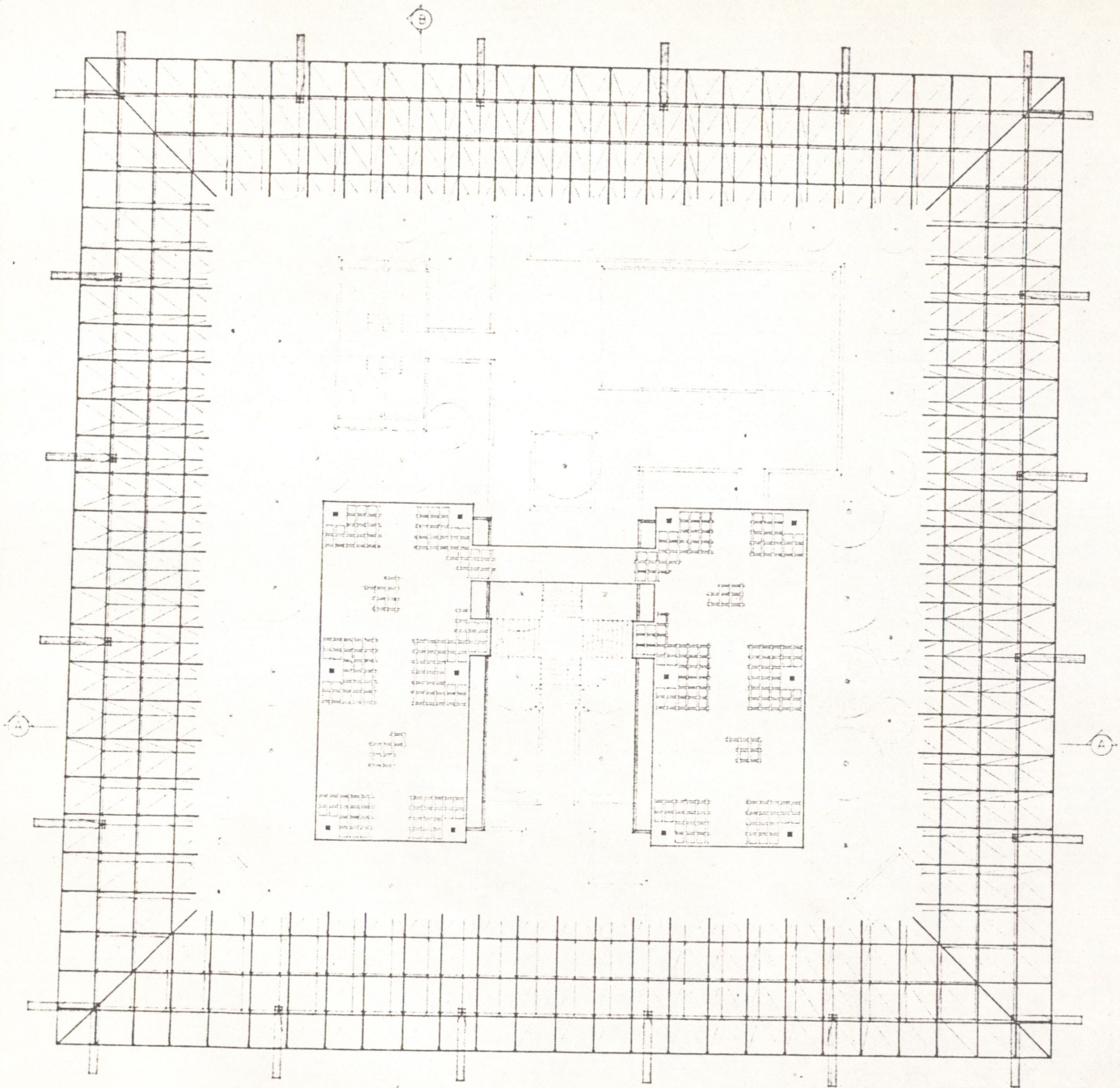


SECTION B

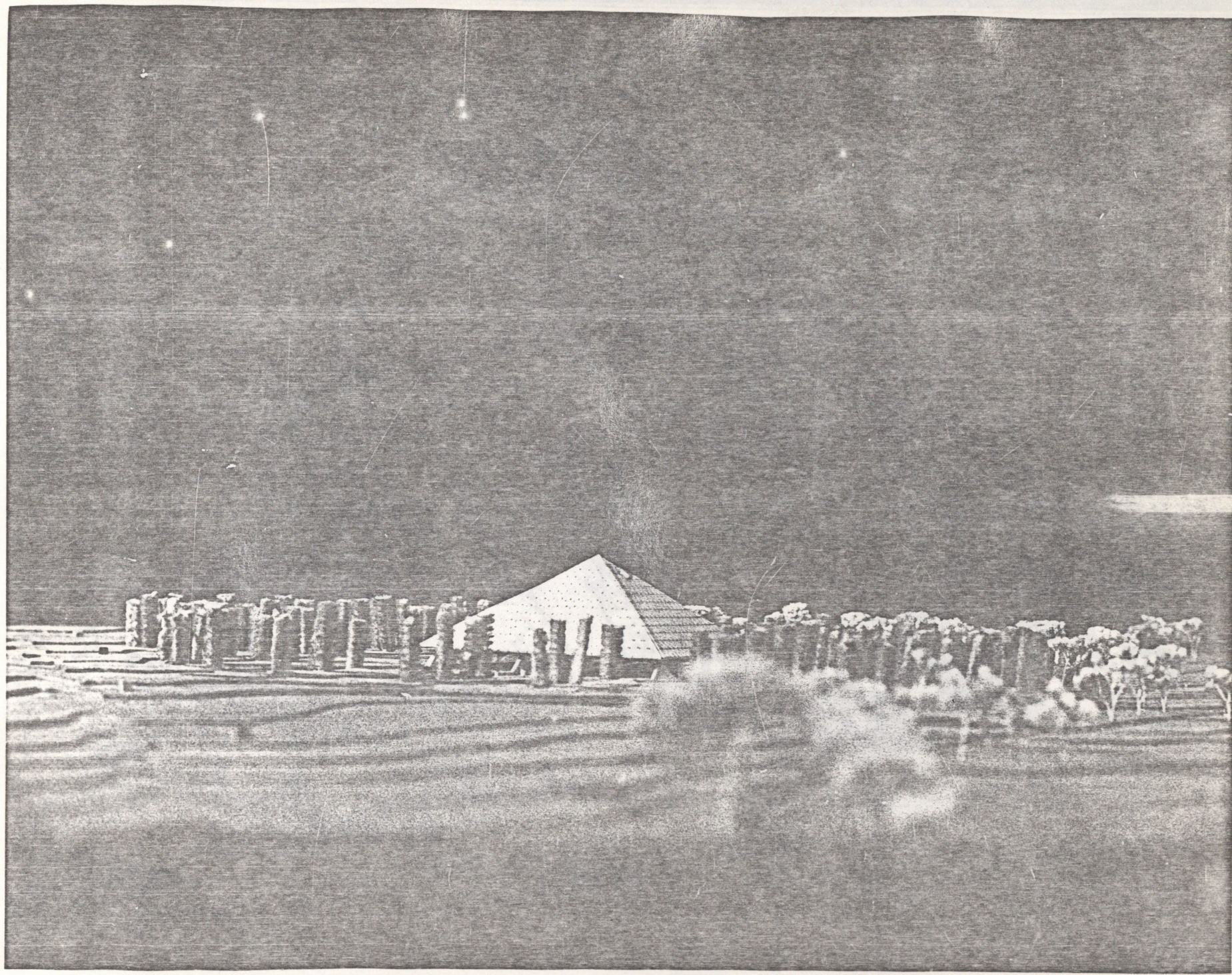
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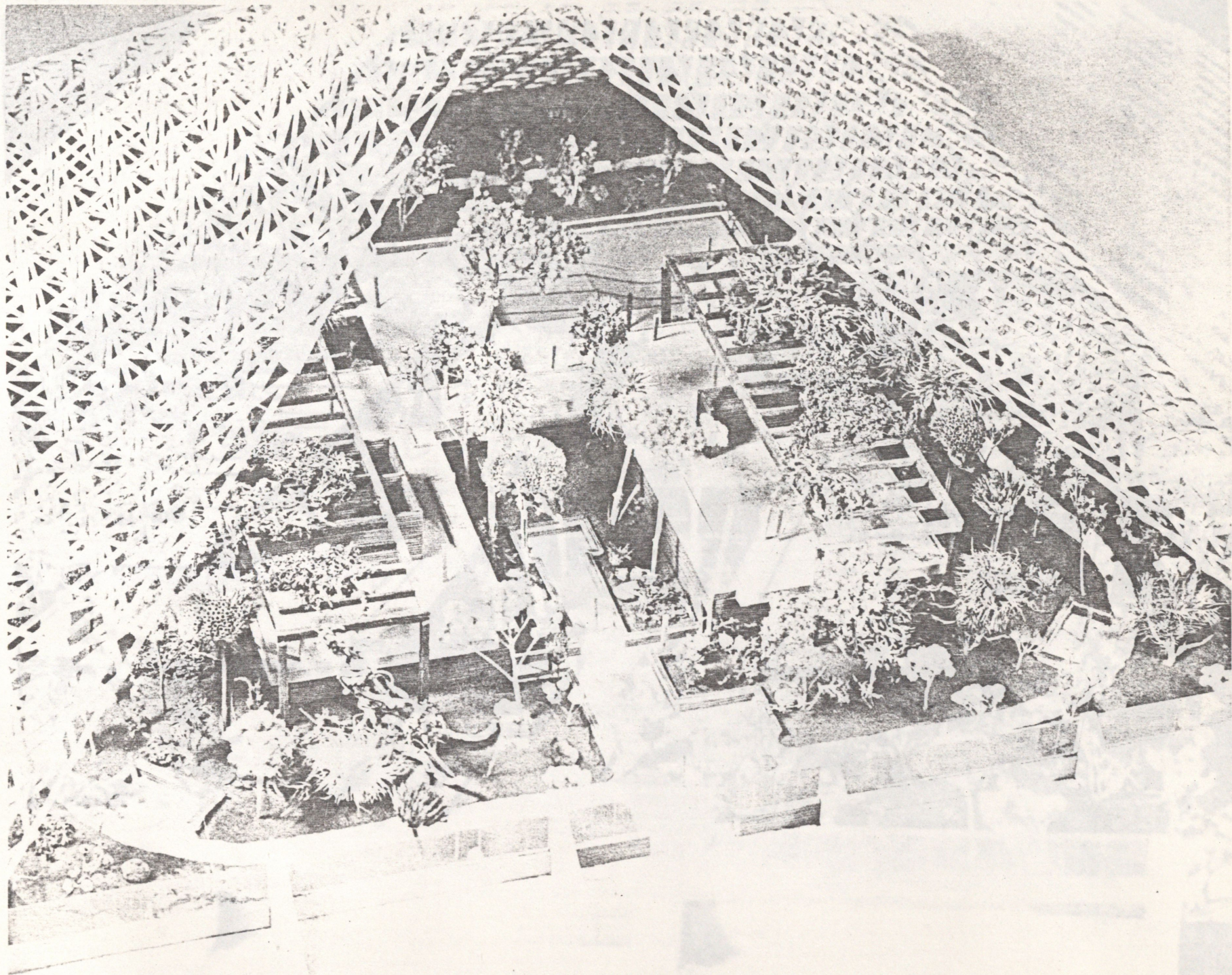
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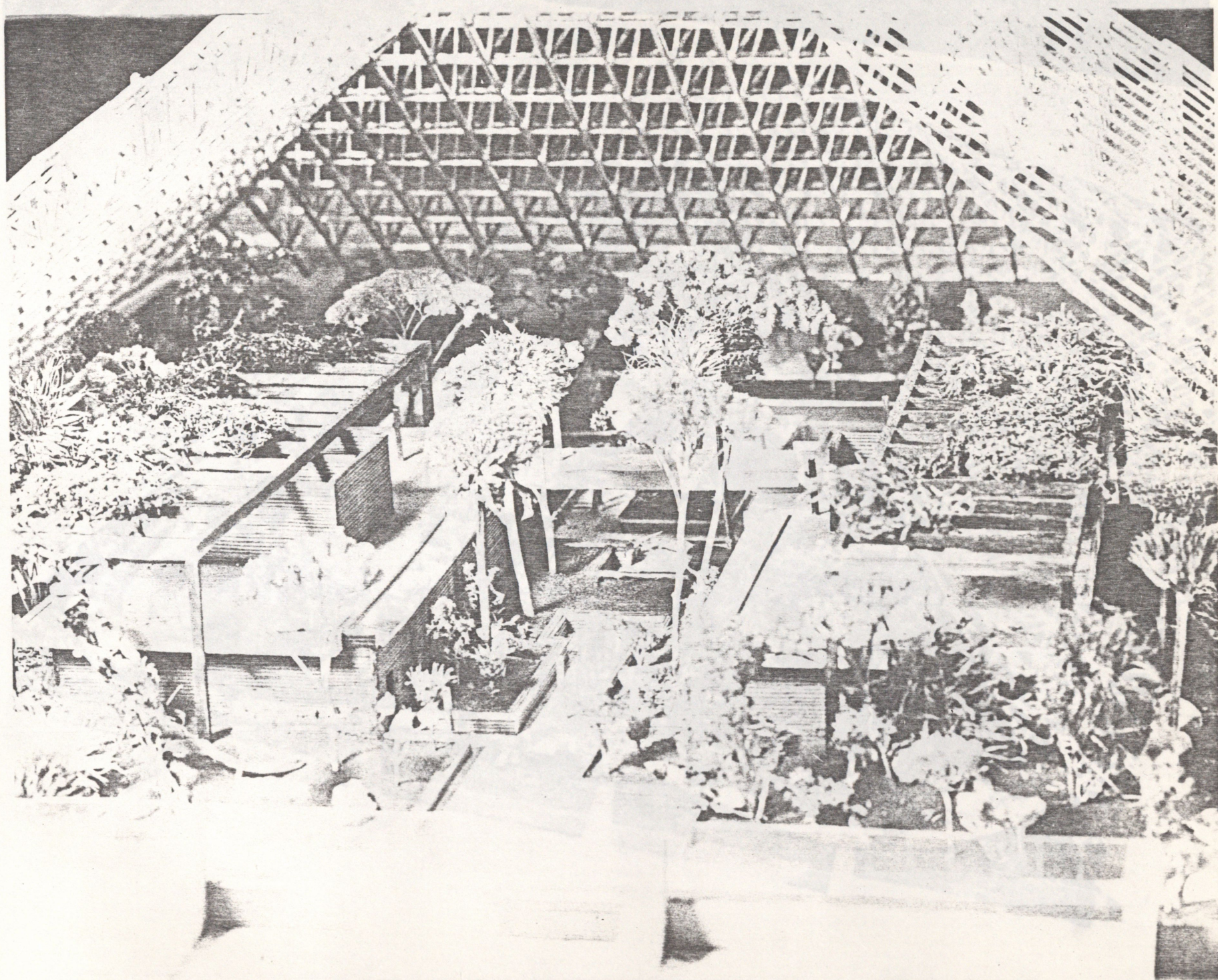
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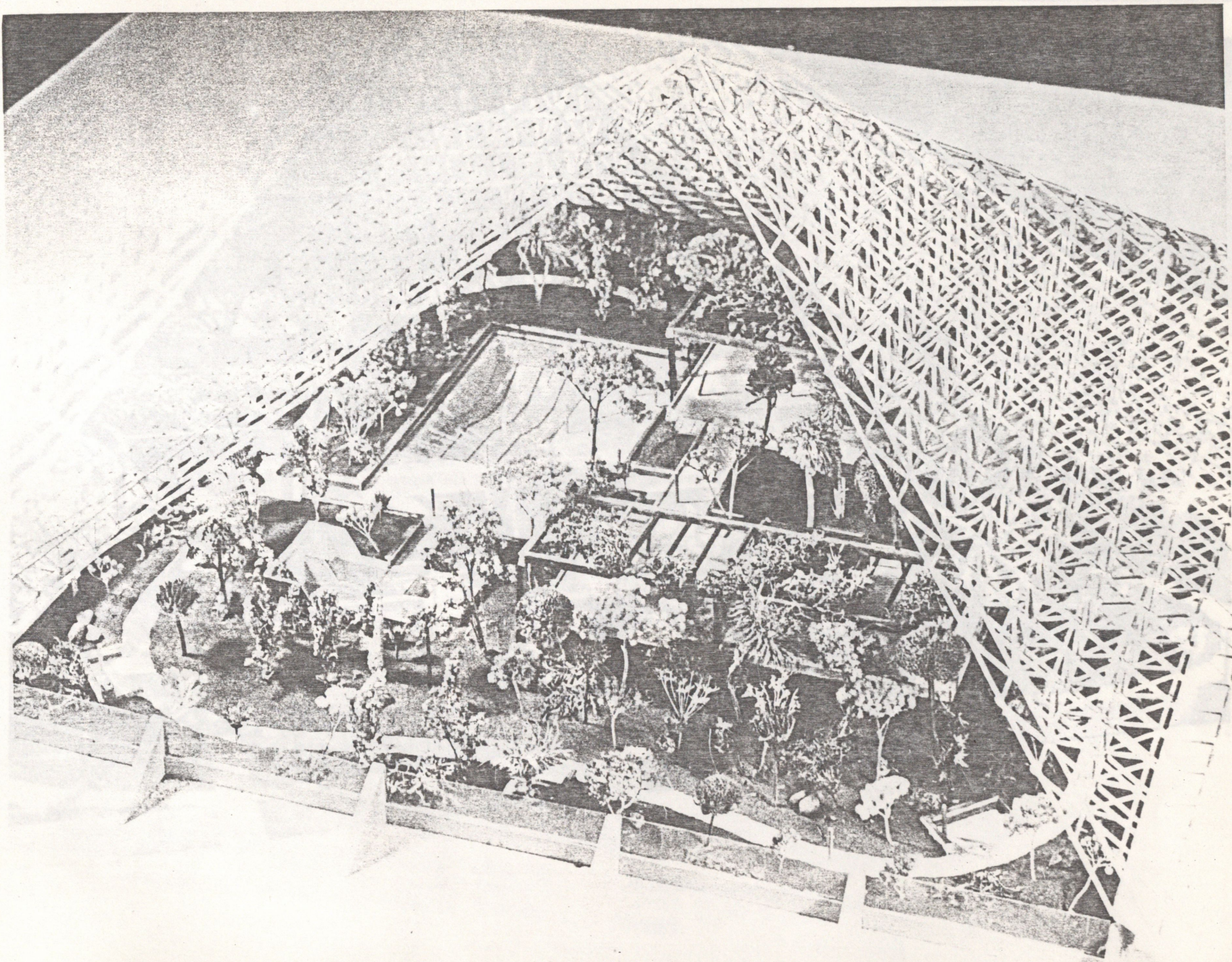


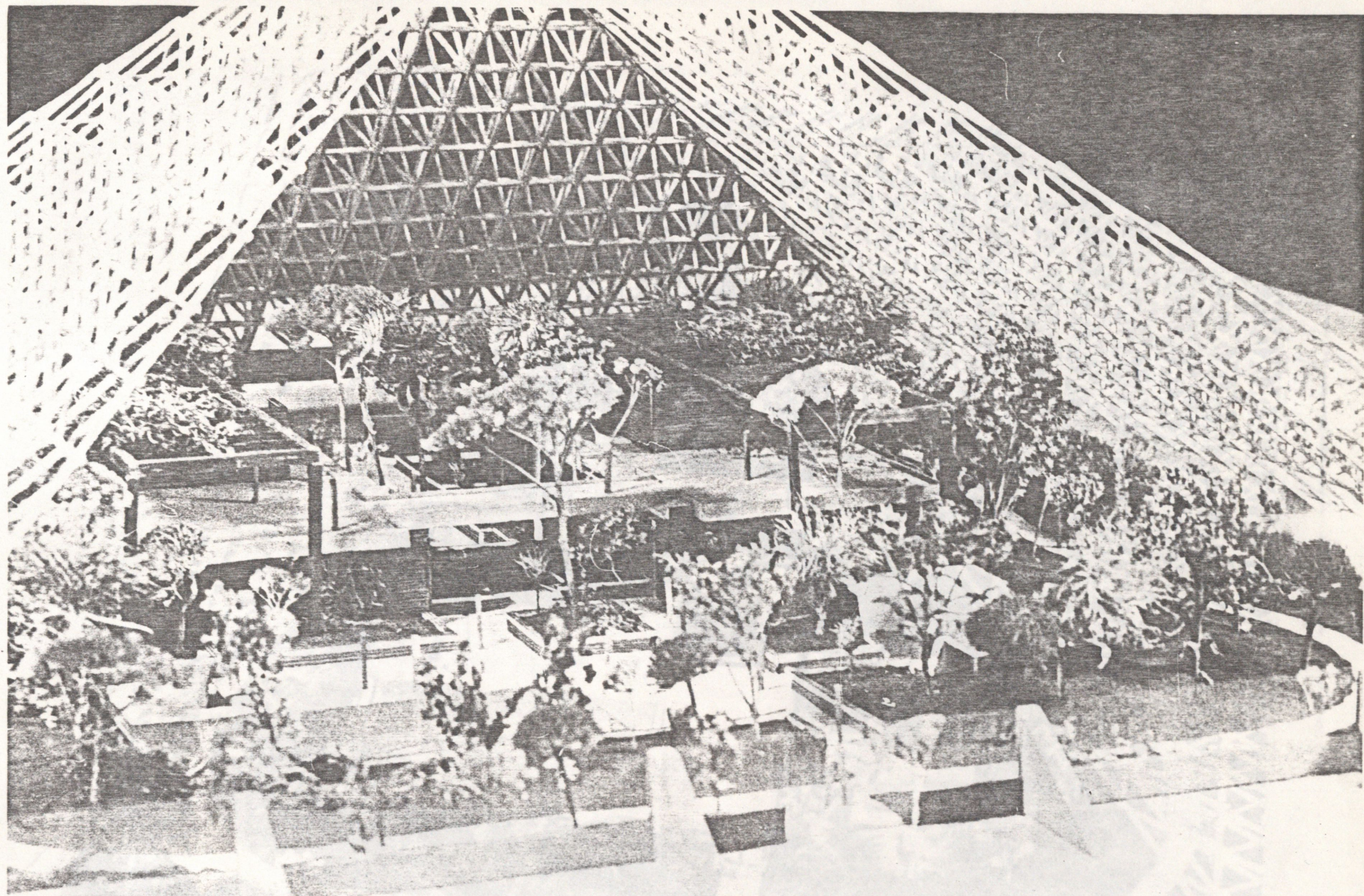
STRUCTURAL PLAN

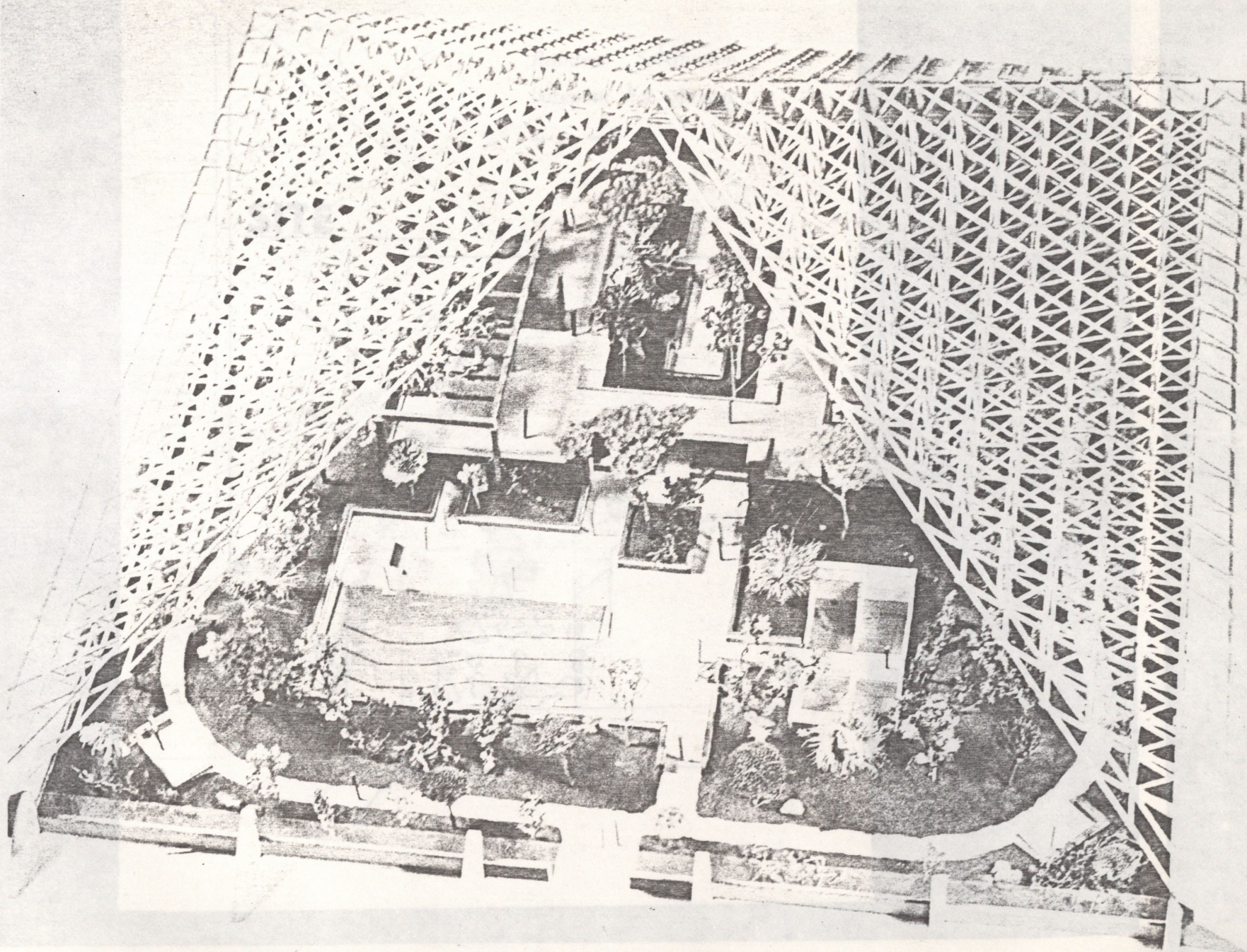












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