INTERN EXPERIENCE AT

AL-RAHA ESTABLISHMENT

AN INTERNSHIP REPORT

by

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Submitted to the College of Engineering
of Texas A&M University
in partial fulfillment of the requirement for the degree of

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August 1983

Major Subject: Mechanical Engineering

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ABSTRACT

Intern Experience at

Al-Raha Establishment. (August 1983)

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This report describes the author's major activities and accomplishments during his nine months' internship at Al-Raha Establishment in Riyadh, Saudi Arabia. During this period, he started working on a major project as a mechanical design engineer, and then was promoted to the position of assistant project manager for the same project.

The internship objectives were set by the author to provide him with an internship experience that would fulfill the requirements of the Doctor of Engineering Program at Texas A&M University. These objectives were (1) to become familiar with the organizational characteristics of the company and functions of the various departments; (2) to make an identifiable contribution in the mechanical engineering field; and (3) to gain practical experience in the non-academic activities and business environment.

During the internship period, the author was involved in

designing the whole irrigation system of a major residential area which is comprised of one main palace, eleven guest villas, servants' quarters, a conference hall, a mosque, and recreational facilities. He also was involved in the selection of materials and equipment suitable to the requirements of the irrigation networks. Furthermore, as assistant project manager, the author had the opportunity to develop interpersonal and management skills by participating in all aspects of daily business activities, and by interacting with managers, engineers, and clients.

The author candidly believes that the internship experience fulfilled his personal objectives as well as the internship requirements for the degree of Doctor of Engineering at Texas A&M University.

A C K N O W L E D G E M E N T S

With all candor and appreciation, the author would like to extend his sincere thanks to all the people who have contributed to making the internship a meaningful experience and have assisted him in the completion of his Doctor of Engineering Degree.

Special thanks go to Dr. Don E. Bray, the author's committee chairman during both his master's and doctor's degree programs, for his valuable advice and guidance through the author's graduate studies. The author would also like to thank the other members of the committee, Dr. Sherif T. Noah, Dr. William E. Murphy, and Dr. Robert W. Burch for their support and timely advice.

The author wishes to express his gratitude to his internship supervisor, Mr. Zahi E. Abou Mansour, for helping and supervising him throughout his assignments and duties during the internship period. The author is indebted to Al-Raha Establishment, especially Mr. Roger Azzam, for providing this internship.

The assistance and help of Mrs. Carmen Lanning in making this report a reality is greatly appreciated. The author also acknowledges the enthusiastic support and encouragement of Mrs. Kathy Shearer.

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TO

MY DEAREST PARENTS WHO HAVE GIVEN ME SO MUCH

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CHAPTER I. INTRODUCTION

INTRODUCTION

This report presents a survey of the author's nine months' Doctor of Engineering internship experience with Al-Raha Establishment in Riyadh, Saudi Arabia. According to the guidelines set forth by the College of Engineering the purpose of this report is to certify that the objectives of the internship have been met. "The objectives of the Doctor of Engineering Internship Program are:

a. to enable the student to demonstrate his or her ability to apply his or her knowledge and technical training by making an identifiable engineering contribution in an area of practical concern to the organization or industry in which the internship is served, and

b. to enable the student to function in a non-academic environment in a position where he or she will become aware of the organizational approach to problems in addition to traditional engineering design or analysis." (1)

The first critical objective was met with the intern performing as a mechanical engineer, designing irrigation systems. The author had to use his education and knowledge in thermodynamics and fluid mechanics in order to design irrigation networks.

The second critical requirement of the internship was fulfilled when the intern served as assistant project manager. This experience provided the author with an excellent opportunity to participate in all forms of daily business activities, observing and interacting with managers and clients, and, most importantly, the opportunity to practice managerial skills such as decision making, organizing, and scheduling.

The intent of this report is to show that the author's internship experience with Al-Raha Establishment satisfies the internship requirement of the Doctor of Engineering Program at Texas A&M University. This will be shown by describing the author's activities during the internship period and demonstrating that each of the internship objectives has been met.

The following chapter describes the author's internship project and work position. Then, the report elaborates on the organizational structure of the firm and the functions of its various parts. Chapters IV and V discuss the author's engineering assignments as well as his experience in the non-academic and business environment. The last chapter consists of a summary of the report and the author's self-evaluation and conclusions. A glossary of terms used in the report is included after the Appendices.

CHAPTER II. THE AUTHOR'S INTERNSHIP PROJECT AND WORK POSITION

II. A. THE INTERNSHIP PROJECT

Prior to the discussion and explanation of the author's internship position and engineering assignments, a description of the internship project is necessary. The project consisted of the design and execution of the Gassim Emirate Palace to be living accomodations for His Royal Highness (H. R. H.) the Prince of the Emirate, Abdulilah Bin Abdulaziz, in the city of Bureidah. Bureidah, the capital of the Gassim region in Saudi Arabia, is located three hundred miles northwest of Riyadh.

The general contract between the client and the main contractor, Woochang Construction Co., LTD., states that the Emirate of Gassim is willing to fund the study, Design, Construction, and Execution of its Palace Accomodation Project at Bureidah for His Highness the Prince of the Emirate, together with demolishing, renovation works, construction of new housing and service buildings, repair of attached houses including all required modifications and additions thereto, and the execution of public utilities with the required networks on the site of work. Furthermore, the Client appointed the Saud Consult as the consulting engineering firm for the Project, the duties of which are to carry out all responsibilities pertinent to the supervision of works, setting up

specifications, and checking on-site work as well as granting approvals to the contracting or subcontracting firms.

As a whole, the project is comprised of two sites, located approximately two miles apart. The first site consists of eight guest villas, supplemented by a recreation area which includes a tennis court, swimming pool and a recreation building. The total area for the site described above is approximately 120,000 ft^2.

The second site, the main site or the Emirate Palace Complex, consists of the Palace Building; the Majlis and Guest rooms; the Palace Mosque; the Conference Hall; three main Guest villas; Servant Quarters consisting of several buildings; Leisure and recreational facilities, including tennis court, swimming pool and sports area; a Power Plant; a Water Treatment Plant with all related buildings, as well as a Palace Warehouse, Stores, and a Main Kitchen. The total area of the main site is approximately one million square feet.

The total value of works under this contract is one hundred-seventy-five million Saudi Riyals, or approximately fifty million U.S. dollars. This amount includes the consultant fees for project supervision, the main contractor's portion for the design and construction of all buildings and facilities, the subcontractor in charge of the interior design and installation of the whole complex, and finally, the landscape

subcontractor's part of the project.

The Landscape portion of the sites was subcontracted to Abdullah Fahd Al Kraidees Establishment (AFK). The total value of the landscape work amounted to thirty million Saudi Riyals, or eight-and-a-half million U.S. dollars. The scope of work of the Landscape Contractor may be summarized as follows:

1. Execution of all fountains shown on specific drawings at the main palace, the conference hall, the pool-leisure building, the support buildings and the guest villas, including installation of piping network and equipment in the corresponding mechanical rooms.

2. Execution of all tiling works needed for the walkways as well as installation of pergolas at particular locations in the complex.

3. Planting in all exterior areas and inside planters around all the buildings.

4. Supply and installation of all exterior lighting including fountains, walkways pavers, and plants.

5. Design and installation of the irrigation water system for the entire project.

The landscaping works could be divided into four major activities: a) Hardscaping or civil works; b) Softscaping or planting; c) Electrical works, consisting of installation of light poles, cabling, and panel boards; and d) Irrigation. Al Kraidees Establishment, the Landscape Contractor, subcontracted all four activities to Al-Raha Establishment. In turn, the latter subcontracted the hardscaping and electrical works to Modern Design Establishment, and the irrigation activities to Obal Establishment, while keeping the softscaping portion under its own supervision and execution.

In order to better coordinate the works of all subcontractors, Al-Raha Establishment required that each subcontractor appoints for the project a company manager to run the affairs of his own firm as well as to report to the Landscaping Project Manager appointed by the Landscape Contractor. Obal Establishment appointed Mr. Luigi Amico as on-site manager responsible for all irrigation activities; Modern Design Establishment assigned the responsibilities of the hardscaping and electrical works to Mr. Wajeeh Wehbe and Mr. Charbel Nemr, respectively. These two activities were to be headed by Mr. Zahi Abou Mansour. It is to be noted that Mr. Mansour was also chosen by Al-Raha Establishment to be Project Manager of all the landscaping works; Al-Raha Establishment also entrusted the management duties of its portion of the landscaping works to the author

himself. Hence, the latter assumed the duties of a mechanical design engineer as well as a manager responsible of the soft-scaping portion of the project. This expanded role provided the author with the privilege of participating in non-engineering and administrative tasks - a great opportunity to fulfill the second main internship objective set forth by the Doctor of Engineering Program.

A chart of AFK's organization - the company under the name of which Al-Raha Est. runs the works - for this particular project is shown in Figure 1. Every division is directed by a Division Head. Each division head is totally independent of the others. However, they all report directly to the project manager; whose duties are to plan, organize, and coordinate the various activities of all departments.

Following is a description of the design process of the project from the preliminary design stages to the execution of the tasks. The author's role and responsibilities while serving his internship at Al-Raha Establishment will then be elaborated.

·GASSIM·EMIRATE PALACE·COMPLEX·

ABDULLAH FAHD AL-KRAIDEES EST.

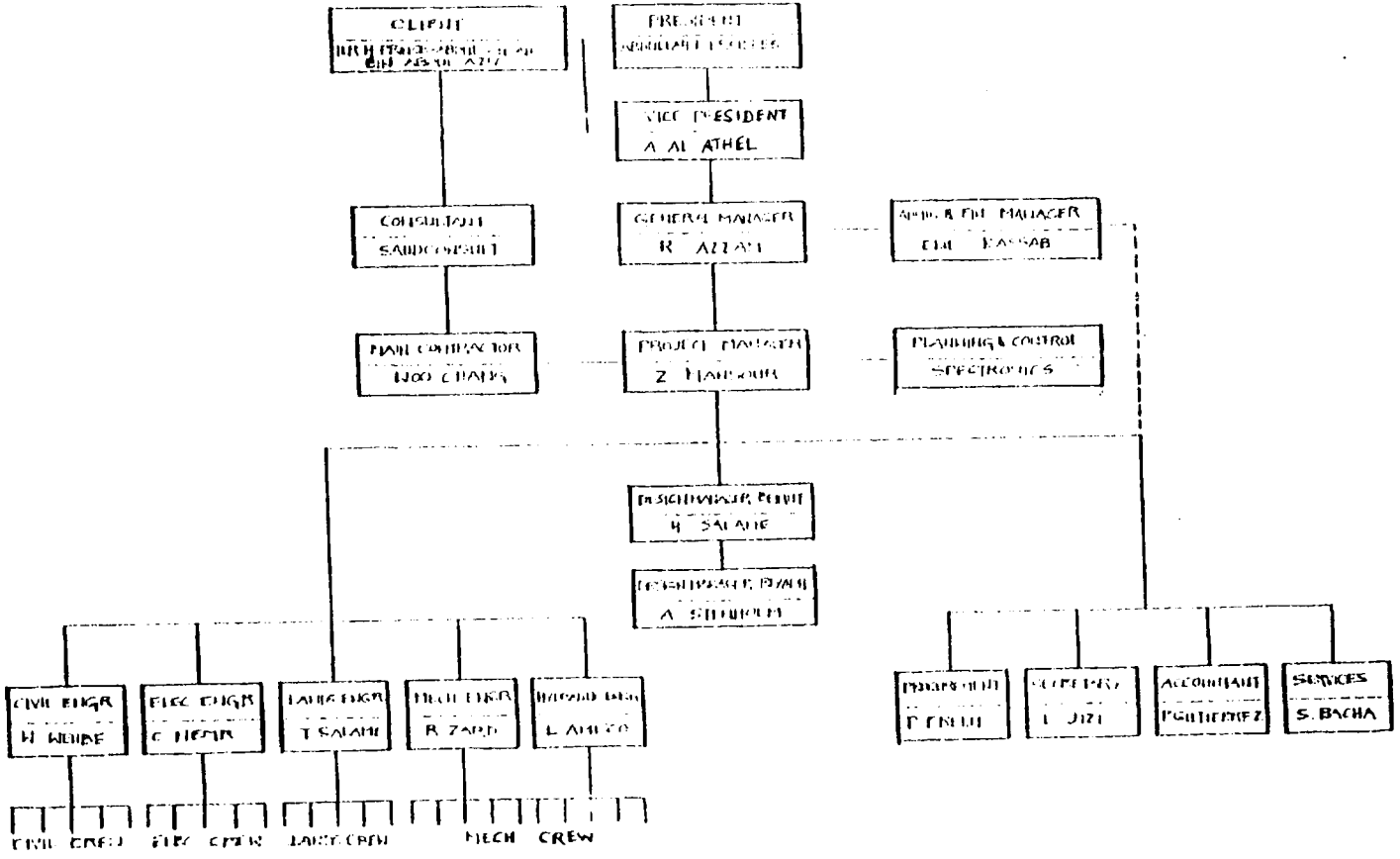


Figure 1

ABDULLAH FAHD AL-KRAIDEES ESTABLISHMENT - ORGANIZATIONAL CHART

II. B. THE DESIGN PROCESS

The preliminary design for all landscaping works including hardscape, softscape, electrical, and irrigation was performed during the stages of the contract negotiations. After the signing of the contract, each subcontracting company was responsible for submitting working drawings or shop drawings to the consultant for final approval. Modern Design Establishment had the civil and electrical designs done by an engineering company in Lebanon, managed by Mr. Habib Salame, a highly reputable Lebanese architect. On the other hand, Al-Raha Est. performed the softscaping design in its own main office in Riyadh, while Obal Est. designed the irrigation system for the project in its office in Riyadh. The sequence of design works was the following: firstly, performing the hardscaping portion; secondly, designing the softscaping part. Thirdly and fourthly, designing the electrical and irrigation systems followed since these two activities are meant to complement the softscaping portion of the project. All landscaping shop drawings are checked, reviewed, and coordinated together at Al-Raha Est., Riyadh office, before their final submittal to the consultant's head office in Riyadh for approval. The design process is illustrated in Figure 2. Once the approval is granted, the execution phase commences. In the event where minor modifications and adjustments are necessary to fit specific

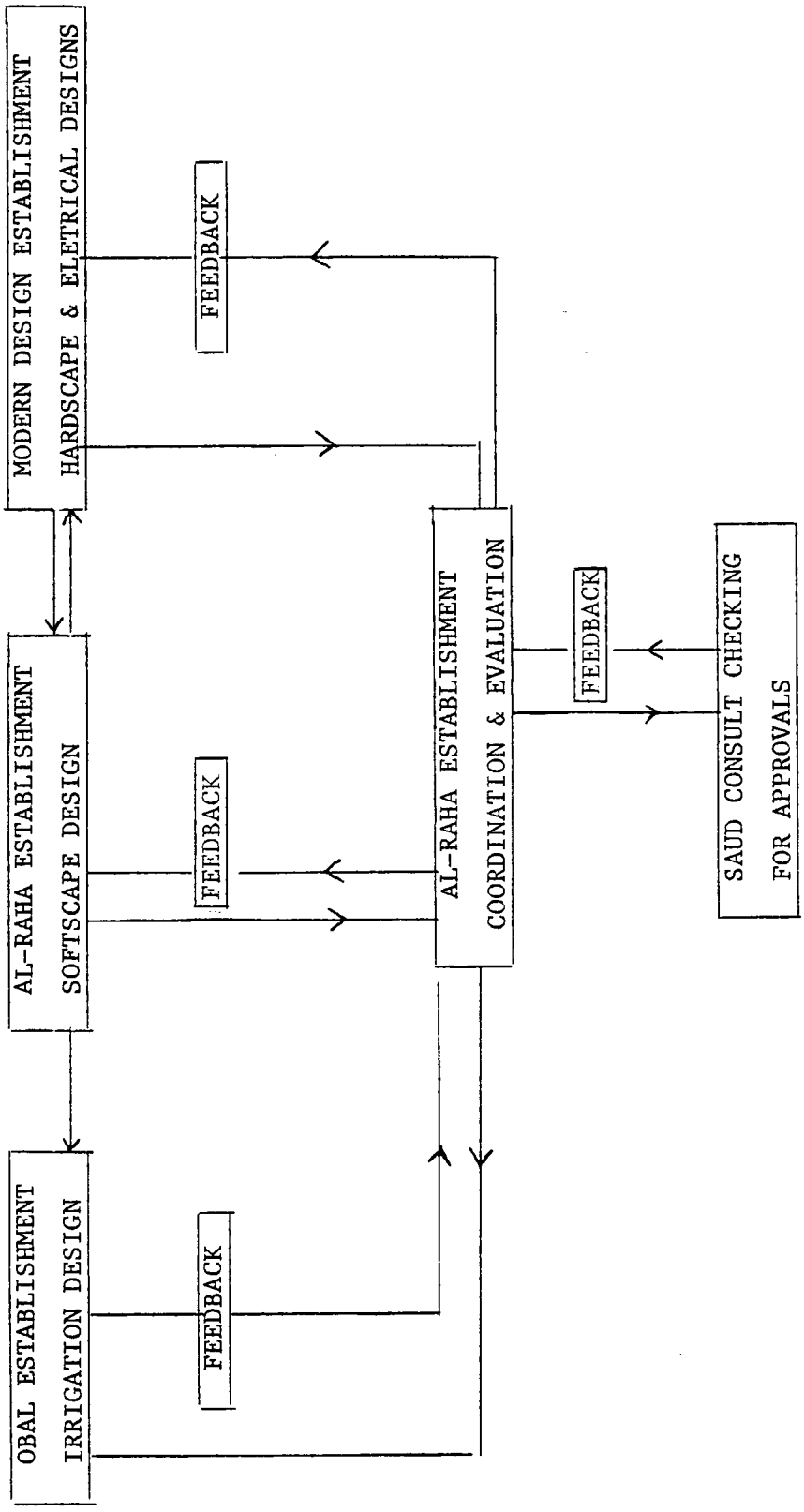


Figure 2

THE DESIGN PROCESS

situations, the consultant's office on site will take charge of approving or disapproving these particular changes.

II. C. THE AUTHOR'S INTERNSHIP POSITION

The author commenced his internship experience with Al-Raha Establishment in October, 1982. He was recruited by the company as a mechanical engineer, a position which he maintained throughout his nine months' internship period. The position requires an engineer with four or more years of experience. However, his bachelor's and master's degrees, and four semesters into the Doctor of Engineering Degree Program, qualified the author for the position.

The author was hired by the company during the final stages of the Gassim Emirate Palace Complex Contract negotiations with Woo Chang Construction Co., the main contractor. At that time, the latter has been performing the construction work for almost one year. The author's duties were to study, learn, and become familiar with the technical aspects of designing and executing an irrigation network since a major portion of the landscaping activities consisted of designing and installing an irrigation system of the whole site.

After the contract was signed, Al-Raha Est. subcontracted the irrigation portion of the landscaping works to Obal Establishment, provided that the author would work in close contact with the irrigation company, gain experience in learning the design process and all the technical aspects needed to

design an irrigation system. As an engineer working for the Landscape Contractor, the author not only had the responsibility of participating in the irrigation design process, but to supervise the execution and installation of the piping network being performed by the subcontracting company. These responsibilities enhanced the author's learning process, and gave him the excellent opportunity to experience all aspects of the design stages, on-site mobilization, and execution and installation of irrigation systems.

During the first five months of the internship, the author was primarily involved in the design of the irrigation network for the project, coordination of works on site between the softscaping and irrigation activities, and directing the Softscaping division of the project.

During the remaining period of the internship, Al-Raha Est. promoted the author to the position of assistant project manager. This was a major and very challenging task for the author. He had to assume all the duties and responsibilities of the project manager during his absence. The author had to participate in all meetings with the Client, Consultant, and Main Contractor, in addition to many different activities in the engineering as well as the non-academic and business fields. An in-depth discussion of these activities will be provided later in the report.

The intern supervisor under whom the author served his nine months internship was Mr. Zahi Abou Mansour himself, the project manager. Mr. Mansour received his Master of Engineering Degree from the University of California at Davis in Civil Engineering. His work experience in the United States, Lebanon, and Saudi Arabia enabled him to qualify fully for his technical and managerial positions in the project. Mr. Mansour's brief resume is included in Appendix A. The author maintained a close contact with the project manager, directly reported to him, and, most importantly, gained an enriching experience and learned from observing how Mr. Mansour managed, organized, and ran the entire project.

CHAPTER III. THE FIRM

III. A. HISTORY

Al-Raha Establishment was founded in October, 1981, by His Royal Highness, Prince Faisal Bin Fahd Al Faisal. This company is located in Riyadh, Saudi Arabia. The founder is also the honorary chairman of Al-Raha's board of directors, which consists of five business men: Messrs Beshr Haffar, Bassam Malhass, Malek Mahamassani, John Edde, and Roger Azzam. Because of these men, the company is built on solid ground which will help it to survive the competition during its first years of operation.

The internship company commenced its operations with a work force of about 18 persons, including 8 salaried employees, and 10 hourly workers. The managing director was Mr. Roger Azzam who is now general manager in charge of the daily operations of the company. All of the administrative and financial duties of the organization were relegated to Mr. Elie Kassab. The remaining employees fulfilled the positions of project managers, foreman, accountant, secretary, and others.

The firm was primarily engaged in the execution of soft-scaping projects in the city of Riyadh, Saudi Arabia. To this end, the establishment of a plant nursery was necessary. This nursery has provided the company with a flexible and effective backup sustem to all its ongoing projects. At the birth of

the firm, the projects were fairly small, involving the landscaping design and works of local residential areas and commercial centers. The money realized from the first few projects was barely sufficient to cover all the costs and expenses incurred by the company. However, due to the board of directors' contacts in the area, the firm started acquiring more and larger projects. The great needs in the field of landscaping in Saudi Arabia have helped the company to grow at a rapid, steady pace.

In order to handle this growth, the organization needed more financing, which the board of directors were not ready to provide. This lead the general manager, Mr. Azzam, to come up with an alternative solution that would alleviate some of the financial leverage and cash flow problems of the company. The first expansion move was to establish a new division in the company. This division is solely involved in producing and selling Agroumousse, an organic material which is mixed with the agricultural soil to improve its water retention capacities and, thus, its quality. This product proved to be a very successful and salable one. However, like all products, it required organized and effective marketing. As a consequence, a marketing manager was hired to help promote and sell the new product as well as to create an expanded marketing department. One of the new duties of marketing is to be

responsible for ensuring further contacts with and securing new projects from other companies for Al-Raha.

The spectrum of the clientele grew from individual home owners to include the residential, commercial, and industrial sectors, as well as the government itself. Within a very brief time span, the company has built a good reputation for providing professional services in the fields cited above. The best example of this is receiving the contract for the landscaping portion of the Gassim Emirate Palace Complex. The value for the work to be executed in the project totalled approximately 9 million U.S. dollars.

At the present time, less than 2 years after the birth of the firm - the company's work force consists of 70 persons, including 30 salaried employees and 40 hourly workers. Furthermore, the firm's range of operations has extended beyond the Riyadh area, to include other projects in different areas, including the one located in Gassim. As a matter of fact, the organization has recently completed an important project involving the landscaping renovation and maintenance of King Fahd Bin Abdulaziz's residence Palace in the city of Taif, Saudi Arabia. Currently, Al-Raha is beginning a new project in the city of Al Medina, which involves designing and executing the softscaping and irrigation works at the Al Medina Sports Complex.

III. B. THE ORGANIZATION OF THE FIRM

One of the main objectives of the Doctor of Engineering Internship is to become familiar with the structure of the organization, its various departments, and how they interact and function with each other and with the external environment. Accordingly, the study of the internship organization was made a major and continuous activity throughout the course of the internship.

The basic organization chart of the company is presented in Figure 3. The firm consists of four major divisions: Project Operations, Marketing, Nursery, and Agromousse Production. Each one of these primary divisions consists of one or more departments. All divisions report directly to the Administrative and Finance department, which is, in turn, supported by other divisions including the personnel, accounts, purchasing and secretariate areas.

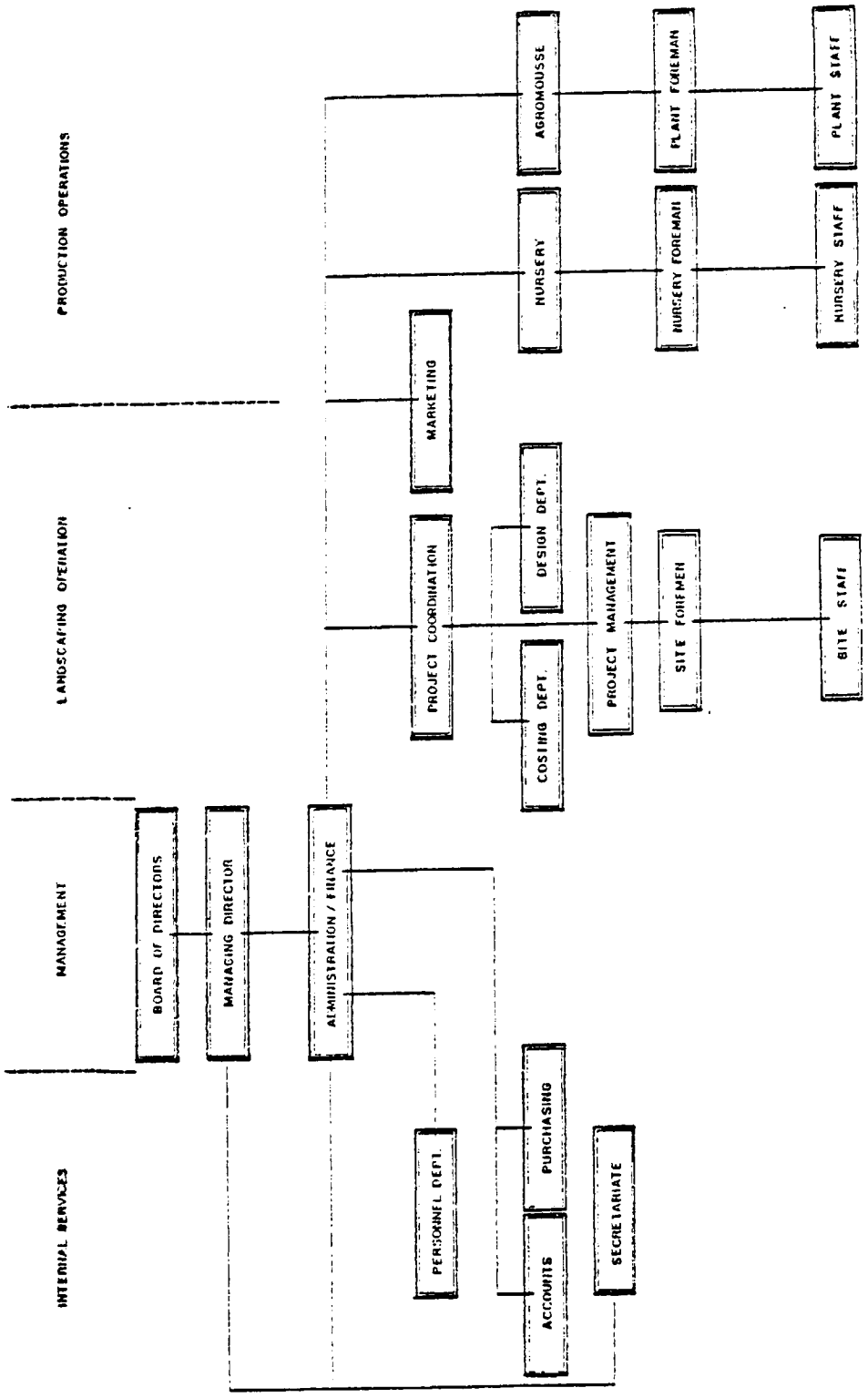


Figure 3

AL-RAHA ESTABLISHMENT ORGANIZATIONAL CHART

III. C. DEPARTMENTAL RESPONSIBILITIES AND FUNCTIONS

A more detailed description of the responsibilities and functions of each division is presented in this section, as well as how they have all functioned together to produce results.

PROJECT OPERATIONS DIVISION

The Project Division of Al-Raha Est. is directed by Mr. Tumair Savache. He is a landscape architect with extensive experience in the design, execution, and management of projects involving engineering tasks dealing with construction work as well as irrigation activities. The Project Division is the company heart for contracting operations in the Kingdom of Saudi Arabia. All projects secured by the organization are studied, designed, and executed by this Department. The latter is comprised of three other components through which its services are provided: (1) the Project Management Department, (2) the Design Department, and (3) the Cost Department. Although the opportunity to work practically in all areas did not present itself, the author achieved familiarity with most of the functions of these departments through attending various meetings and dealings with their employees during the normal course of employment.

(1) The Project Management Department

The Project Management Department, headed by the project coordinator, Mr. Tumair Savache, consists of several project managers directing various projects. Very seldom is one project manager in charge of more than one project at a time, unless the particular ongoing projects are fairly small. The project managers perform their duties independently from each other. They are responsible for planning, organizing and executing the sites assigned to them either by the project coordinator or the administrative manager of the company.

"The role of the project manager is a two-fold organizer - manager type role. As an organizer he establishes the project objectives to be achieved, while as manager he is responsible for the project, from the time of project initiation through project completion. The project objectives are both technical and financial. That is to say that the project manager sets objectives for the quality of the professional services to be provided, project deadline, and budget. The project manager is given authority in order to carry out his responsibilities and prosecute his duties." (2)

As a matter of fact, the project manager in Al-Raha Est. is responsible for all activities needed to accomplish his project. These involve mobilization on the site; purchasing of materials and equipment; informing the project coordinator about the client's requirements for addition to or modifications of the

original design; meetings with the main contractor and consultant to resolve pending issues in order to expedite the works, scheduling of works, labor, and materials; and the complete management of all the accounting and financial aspects of the project. As mentioned previously, the author was assigned such responsibilities in addition to his engineering design duties by managing the softscaping portion of the Gassim Emirate Palace Complex Project. The learning process was enhanced especially in the last four months of the internship when the author was assigned the responsibilities of assistant project manager for the whole project undertaken by the company.

(2) The Design Department

The Design Department is actually headed by Mr. Toni Stenholm, the architect. It is the center of all studies, designs, and analysis of the services provided by the company through its Project Management Department. In this division Mr. Stenholm directs several draftsmen. The design division must provide the project managers with the necessary shop drawings for the consultant's final approval. If any changes or adjustments are required, whether they are upon the Consultant's or the client's requests, the Design Department has the obligation to perform such modifications and feed the Project Management Division with the necessary information and drawings. Hence, the Design Department through the project

coordinator, is in continuous interaction with the Project Management Department throughout the course of the project execution.

(3) The Cost Department

The function of this department is to perform cost-estimations and feasibility studies for potential projects. The pre-evaluation of such projects during the bidding phase determines whether or not the company should undertake the project. Once the project is awarded to the firm, the duty of the Cost Department would be to constantly compare estimated expenses with actual costs incurred during the project. It is the project manager's responsibility to provide the Cost Department with detailed information pertinent to the accounts allocated to each activity of the work being performed. Then, the Cost Department takes advantage of the company computer facilities to review, study, and file such information so that it can evaluate future projects in a more professional, accurate manner. By acquiring a better working knowledge of the company expenses during each project, the firm can adjust, control, and reallocate its resources to have more profitable operations, and can become more competitive in the market.

MARKETING DIVISION

The need for a marketing department at Al-Raha Est. became essential after the "Agromousse" was put into production. The

Marketing Division, headed by Mr. Charles Abi Nader, has the responsibilities to perform market research and analysis pertinent to the selling of Agromousse as well as other commodities which are thought to be highly demanded in the Saudi Market; also this division attempts to establish contacts with new and potential clients. The Marketing Department has been very effective in promoting the company's new product, by using sound marketing principles and practical techniques. Al-Raha's Marketing Department has participated in major annual industrial exhibitions in the city of Riyadh, Saudi Arabia. Through its contacts established with a wide range of clientele including contractors, clients, suppliers, and customers from all business sectors the Marketing Division has been able to secure several projects to the company which involve design as well as execution.

NURSERY DIVISION

The Nursery Division was established at the inception of the company. It is located approximately 60 miles away from the firm's main office. This Division consists of a plant nursery, headed by Mr. Imad Al-Jizi and operated by ten salaried employees. These include 2 foremen, and 8 workers. The nursery is used as a temporary storage and maintenance area for all the plants to be used in the softscaping part of the landscaping projects undertaken by the company. The Nursery Division

receives its plant orders from the Project Operations Division as Bills of Quantities of the plants needed for a specific project. Then, the Nursery Division attempts to place its orders and secure the requested quantities by contacting its agents in Saudi Arabia, Lebanon, France, Spain, and Holland, depending on the particular type of plants needed.

During the internship, the author had the opprotunity to visit the nursery on several occasions and learn how the management and operations were being performed in that Division. On the second visit to the nursery, the author was accompanied by 2 horticultural experts from the consultant's part to check whether the quality and quantity of the plants to be used in the Gassim Emirate Palace Complex Project met the specifications agreed upon in the contract.

AGROMOUSSE PRODUCTION DIVISION

As mentioned previously in the report, Agromousse is an organic agent similar in appearance to white foam, which is mixed with agricultural soil in order to improve its water retention characteristics. The factory producing this material is located in the same private area as the plant nursery. Mr. Al-Jizi is also responsible for the production of the Agromousse. However, the management of its sales, and delivery is handled by Mr. Charles Abi Nader, the marketing manager.

It is to be noted that all four major divisions consti-

tuting the company operate as profit centers, independent in management and operations from one another. Each division has its own financial and accounting system which reports directly to the Administration and Finance body through its division manager.

III. D. EMPLOYEE'S PERFORMANCE, EVALUATION, AND MOTIVATION

Employees' performance is the most important element to determine the overall performance and effectiveness of an organization. Through the evaluation of employee performance, a firm can identify the deficiencies in the system and correct them, as well as recognize good performance and maintain it. Hence, one of the major advantages of an employee performance evaluation is that it provides the company with a feedback system that can allow it to improve its overall effectiveness.

The performance of an employee is highly dependent on the motivational aspects in an organization. Motivation is defined as "the condition responsible for variation in the intensity, quality, and direction of ongoing behavior." (3) It can be enhanced through several means at Al-Raha Est. : a) pay raises; b) bonuses; and c) promotions.

Once every year, the company's upper management conducts an official employee performance evaluation. In this process, department and project managers fill out individual forms corresponding to each employee under their line of authority and submit the information to the upper management committee. Based on such information as well as their own personal observations, the committee authorizes the appropriate rewards

to the respective employees. Pay raises result in an increase of the employee's monthly salary. Bonuses also occur at the end of the year; however, they are lump sums of money, and in multiple amounts of the person's monthly salary. Promotions may take place any time during the year depending on the merit and performance of the individual.

While this method does motivate, employees can be more effectively motivated by other methods. The author believes that the managers ought to discuss the available information with their subordinates before submitting recommendations to the special committee. This would provide the employees with a feedback concerning their performances, as well as help all parties to clarify some discrepencies and misunderstandings. The author also believes that the performance evaluation process should take place more than once a year. As a matter of fact, employees in the Project Operations Division should have their performance evaluated at the end of every project they complete, and be rewarded accordingly.

III. E. FUTURE GOALS

Al-Raha Establishment is a fast growing company. Even though it has not yet achieved a solid ground for its financial security, the firm is characterized by its good reputation as well as its influential contacts. The company's goals for the future are:

(1) To expand in size and operations to cover all potential areas in the Kingdom of Saudi Arabia and the rest of the Middle East. Such a goal is being tested at the present time with the organization's involvement in several projects outside the Riyadh area- namely, Gassim, Taif, and Al Medina.

(2) To be engaged in a more diverse spectrum of operations. As a matter of fact, the company intends to establish a new irrigation division which will study, design, and execute irrigation projects. When he returns, the author will be assigned a new position with the firm. He will plan, direct, and manage such a department in the very near future. Also, the company is determined to establish another division which will handle all landscaping projects involving both such civil and electrical activities as: fountains, artificial lakes, walkways, outdoor lighting,

and others.

The author candidly believes that Al-Raha Est. has a very promising future. The constant support of an influential and reputable board of directors, along with a competent and professional personnel, is a guarantee to the company's continuous growth and success.

CHAPTER IV. THE AUTHOR'S ENGINEERING WORK

IV. A. INTRODUCTION

The author joined Al-Raha Establishment while the latter was involved in the bidding for and negotiations on the Gassim Emirate Palace Complex contract. Since the project consisted of designing and executing landscaping activities which involved large irrigation networks, the company assigned to the author the responsibilities of learning about and participating in the design as well as executing processes of the entire irrigation system, to be created by Obal Establishment, the irrigation subcontractor for Al-Raha.

During the first few weeks of the internship (one month before the contract was signed), the author devoted himself wholly to learning about irrigation system design. This was accomplished through reviewing irrigation literature and by closely interacting with Obal Est.'s irrigation design engineers. This interaction provided the author with the opportunity to study and review the general irrigation layout for the Gassim project before it was submitted to the consultant during the bidding phase.

During the first five months after the contract was signed, the author's major involvement was in the detailed design of the project's irrigation system. Working very closely with Mr. Mahmoud Saleh and Mr. Luigi Amico, Obal Establishment's irrigation designers, he learned a great deal from their

experiences in the irrigation field, and assisted them in designing all the irrigation networks of the project. The author was also appointed by his company to review and supervise the execution of the irrigation activities on site. This task included (1) constantly checking whether the work was being performed according to specifications agreed upon in the contract, and (2) obtaining thorough information about the types of materials and equipment used for irrigation purposes.

During the remaining period of the internship, the author's major contributions to the company in the mechanical engineering field were the studying and checking of irrigation design systems which were performed by the company's various subcontractors on different irrigation projects.

This chapter primarily deals with the design of irrigation networks and the author's contribution to the entire Gassim project irrigation system design.

IV. B. GASSIM EMIRATE PALACE COMPLEX: GUEST VILLA SITE

As described in Chapter II, the Gassim Emirate Palace Complex project is divided into two sites: the guest villa site and the main site. The landscaping area at the guest villa site is about 6,500 m^2, or approximately 60,500 $ft.^2$ The irrigation activities in this particular site cover more than 4,500 m^2, or 40,500 ft^2 of the area to landscape.

The execution of the irrigation works at the guest villa site commenced two weeks after the contract was signed. At that time, no irrigation shop drawings were yet ready. They were still being designed by Mr. Saleh, Mr. Amico, and the author, himself. Unfortunately the client desired to expedite matters himself. As a consequence of the client's order, the consultant verbally instructed Al-Raha Est. to resume all landscaping activities at that site. As a consequence of this unexpected incident, a portion of the irrigation work was executed without any detailed design - an error which resulted in poor quality of work and the installation of a faulty irrigation network. The system had to be redesigned and executed correctly. This experience taught the company a lesson: not to execute any work without the written approval of the consultant - no matter what the circumstances are.

All irrigation working drawings and design calculations

for the guest villa site were performed within one month. Then, the plans were submitted to the consultant for approval. Mr. Saleh and the author met with the consultant on three occasions to discuss and finalize the pending issues leading to the consultant's final approval. However, due to construction and architectural interferences, minor modifications and adjustments proved to be necessary even during the execution phase.

IV. C. GASSIM EMIRATE PALACE COMPLEX: MAIN SITE

The Main Site of the project encompasses the living accomodations of H.R.H., Prince of the Gassim Emirate, including all the support buildings discussed previously. The landscaping area at the main site is about 57,000 m^2, or approximately 570,000 ft^2. The irrigation activities in this specific area consist of approximately 40,000 m^2 or 400,000 ft^2. An overall picture of the main site, taken in May, 1983 is shown in Appendix B.

The irrigation design calculations and drawings for the main site were also performed by Messrs Saleh and Amico and the author. The design phase started four months after the contract was signed. Meanwhile, the ongoing irrigation works at the guest villa site were being completed.

After a month and a half of design work by the previously mentioned team, the consultant reviewed and checked the plans; then he gave final approval of all main site irrigation shop drawings and design calculations. However, due to work delays in the construction phase executed by the main contractor, the irrigation mobilization and works have not yet started, at the main site.

Following is an elaboration of the irrigation design procedure used to design the irrigation systems of both the guest villa and main sites.

IV. D. THE IRRIGATION DESIGN PROCEDURE

Irrigation generally is defined as "the application of water to soil for the purpose of supplying the moisture essential for plant growth." (4) However, a more comprehensive definition holds true for any number of the following eight purposes:

1. To add water to soil to supply the moisture essential for plant growth.
2. To provide crop insurance against short duration droughts.
3. To cool the soil and atmosphere, thereby making more favorable environment for plant growth.
4. To reduce the hazard of frost.
5. To wash out or dilute salts in the soil.
6. To reduce the hazard of soil piping.
7. To soften tillage pans and clods.
8. To delay bud formation by evaporative cooling." (5)

Since the Middle East is generally characterized by arid and semi arid climates, most planting schemes necessitate supplements to the natural moisture supplies. Hence, irrigation is an integral part of the vast majority of landscape projects. No matter how good the landscape design, without carefully designed irrigation, the scheme will not be successful.

In order to design the sprinkler system properly for the guest villa and main sites of the Gassim project, the following

procedure was necessary: (It is to be noted that the individual steps of the design procedure were taken from Rain Bird Irrigation Systems Design Manual as general guidelines.)

1. Obtain site information.
2. Determine the system irrigation requirements.
3. Determine water and power supplies.
4. Select sprinklers and determine spacing ranges.
5. Circuit sprinklers; locate valves and mainlines.
6. Size pipe and valves, and calculate total system pressure requirements.
7. Estimate potential mainline surge pressure.
8. Locate controllers and size wire.
9. Prepare the final irrigation plan.
10. Prepare a Bill of Materials.

Following is an elaboration of the steps mentioned above and how the author made use of each one of them while designing the irrigation system for the Gassim Project.

STEP NO. 1: OBTAIN SITE INFORMATION

It is very important to secure complete and accurate field information on the actual site that is to be sprinkled. Some of the major information that was desired while designing the entire irrigation system is listed below.

A. PLOT PLAN

The first phase of sprinkler system design is the preparation

of a plot plan of the property. This phase is extremely important and should be done accurately to avoid errors in the head layout and cost estimate. However, no plot plan was made for either site. Instead, hardscaping layouts were provided to Al-Raha Est. by the main contractor. In turn, the former supplied Obal Est. with the available information on the basis of which Mr. Saleh, Mr. Amico, and the author performed the irrigation design. The main site hardscaping layout is presented in Appendix B. As shown on this drawing, the main site was divided into seven major zones which, in turn, were subdivided to encompass seventeen different sectors. The guest villa site was also divided into separate areas. All landscaping shop drawings for both sites were based on these divisions. This method proved to be advantageous in many respects: (1) it helped the designers to work on larger scale drawings; (2) the drawings were more clear, readable, and easy to work with; (3) it made the task easier for the team executing and installing the irrigation system; and (4) provided a practical scheme to schedule the work according to regions and zones compatible with the existing drawings.

The need for accurate plotplans was hence overlooked by Obal Est. and the author as well. As a consequence, errors committed during the execution phase resulted in cost overruns and loss of profit; several heads had to be added, extra

piping was required, and additional fittings needed to be installed. These errors compounded the costly time delays and extra costs in manpower and equipment on the site.

B. TYPE OF PLANTINGS

Al-Raha Establishment supplied Obal Est. with its soft-scaping drawings showing the type of plants and their locations. These plans enabled irrigation designers to indicate all areas with different types of plantings that would require separate control valves and different sprinklers for special control of watering. Then, all areas requiring a different frequency of irrigation than the normal turf areas were noted so that they might have separate control valves and be placed on separate stations of the controller to be programmed differently.

C. OTHER CONSIDERATIONS

Various factors were also considered before designing the irrigation system: (1) the type of soil that was to be used, in addition to the information available on the type of plants, was determined in order to provide the designers and the author with a guide as to the length and frequency of each irrigation; (2) the amount of prevailing wind velocity and direction of the wind were also required to determine the maximum spacing of sprinklers to assure proper coverage; and (3) the various elevations on the site were recorded to enable the determination of the pressure gains and losses throughout the system

due to elevation differences. Each foot of elevation difference is equal to 0.433 psi pressure loss or gain in the system.

STEP NO. 2: DETERMINING THE SYSTEM IRRIGATION REQUIREMENTS

Several factors affect the overall requirement of an irrigation system. Among these are terrain, water supplies, and climate.

A. TERRAIN

Both areas to be sprinkler irrigated at the guest villa site and the main site involved slopes and various contours. In general, as the slope increased, the intake/ infiltration rate decreased so the chances for erosion were greatly increased. Therefore, the designers had to specify that more than one irrigation cycle was necessary to apply the sufficient water for the plants at these sites.

B. PLANT WATER REQUIREMENTS

To design an irrigation system properly, the designer must understand the water requirements of the different types of grasses, ground covers, shrubs, and trees. Since such information was in the field of Al-Raha's expertise, it was provided to Mr. Saleh, Mr. Amico, and the author by Al-Raha. It is to be noted that the presence of ground cover will mechanically increase the "ability" of the soil to take in water without run-off. Thus, ground cover has been planted at both sites.

C. CLIMATE

The climate of the irrigated area will directly affect the total irrigation requirement. During the summer season, the Gassim region is characterized with a hot climate which requires more water for irrigation; during the winter a cooler climate prevails, requiring less water and less frequent irrigation. Adverse wind conditions will also influence the total irrigation requirement. Strong winds will tend to dry out the irrigated areas and thus require additional water to be added. These factors were taken into account in the designing of the irrigation system: different watering programs were set up for different seasons of the year and different type of plants, and sprinkler heads were spaced to minimize the effects of wind on sprinkler distribution.

STEP NO. 3: DETERMINING WATER AND POWER SUPPLIES

To determine the available water supply and power supply requires several specific steps in selecting new equipment or estimating the capacity of any existing equipment. The author will not discuss all these steps in this report. However, information relevant to the Gassim project will be elaborated upon.

A. WATER SUPPLY

The importance of acquiring correct, detailed information on the water source should be emphasized since this data is

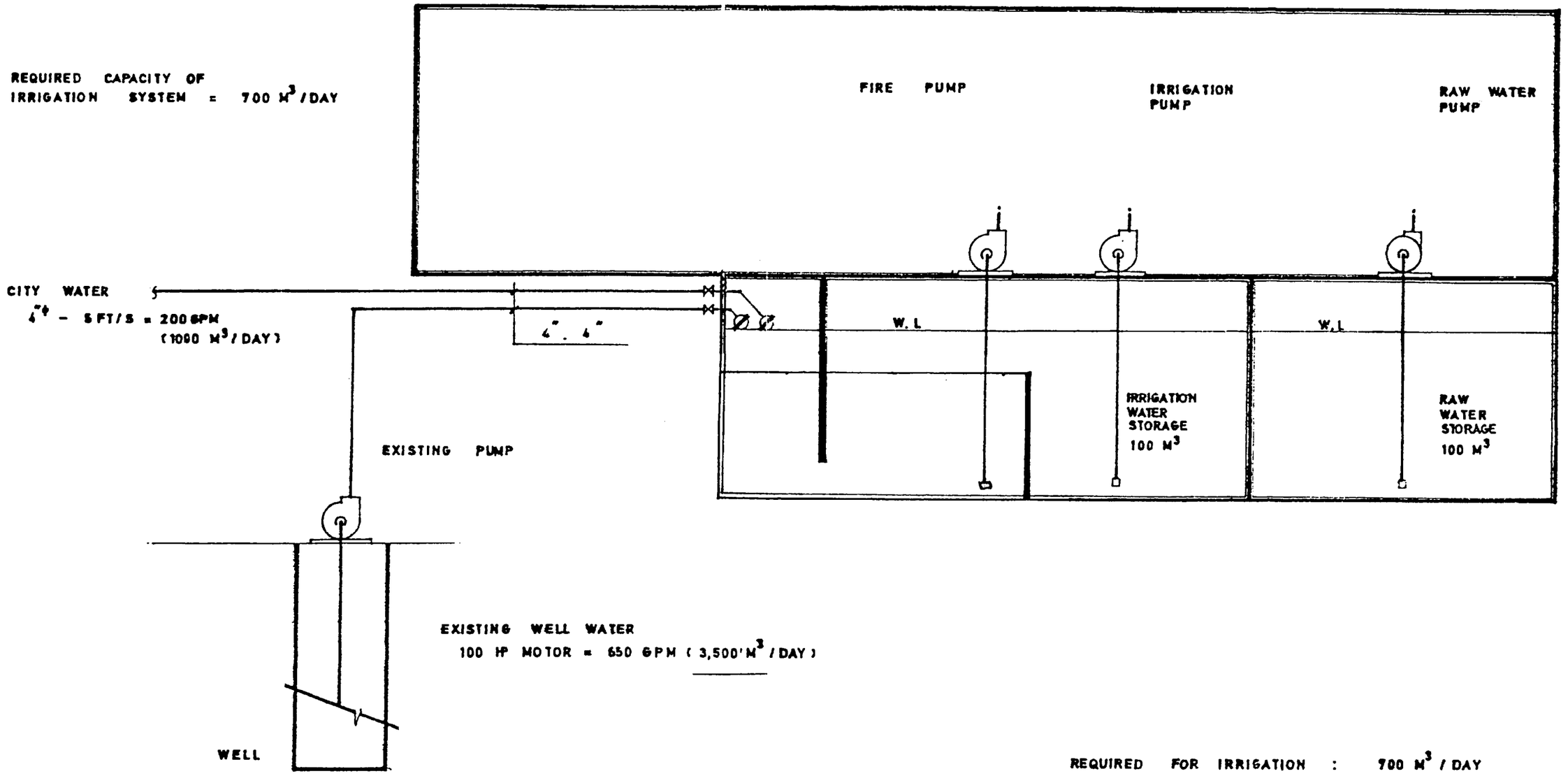
required to determine the following:

1. Amount of gallonage that can be used for each circuit; - this sum determines the total number of circuits in the system.
2. The amount of time that will be required to irrigate the area.
3. The type of sprinklers that may be used on the system.
4. The gallons per minute and pressure available at the sprinkler heads.

The sources of water supply at the guest villa site were one tank and one pump. According to the contract, the main contractor is responsible for building the irrigation water tank and supplying it with sufficient daily municipal water to irrigate the designated area. On the other hand, it is Al-Raha's responsibility to provide the appropriate size of pump for the irrigation design. The consultant designated as the sources of water supply at the main site as one well, one tank, and two pumps. Figure 4 shows a schematic of the main site water sources.

B. POWER SUPPLY

The power supply at both sites was to be provided by the main contractor. Fortunately, there were no restrictions on the power availability or the cost. Thus, there was no need for any adjustments in the programming of the controller or of



REQUIRED FOR IRRIGATION : 700 M^3 / DAY

CITY WATER $4"\phi$ - 5FT/S : 200 GPM (1090 M^3 /DAY)

EXISTING PUMP : 650 GPM (3500 M^3 / DAY)

Figure 4

MAIN SITE WATER SOURCES

the sprinkler control valves to make available enough voltage to properly operate the system. However, the location of the 120-V AC power for the automatic controller, as well as the capability of the power source to maintain a stable 120-V AC power, were determined and checked by the designers.

STEP NO. 4: SELECTING SPRINKLERS AND DETERMINING SPACING RANGES

One of the most important steps in designing a sprinkler system is determining the proper sprinkler and the proper spacing for that sprinkler. This step is not so easy as it may seem. It requires expertise in the various types of sprinkler; their characteristics including range of operating pressure, diameter of coverage, cost, and other important features; and their availability in the market. Also, the designer has to acquire the basics of the sprinkler spacing theory before getting involved in any kind of irrigation system design. The author spent a great deal of his time while serving on his internship learning about the types of sprinklers available and their respective theoretical distribution profiles as well as their practical applications in an irrigation design. This was accomplished through the review of various irrigation manuals, manufacturers' product manuals, and other literature pertinent to the design of an irrigation system. From this review, the author acquired very extensive and enriching information on sprinkler systems. However, he will limit himself

to discussing only the basic points pertinent to the proper selection of sprinklers and their respective spacing in the following sections.

A. TYPES OF SPRINKLERS

There are two basic types of sprinklers available for use in a system. These types are:

1. Sprayhead sprinklers

   a. Surface type - which do not pop.
   b. Pop-up type - available in standard and High-pop models.
   c. Shrub spray - fixed pattern.
   d. Bubble type - used to flood flower bed or Basins.

2. Impact sprinklers

   a. Permanent riser, mounted above ground.
   b. Used with portable key and quickcoupling valve.
   c. Rotor pop-up type submerged to ground level.

B. SPRINKLER FEATURES

1. Sprayhead sprinklers

   a. Emit single or double sheets or fans of water.
   b. Operate well in low pressure range of 15 to 30 psi.
   c. Cover small areas of 10 to 20 feet radius.
   d. Apply water at a relatively high rate - from one to two inches or greater per hour.

2. Impact Sprinklers

   a. Single or double nozzle, with water streams revolving over the area of coverage.
   b. Operating at high pressures - 30 to 80 psi. range.
   c. Covering large areas of 40 to 100 feet radius.
   d. Applying water at a low rate, generally from 0.20 inches to 0.50 inches per hour.
   e. Most economical for large, open turf areas - reduces the number of sprinkler heads, fittings, amount of pipe and trenching, installation, etc.
   f. Not distorted so easily by the wind because of sending a larger, more compact stream of water.

C. SELECTING SPRINKLERS

Selection of sprinklers and their spacing is usually affected by any one or all of the following factors:

1. General factors

   a. Type of sprinklers required. The choices include sprayhead or impact pop-up versus stationary.
   b. Size and shape of the areas to be irrigated. The engineers designing the sprinkler system should always take into account one of the most important economic factors - to cover the area with the least number of sprinklers without sacrificing water coverage on any area.
   c. The type and mixture of turf, shrub, and flower bed areas. As was the case in the Gassim project, the use of smaller sprinklers was necessary to water randomly mixed areas.
   d. The available water supply. This may influence which sprinkler is selected. However, this factor was irrelevant for the Gassim project because the availability of water for the Emirate was well secured.
   e. The local environmental conditions such as wind, rain, and temperature, as well as the type of soil and its ability to accept water. These will also affect the type of sprinkler selected. All these factors were taken into consideration by the project irrigation design engineers.

2. Special factors

Special factors to properly design the sprinkler system at the Gassim Emirate Palace Complex project were taken into account. Adequate consideration was given to the following factors:

   a. Different types of sprinkler heads should not be mixed together on the same circuit; the application rate must be nearly the same. Even with the same type of sprinklers on a circuit, half circle and quarter circle models must be selected at one-half and one-fourth the gpm discharge from that of the full circle heads.
   b. The operating pressures should be nearly the

> same for all sprinklers on a circuit. Furthermore, within the circuit of compatible sprinklers, the operating pressure at the various heads must be within certain limits for proper performance. Pressure variation between extreme heads on a given circuit should be within a 20 percent variation for good design and proper operation of a system.

D. BASICS OF SPRINKLER SPACING PATTERNS AND HEAD LAYOUT

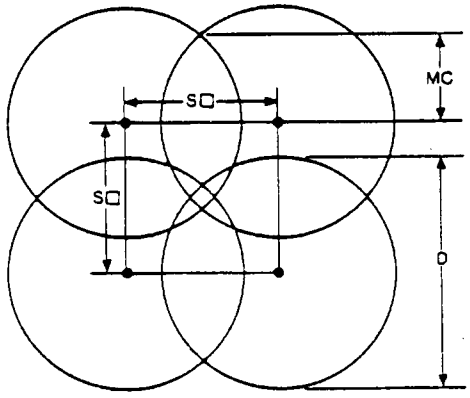
A brief discussion of the principles of sprinkler head layout is presented in this section.

There are two basic types of sprinkler spacing patterns: triangular and square spacing. Their shape and dimensions will depend upon the diameters of coverage by the individual sprinklers and the wind velocities apparent at the time of sprinkling.

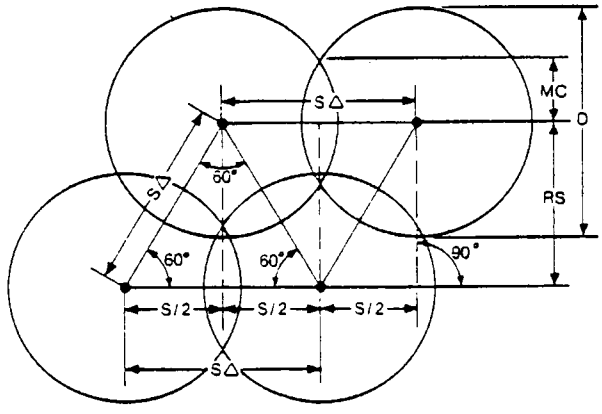
"In square spacing (Shown in Figure 5) heads are located at each of the four corners formed by a square. And in triangular spacing, heads fall at each of three points formed by an equilateral triangle in which the included angles are 60 degrees.

Square spacing is largely obsolescent because it does not provide the relatively uniform distribution of water characteristic to triangular spacing. This is due to the excess amount of overlap that occurs between heads to provide sufficient water at the center of the square where the four circles of coverage must overlap. With triangular spacing, heads can be spaced further apart as compared to square spacing; thus, fewer heads perform better at less cost." (5)

Very few areas will be of an exact size to accomodate a



Square Spacing



Equilateral Triangular Spacing

S□ = Square Spacing of heads
S△ = Equilateral triangular spacing of heads
S/2 = Equilateral triangular 1/2 spacing of heads
RS = Spacing between rows of heads
D = Diameter of coverage
MC = Mean coverage

Figure 5

SQUARE VS. TRIANGULAR SPACING

true equilateral triangular sprinkler pattern. However, the same quality of layout may be obtained with an equal spacing triangle pattern. This type pattern is produced by compressing an equilateral triangular pattern from one or both sides. It can easily be plotted if the following rules are followed:

1. Use the same spacing for all heads on all rows of heads.
2. Use the same spacing between all rows of heads.

Modifications of the two basic triangular and square patterns are often necessary to fit particular areas. Such modified patterns include the sliding pattern and the rectangular, staggered pattern - which represents a mixture of rectangular and triangular patterns.

Having obtained relevant knowledge of sprinkler head layout principles, Mr. Saleh, Mr. Amico, and the author proceeded with the project irrigation design by locating sprinkler heads so that they would water the lawn and all other plantings properly.

First, all sprinklers in trouble areas were located. Second, the designers proceeded to the open areas and located all sprinklers using the pattern of spacing which best suited that area. Finally, adjustment of sprinkler locations was made to fit into the overall system by compressing the pattern of heads. Special methods were used to locate sprinklers properly at special areas such as, strip areas, hedge row

areas, rounded corners, and inside and outside curves.

After the sprinklers had been spotted in all areas and the entire system checked for good coverage, the design system was ready for circuiting, pipe sizing, and programming.

STEP NO. 5: CIRCUITING SPRINKLERS AND LOCATING VALVES AND MAINLINES

To determine the sprinkler circuits the designers had to discuss such previously mentioned factors as the type of plants in each area, the type of sprinklers needed to water the particular plants, and the compatibility of the sprinklers in that area. Compatibility includes flow requirement and operating pressure. To determine the approximate gpm needed in each separate area of landscape, the designers added together the individual gpms for each sprinkler at that particular area. The sum of the gpm needed in each area equals the total system demand for water as if all sprinklers were turned on at once. The next important step in designing the sprinkler circuit was to locate the control valves and the mainline pipe, and calculate the circuit operating time.

A. LOCATING VALVES

Some of the factors determining their location are:

1. Valves should be located in areas where they are accessible for adjustment and maintenance;
2. Valves should be located in areas where the presence

of an exposed valve box cover will not interfere with normal traffic;

3. Valves should, when possible, be located between the extreme ends of the lateral line.

B. LOCATING MAINLINES

The location of the mainlines is done after balancing the size and arrangement of the lateral circuits by arranging each circuit to flow approximately the same flow rate. The mainline pipe should be located in such areas as - during and after installation - maintenance, and/or repair will create minimum interruption to the landscaped areas. In general, mainlines are located at the contours of the irrigated areas, and the circuits for lateral routings are selected in such a manner as to create the least possible total pressure loss.

C. CALCULATING CIRCUIT OPERATING TIME (PROGRAMMING)

At this stage of the design phase, a very important feature of the system design - the operating time for each type of sprinkler being used to distribute water to different types of plant material - should be determined. First, the rate of precipitation of sprinkler systems should be defined. "Rate of precipitation describes the length of time required to deposit a given depth of water on an area. System precipitation can be thought of as an equivalent amount of rainfall: both are measured in inches of depth water, would cover an

area." (5) The following formulas provided average precipitation for a system of full-circle and half-circle sprinklers:

1. full-circle sprinklers

$$P_r = \frac{\text{one head (gpm) x 96.25}}{\text{head spacing on row (ft) x row spacing (ft)}} = \text{in/hr precipitation}$$

(eq. 1)

2. half-circle sprinklers

$$P_r = \frac{\text{one head (gpm) x 192.50}}{\text{head spacing on row (ft) x row spacing (ft)}} = \text{in/hr precipitation}$$

(eq. 2)

To calculate the effects of the irrigation requirement for the system, sprinkler flow rate, and circuit precipitation rate on the circuit operating time requires the use of the following simple formula:

$$T_0 = \frac{I_0 \times 60}{P_r \times D_a}$$

(eq. 3)

where:

T_0 = Circuit operating time in minutes per day (min/day)

I_0 = System irrigation requirement in inches of water required per week (inch/week)

P_r = Circuit precipitation rate in inches of water applied per hour of irrigation (inch/hour)

D_a = Days of available irrigation time per calendar week (days/week)

60 = Constant conversion factor of 60 minutes per hour.

However, Mr. Saleh and Mr. Amico chose not to use the

method explained above. Instead, they calculated the irrigation time required for the various circuits by simply dividing the total water required by a circuit with the actual circuit flow rate. The author believes that the former method is a more accurate one and entails less adjustments after the system is installed.

The irrigation time for all circuits at the guest villa site and the main site of the Gassim project, along with the circuit total flow rate and water requirements, are shown in Appendix C.

STEP NO. 6: SIZING PIPE, VALVES, AND CALCULATING TOTAL SYSTEM PRESSURE REQUIRED

Sizing lateral pipes, mainline pipes, and valves, as well as calculating the total system pressure requirement constitute the heart of an irrigation system design. In this section, the author will describe the procedure and method he followed while designing the irrigation system of the Gassim project.

A. SIZING PIPE - Friction Factor Method

The Friction Factor Method provides for the calculation of a numerical guideline called the "friction factor." "The friction factor is an indicator of the allowable pressure loss (psi) or pressure variation between specific points in a sprinkler circuit." (6)

The friction factor method enables the designer to select

pipe sizes which will not exceed the allowable pressure variation over the length of the sprinkler lateral and or mainline.

The Friction Factor is calculated as:

$$F_f = \frac{\text{Sprinkler operating pressure x percent variation}}{\text{Critical length of circuit in hundreds of feet}} \qquad \text{(eq. 4)}$$

where:

Sprinkler operating pressure (P_o) equals the specified base or nozzle pressure at the last sprinkler head on the lateral line.

Percent variation (P_v) is the allowable variation in pressure between the extreme ends of the critical circuit. This value should be between 10 percent and 20 percent for optimum pipe sizing and system performance

Critical length of the circuit in hundreds of feet (L_c) is the length over which the allowable pressure variation is measured.

Hence, to select the appropriate critical pipe lengths and friction factors. The following step by step procedure was used.

1. Calculate the lateral critical length. This length is the longest distance from the circuit control valve to the sprinkler at the end of the lateral pipe.
2. Calculate the lateral friction factor using the formula explained above:

$$F_f = \frac{P_o \times P_v}{L_c} \qquad \text{(eq. 4a)}$$

The result is the average amount of pressure (psi) loss per 100 feet of pipe, regardless of pipe size.

3. Select the individual pipe section sizes. By entering the appropriate friction loss chart opposite required gpm flow, and reading horizontally, the designer finds a nominal pipe diameter for a particular PVC type.
4. Calculate the actual lateral pressure requirement. First, the decimal equivalent of the actual length of each pipe section is multiplied by the "actual friction factor" for that section. The result is the actual pressure loss. Second, all the actual pipe pressure losses are added together. Third, added to this quantity are the sprinkler operating pressure, a quantity of pressure to compensate for fitting losses - which may be approximated at 10 percent of the total pipe friction loss - and the pressure loss through the control valve.

The total of all the above pressure of friction losses now becomes the actual lateral pressure requirement.

5. Size the mainline pipe. Using the actual lateral pressure requirement from step 4, the mainline friction factor is calculated as follows:

$$F_{fm} = \frac{\text{Allowable Mainline Pressure Variation}}{\text{Length of Mainline (hundreds of feet)}} \qquad \text{(eq. 5)}$$

The "Allowable Mainline Pressure Variation" is determined by multiplying the pressure required at the inlet of the most

distant valve by 10 to 20 percent. The selection of mainline pipe sizes from the appropriate friction loss charts is done in the same manner as the one used to select lateral pipe sizes.

To calculate the actual mainline friction loss, the actual mainline friction factor is multiplied by the decimal equivalent of the mainline pipe length.

B. SIZING VALVES

Control valves are sized and selected for the amount of water which they must deliver to the sprinklers. They are selected so that the pressure loss through the valves remains less than 10 percent of the available pressure of the total flow.

From the valve performance chart, the appropriate valve sizes in inches opposite the gpm and approximate pressure loss rating are determined.

C. CALCULATING THE TOTAL SYSTEM PRESSURE REQUIREMENT

The total system pressure requirement is the accumulation of all losses incurred between the pump and the most distant sprinkler on a lateral pipe. These losses include sprinkler operating pressure, control valve pressure loss, elevation pressure loss, mainline and lateral pressure losses, etc.

The design calculations to determine the friction losses for both sites of the Gassim project irrigation systems are shown in Appendix D. Using the Al-Raha computer, Mr. Saleh and the

author programmed the calculations, using the Hazen and Williams empirical formula. The assumptions and elaboration of the formulas used are also presented in Appendix D.

At this stage of the design process, the designers were able to select the pumps for the project irrigation systems. Knowing the total required flow rate and the total pump head enabled the designers to determine the pump horsepower by the following formula (7):

$$\text{Brake hp} = \frac{\text{gpm x H (in feet) x sp gr}}{3960 \text{ x efficiency}} \qquad \text{(eq. 6)}$$

where:

gpm = U.S. gallons per minute delivered

H = total head in feet of liquid - differential

sp gr = specific gravity

STEP NO. 7: ESTIMATING POTENTIAL MAINLINE SURGE PRESSURE

When designing a sprinkler system the designers must consider surge pressures which may damage the mainline piping system. Surge pressure or "water hammer" occurs in a mainline pipe when the flow of water in that pipe is suddenly stopped. The magnitude of the surge pressure depends upon several factors: (1) the initial velocity of flow, and/or the quantity of water flowing through the pipe; (2) the amount of time it took to stop the flow of water in the pipe; and (3) the length of the mainline pipe between the point where the flow first stopped and the first entrance connection into the source of water.

However, the designers did not use a particular formula or nomograph to estimate the magnitude of potential surge pressures in this project. Instead, they took account of such problems by maintaining a fairly low velocity - 4ft/sec - and selecting plastic (PVC) pipes with safe burst pressure ratings.

STEP NO. 8: LOCATING CONTROLLERS AND SIZE WIRE

The location of the electric controllers is dependent on several factors, which were all taken into consideration while designing the project's sprinkler system: (1) the location of adequate power - 120 VAC - (2) the extreme locations of sprinkler circuit control valves; and (3) the requirement to place controllers inside a protective structure rather than to install them outside of the structure.

At the Gassim project, the electric controllers were located inside the irrigation pump room and very close to the source of power provided by the main contractor.

SIZING VALVE CONTROL WIRE AND CONTROLLER POWER WIRE

Valve control wire sizing charts are provided in every manufacturer's equipment catalog and for different operating pressure ranges. The procedure in sizing the wires for control valves in the case where there is only one valve per controller station is fairly simple. Knowing the distance from the controller out to each valve, the designer considers the longest distance and then uses the appropriate wire sizing chart

to select a ground and control wire size combination which meets the requirements of that specific valve. Since the longest wire circuit was selected, the largest wire size automatically must accompany it.

However, a more complicated problem was present in the Gassim project. More than one valve per controller station, and several controllers at one location, posed a different problem requiring a special design procedure. This procedure was accomplished by using several charts, the "equivalent length" method, the "F" wire factor, and a few relevant fromulas from electrical engineering.

The author acquired his knowledge of designing the electrical phase of an irrigation system through studying and reviewing literature pertinent to that subject, and learning from Mr. Saleh and Mr. Amico while closely interacting with them during the design process.

STEP NO. 9: PREPARING THE FINAL IRRIGATION PLAN

At this point, the design engineers should be able to present the final irrigation, plan including the general layout, legend, and all working drawings of the sprinkler system.

All irrigation drawings for the guest villa site and the main site of the Gassim project are shown in Appendix E. These shop drawings were submitted to and approved by the Saud Consult,

the consulting firm for the project.

STEP NO. 10: PREPARING A BILL OF MATERIALS

Preparing a bill of materials of a system design is an important factor that helps the designers to estimate the system costs as well as the approximate amount of different types of materials that need to be ordered to execute the work.

Accurate accounts of the number of sprinkler heads, valves, controllers, etc. are taken. Reasonable estimates of the number of fittings, quantities of pipe and wire are also determined. Then, a bill of material format is used to include all of this information.

IV. E. OTHER ENGINEERING WORK

One of the responsibilities assigned to the author while serving on his internship, other than designing the irrigation system for the Gassim project, was to supervise the execution and installation of the entire irrigation system at both the guest villa site and the main site. The author had to inspect the irrigation work to see if it was in accordance with codes and specifications set by the consultant; the piping network was performed according to the design shop drawings, and the type of materials being used for the irrigation networks were of good quality.

The author had the opportunity to supervise and experience the execution, operation, and maintenance of the entire irrigation system at the guest villa site. Unfortunately, only the design phase was accomplished for the main site. Free access to this site was not possible due to the main contractor's heavy works and time delays.

Furthermore, the author took advantage of every opportunity to learn about and contribute to the company in the field of mechanical engineering. He studied, reviewed, and supervised the design and execution of the mechanical systems of the fountains which were designed and executed by Modern Design Establishment, Al-Raha's subcontractor.

Having participated in all the phases of irrigation

system - including design, execution and supervision - the author feels that he gained enriching experience, through which he was given the opportunity to contribute much to the company in the technical aspect of his mechanical engineering field.

CHAPTER V. THE AUTHOR'S NON - TECHNICAL EXPERIENCE

V. A. INTRODUCTION

This chapter describes the author's involvement and experience in the non-academic, business environment while serving on his internship at Al-Raha Establishment in Riyadh, Saudi Arabia.

As mentioned previously, the author was assigned the duties of project manager over the softscaping portion of the project at the commencement of the work. The author was responsible for organizing and recruiting the members of the softscaping team, scheduling and budgeting the works, purchasing equipment and materials, and most importantly, effectively managing his team to produce satisfactory results.

During the fifth month of the internship, Al-Raha Establishment promoted the author to the position of assistant project manager for all the landscaping activities while permitting him to keep his position as project manager for the softscaping work. Assuming these two managerial positions was the most challenging and interesting task of the internship. In this dual role, through constant interaction with technical and administrative managers, the author learned much about decision making, human relations, planning, and organizing.

Following are the sections discussing the various activities in which the author was involved as activity manager and then as assistant project manager while serving on his internship at

the Gassim Emirate Palace Complex in Gassim, Saudi Arabia.

v. B. THE AUTHOR'S EXPERIENCE AS SOFTSCAPING DIVISION HEAD

The purpose of this section is to present the author's internship activities as company manager of the softscaping portion of the Gassim project.

1. Planning, Organizing, and Scheduling

Planning, organizing, and scheduling constitute the most important roles of a manager. The author was continuously involved in these actvities throughout the period of the internship. At the commencement of the project, he had to set the primary objectives pertinent to the execution of the softscaping work and then devise methods and procedures to implement those objectives. During this process, the author was in constant interaction with other more experienced project managers in the company - learning, discussing, and observing how they were running their projects. First, the author had to determine and secure his team to perform the works effectively. This involved the establishment of a group of engineers, foreman, secretary, and laborers. Second, he had to determine the type, quality, and quantity of materials and equipment needed for the project. Finally the author had the responsibility of organizing and utilizing the available manpower and material resources to execute the works.

The softscaping works involved several activities such as rough grading, excavation for trees, backfilling with agricul-

tural soil, soil spreading, and planting. Because these activities could upset the time tables for such other work as irrigation, electrical, and hardscaping, the author had to coordinate schedules with the other company managers to avoid interfering with their work. The author took advantage of the services Spectronics - Al-Raha's management consulting firm - is providing to his company to devise one schedule encompassing all the landscaping activities of the project and combining them in a way that is agreed upon by all division managers. Each activity manager is responsible for the execution of his work while cooperating with the other managers to complete all the works within a specified time span. This required constant organization, scheduling, reviewing, checking, and follow-up on the part of the author to effectively accomplish his task.

2. Personnel Recruitment

The author felt highly gratified that the general manager and administrative manager of the company asked him on many occasions to meet and interview job applicants. Interviewing each applicant was a new, interesting experience in itself. Some applicants were able to travel to Gassim and visit the site with the author while the latter explained to them the various activities involved in the project; and the author interviewed others at the main office in Riyadh. On several

occasions, the candidates resided outside of Saudi Arabia. In these cases, the author would carefully read their resumes and then contact the highly potential applicants either by phone, telex, or letter depending on the situation or location of the applicant.

Based on the author's interviews and evaluations, the higher management would make a decision whether or not the applicant receive an offer. Conversing with the potential employees was an enriching and illuminating experience during the course of the internship.

3. Purchasing and Accounting

As a director managing Al-Raha's softscaping work in the project, the author also had the duties of deciding and approving the purchase of all materials and equipment required by this division. The regular procedure was that the responsible engineer on the site would report to the author about the materials needed for the project, and then the author would decide whether or not to order these. One of the author's major involvements in this activity was when he suggested to the administrative financial manager the purchasing of a new loader and a new excavator-totaling to forty thousand dollars in value-to be used for the project and other ongoing ones. This suggestion was a result of numerous meetings between heavy equipment agents and the author to discuss equipment characteris-

tics and prices, and finally performing a cost - benefit analysis on purchasing a new equipment versus renting one or using laborers to accomplish the job.

Furthermore, the author was responsible for all the accounting and financial aspects of the work under his authority. Almost every week, he had to travel to Riyadh and meet with the financial manager in order to keep him up to date with the costs and expenses incurred or to be incurred in the project. He filled and signed all the payment vouchers for all purchase orders, and performed the monthly financial statements pertinent to the project. By constantly interacting with the financial manager and the company accountants throughout the course of the internship, the author acquired excellent experience in the financial and accounting fields. It is to be noted that the core required courses of the Doctor of Engineering Program in accounting and finance provided the intern with a good background to understand and perform the financial practices of the company.

4. Meetings

Among the managers at Al-Raha Establishment, the business, technical, and coordination meetings are common features of almost every business day. It soon became a very important task for the author to learn how to conduct an effective business meeting.

With all the managerial responsibilities assigned to him, the intern had little choice but to develop this fundamental skill as rapidly as possible. To meet this challenge, the author had to attend as many meetings as possible and actively participate in all of them. These meetings included weekly meetings among company department heads and the top management, as well as meetings between the administrative and financial manager and other company managers. The intern also attended numerous other meetings involving managers, engineers, materials supply agents, and salesmen whenever the opportunity arose. The attendance of these meetings not only helped to develop a feel for the characteristics of a good meeting but to provide the intern with a valuable insight into the events taking place throughout the firm.

From observing these many meetings, the intern was able to establish the following guidelines for conducting his own meetings effectively.

(1) Prepare in advance for the meeting and keep it moving once it has started.

(2) Avoid being led off the subject or having the meeting dominated by any person.

(3) Follow an agenda as closely as possible.

The author has learned that following the above keeps a meeting precise and concise.

The author organized and chaired all the meetings involving the softscaping team of the project and various other business meetings in connection with non-technical activities. Serving in the chair position presented a great chance for the intern to learn, experience, and then improve his ability in conducting business and technical meetings.

V. C. THE AUTHOR'S EXPERIENCE AS ASSISTANT PROJECT MANAGER

The promotion to the new position of assistant project manager for all the landscaping activities of the Gassim project constituted the most important, challenging event during the internship. The results were more responsibilities and challenges, which were soon to be translated into even harder work longer working hours. However, there was nothing the intern did not want or enjoy:

The following is an elaboration of the internship activities providing the intern with an opportunity to develop his own interpersonal and management skills. Some of these activities consisted of actual participation, while others were limited to observation only.

1. Project Coordination

Only through effective cooperation and coordination among all four activities of the landscaping work could good performance and meeting of deadlines be ensured. One of the responsibilities of the intern as assistant project manager was to coordinate the execution of the on-site work in order to ensure smooth operation, and to prevent disputes and time delays. It was also essential to create a good working atmosphere with the main contractor and the consultant as well.

At the request of the project manager, meetings including the heads of each landscaping activities were to be held at

the end of every working day. It was the intern's responsibility to organize and chair these daily meetings. A daily report of the accomplished work during that day was requested by the project manager to be submitted to the main contractor and, in turn, to the consultant for records. Hence, the intern had to fill out the daily report, based on the information and input of the different activity heads as well as his own observations of on-site progress. During those meetings, the work to be executed the following day was discussed, coordinated, and recorded for follow up and checking purposes. On many occasions, disputes due to lack of cooperation and work interference were translated into complaints. It was the intern's job to settle these disputes, stop any interference, and ensure better coordination among all activities. As the internship progressed, the chairing of these meetings became a pleasurable experience and a source of pride.

Project coordination not only involved the coordination among the various subcontractors but also encompassed dealing with the main contractor as well. Daily informal meetings with the main contractor's technical managers and often times its project manager were inevitable. These meetings were held for many different reasons depending on the circumstances. They consisted of daily on-site problems, requiring mainly cooperation and coordination of works.

A weekly meeting between the main contractor and the subcontractors was held at the main contractor's office on site. These meetings were generally attended by the project managers, the author, and the main contractor's engineering department heads. They were meant to be coordination meetings in which all pending issues and problems would be discussed and resolved. A typical agenda included such topics as checking the joint working schedule and how the work could be expedited to meet the deadlines; providing free access to a new area with no joint accupancy for the subcontractor to work in; and clarifying shop drawings.

2. Daily Correspondence

Most of the dealing with the main contractor and consultant was done in writing. As assistant project manager, the intern had the responsibility to read, review, and check all incoming correspondence as well as respond to it through either memorandums or letters. The most interesting part of this activity was to ensure constantly that the interest of the company was always protected. Claims charging the company with the responsibilities for time delays were to be defended, because soon these delays will be translated into financial liabilities to the company.

With the valuable help of the project manager, the intern was successful in protecting the firm's interests in the project;

he took weekly photographs of the work in progress and filed them, and effectively responded to all incoming correspondence from either the main contractor or consultant.

3. Monthly Progress Payments

The four major activities of the landscaping work were divided into several secondary ones varying in type and amount of work from one sector to another. They consisted of such activities as layout, concreting, trenching, cabling, soil spreading, pipe installation and testing. At the end of every month, the intern was responsible for accurately estimating the percentages of work accomplished during that particular period. This information was the basis on which the project manager and the author determined the company's monthly progress payment to include it in the monthly progress report. The monthly report shows the value of all the work accomplished to date as well as the value of the work performed during the last period. This report is then submitted to the consultant through the main contractor for final review before submitting it to the client for the monthly settlement of accounts.

Conducting and participating in all phases of work progress payments, from the estimation phase to the receipt of the check provided the intern with a rare and enriching experience,

4. Meetings

In addition to all the meetings discussed previously, the

author had the opportunity of attending the weekly meetings chaired by the consultant's project manager; these meetings involved only the main contractor's and subcontractor's project managers. Furthermore, the intern attended monthly meetings at the consultant's headquarters in Riyadh; these encompassed only project managers and top technical managers.

During all of these meetings, the intern carefully observed the managers' responses to highly complicated and critical issues.

For the intern, this activity was not only a skill to be learned; it gave him exposure to many key people in various companies and allowed him to observe how they interacted with each other.

V. D. OTHER NON-ACADEMIC EXPERIENCE

Numerous other internship activities contributed to the development of interpersonal and management skills. Interactions with many different people about various subjects took place every day. As a result, the author was able to develop further communication skills and more effective techniques of dealing with people.

The following two sections describe some of the different activities in which the intern was involved while serving on his internship.

1. Contract Writing

After the Gassim contract was signed, the intern was asked to write the contract between Al-Raha Establishment and Obal Est., the irrigation subcontracting company . At that time, the author had little knowledge and no practical experience in this field. To compensate, the intern made a very thorough study of previously signed contracts in the company as well as other contracts from different firms. After several weeks of preparation, the author was able to produce the required contract. It was then signed by both parties. A portion of this contract is included in Appendix F.

The learning process of contract writing was most interesting and valuable to the author. Not only had he the opportunity to learn how to write a contract but to be exposed to the

financial and banking aspects of securing a project. These include bank guarantees, performance bonds, and advance payments.

2. Seminars and Exhibitions

In addition to the previously mentioned involvements, the intern was careful to be constantly alert for the opportunity to participate in professional development activities beyond his duties for Al-Raha. Several seminars and annual exhibitions took place in Riyadh during the internship. The author attended all of these that fitted into his schedule.

The most important ones were the Rain Bird seminar and the annual exhibition of the Ministry of Agriculture. Rain Bird is the largest and most reputable irrigation company in the United States. Its seminar was chaired by the Rain Bird division manager in Saudi Arabia, and conducted by the company director of product development in the United States. Other than being a promotion session of Rain Bird products, the lectures in the seminar included topics such as irrigation design principles and techniques, new products, and the advantages of using specific products for particular applications.

The Annual Exhibition of the Ministry of Agriculture was an even bigger event. Local and international companies involved in the business of designing, manufacturing, and selling agricultural products or equipment and materials to be

used for agricultural practices participated in that exhibition. Getting acquainted with companies involved in the irrigation design and equipment manufacturing provided valuable experience to the intern. He had first-hand opportunity to inspect pumps, sprinklers, valves, and controllers, and meet with the representatives displaying these products.

Attendance at such seminars and exhibitions contributed to the fulfillment of the internship objectives, mainly because of the exposure it gave the intern to the up-to-date technology and engineering practices; it certainly contributed toward the intern's professional development.

CHAPTER VI. SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

This report served the purpose of elaborating on the various aspects of the author's internship experience with Al-Raha Establishment in Riyadh, Saudi Arabia. In evaluating the internship, the author feels that it fulfilled all the objectives of the Doctor of Engineering program. The intern had the opportunity to study and gain exposure to practically every part of the organization; acquired an excellent experience in engineering design; and significantly increased his interpersonal and management skills by participating in all project management activities

The internship experience has been most challenging, productive, and rewarding. The positive attitude of the internship supervisor, Mr. Zahi A. Mansour, and all of my colleages helped to make the internship even more enjoyable and successful.

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A P P E N D I C E S

APPENDIX A

Resume of Mr. Zahi Abou-Mansour (Intern Supervisor)

بسم الله الرحمن الرحيم

مؤسسة الرها للتجارة
ALRAHA EST. FOR TRADING
LANDSCAPING DIVISION
لصاحبها : الأمير فيصل بن فهد الفيصل

Tel. : 4760840 - 4778676
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Telex : 200692 ALRAHA SJ

تلفون : ٤٧٦٠٨٤٠ ـ ٤٧٧٨٦٧٦
ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ الرها أس جي

RESUME

Personal Data :

Name : Zahi Emile Abou-Mansour
Nationality : Lebanese
Birth Date : August 5, 1955
Height : 6' 0"
Marital Status : Single

Education :

Master of Engineering Degree, June 1979,
University of California at Davis, Civil Engineering.

Major in structural engineering with a minor in business management, including marketing and decision making policies.

Master Thesis : A computer aided report on wind effect on portable guyed towers.

Bachelor of Science Degree, May 1978,
Iowa State University, Civil Engineering

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تلفون : ٤٧٦٠٨٤٠ ـ ٤٧٧٨٦٧٦
ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ ارها س جي

Work Experience :

A. Oct. 1, 1982 - . Al Raha Establishment, Riyadh, Saudi Arabia. Work as a Project Manager on a Ten Million U.S. Dollar job. The work encompasses all landscaping (i.e. irrigation, planting, walkways, fountains, pergolas, swimming pools and external lighting) for the Gassim Emirate Palace Complex in Gassim, Saudi Arabia.

B. Sept. 1, 1980 - Sept. 30, 1982; Saudi Oger Ltd., Riyadh, Saudi Arabia.

- I started out as a Site Engineer in the Department of Private Villas. I was directly involved in the site problems (i.e. technical, materials, coordination between subcontractors). The site consisted of an approximate 8000 m2 of built area located in three different areas of Riyadh. The duration of the job was ten months and it was handed over on time.

C. - In September 1981, I was promoted to the position of Assistant Resident Engineer for a Forty Million U.S. Dollar job, consisting of a sophisticated palace of an approximate area of 15000 m2.

D. - In December 1981, I was promoted to the position of Resident Engineer on the same job and was responsible for all the management and coordination of the site.

E. - In April 1982, Saudi Oger Ltd. established a new branch office in London, and I was transfered there as a procurement manager for projects performed in Saudi Arabia.

F. - In September 1982, I resigned from Saudi Oger and joined Al Raha Est. as a Project Man. for their Gassim Emirate Palace Complex Project.

G. - July 1980 - June 1981, California Department of Transportation (Caltrans), Bridge Division. I held the position of an assistant Engineer and worked on the design of two overpasses. The first one was a regular reinforced slab and the second one was designed on a prestressed box girdle basis. Both designs were finished in six months, then I was transfered to the construction field to supervise the erection of five overpasses and two ramps in Oakland, California.

H. - March 1981 - June 1981 : Worked as a reader for an undergraduate Structural Engineering course at the University of California at Davis.

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ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ الرها اس جي

Work Experience cont.

I. Summer of 1978 : Worked on the structural design of a seven story building at the Bureau of Technical Studies in Beirut, Lebanon.

J. - Summers of 1973 thru 1977 : Worked in the logistics department of the Lebanese Organization for International Commerce (LORICO) in Beirut, Lebanon.

Languages :

Ability to read, speak and write English, French and Arabic fluently.

Hobbies :

Music and volley-ball.

APPENDIX B

Main Site Hardscaping Layout
Main Site Overall Picture, May 1983

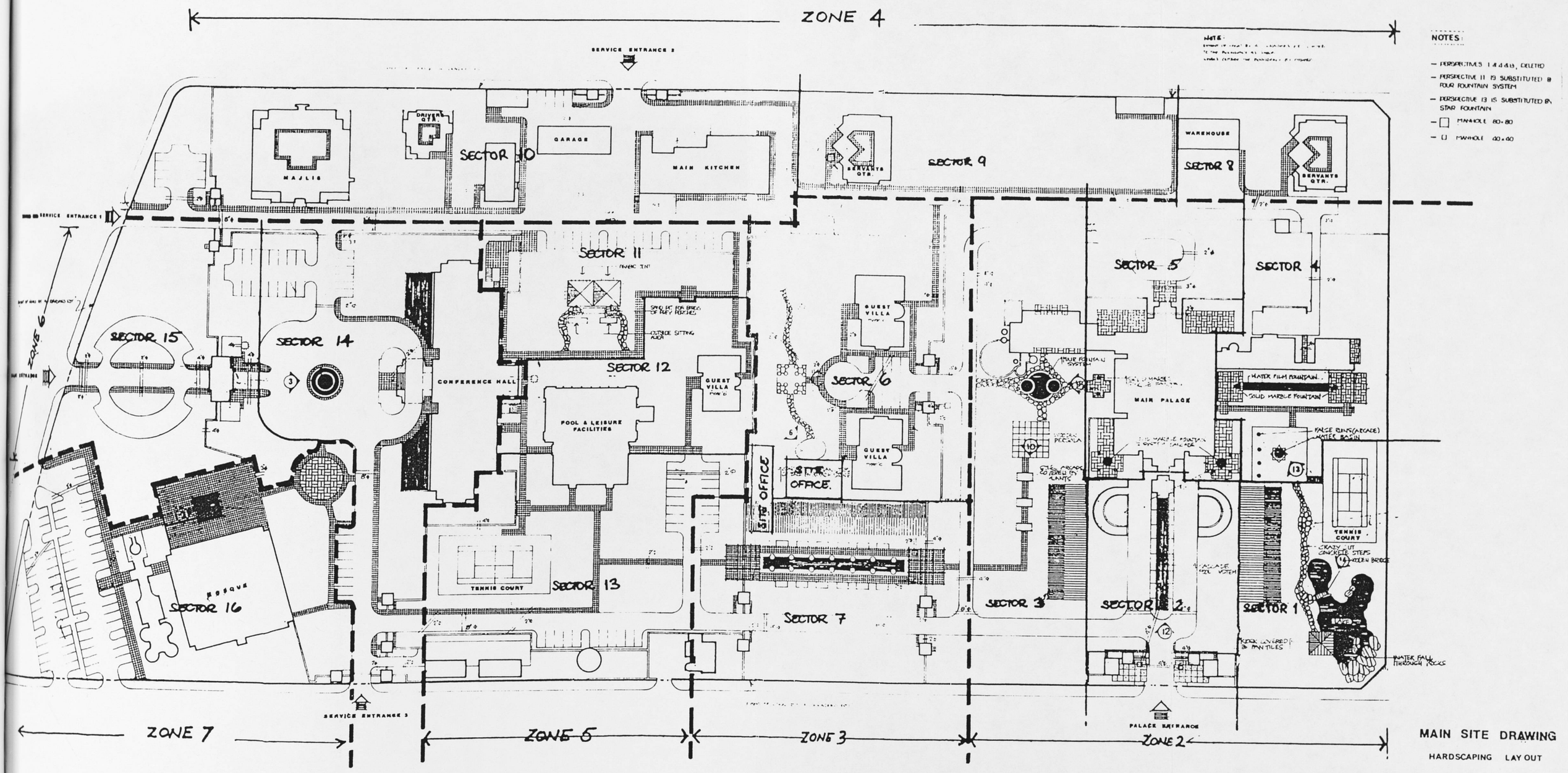


Figure B. 1

MAIN SITE HARDSCAPING LAYOUT

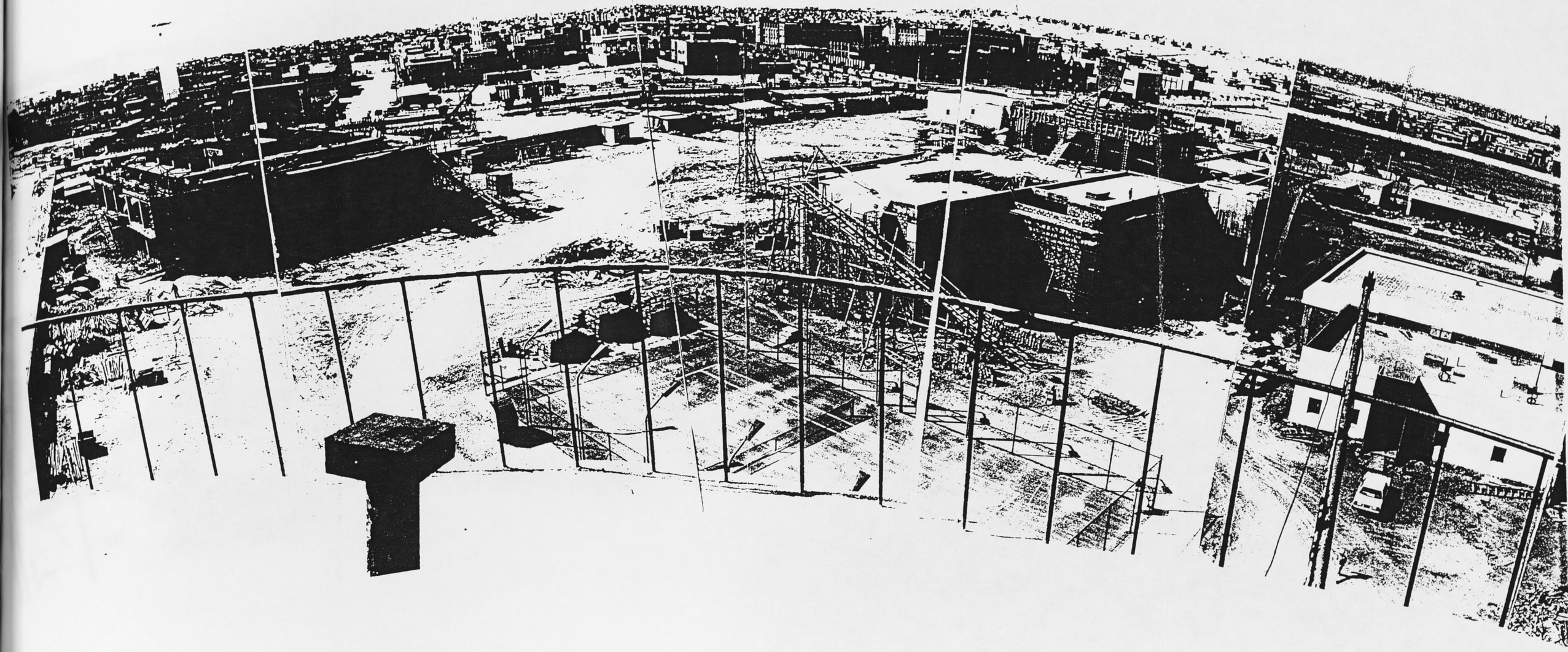


Figure B. 2a

MAIN SITE OVERALL PICTURE, MAY 1983

Figure B. 2b

MAIN SITE OVERALL PICTURE, MAY 1983

APPENDIX C

Water Requirement and Irrigation Time: Guest Villa Site and Main Site

PAGE NO. 00001

WATER REQUIREMENT AND IRRIGATION TIME * GUEST VILLA SITE

E.V. NO	SIZE E.V.	SYSTEM GPM	SYSTEM L/MIN	GR.COVR AREA	WATR REQ	TOT.WATER REQUIRED	TREE NOS	WATR REQ	TOT.WATER REQUIRED	IR.TIME.MIN GR.COVR.	IR.TIME.MIN TREES
1	2"	33.0	124.740	225.00	18	4050.00	0	0	0	32.467	0.000
2	2"	26.0	98.280	136.50	18	2457.00	0	0	0	25.000	0.000
2A	11/4"	16.8	63.504	0.00	0	0.00	12	75	900	0.000	14.172
3	2"	38.0	143.640	246.50	18	4437.00	0	0	0	30.889	0.000
3A	11/4"	14.0	52.920	0.00	0	0.00	10	75	750	0.000	14.172
4	11/4"	15.2	57.456	109.00	18	1962.00	0	0	0	34.147	0.000
4A	2"	32.2	121.716	0.00	0	0.00	23	75	1725	0.000	14.172
5	2"	41.0	154.980	273.25	18	4918.50	0	0	0	31.736	0.000
6	11/2"	17.0	64.260	112.50	18	2025.00	0	0	0	31.512	0.000
6A	11/4"	11.2	42.336	0.00	0	0.00	8	75	600	0.000	14.172
7	21/2"	58.4	213.192	555.25	18	9994.50	0	0	0	46.880	0.000
8	11/2"	22.2	83.916	91.50	18	1647.00	0	0	0	19.626	0.000
8A	11/4"	16.8	63.504	0.00	0	0.00	12	75	900	0.000	14.172
9A	11/2"	25.2	95.256	0.00	0	0.00	18	75	1350	0.000	14.172
10	2"	28.5	107.730	288.50	18	5193.00	0	0	0	48.203	0.000
10A	2"	35.0	132.300	0.00	0	0.00	25	75	1875	0.000	14.172
11	1"	8.8	33.264	88.00	18	1584.00	0	0	0	47.619	0.000
12	11/2"	33.5	126.630	179.00	18	3222.00	0	0	0	25.444	0.000
12A	11/2"	14.0	52.920	0.00	0	0.00	10	75	750	0.000	14.172
13	2"	33.3	125.874	235.25	18	4234.50	0	0	0	33.640	0.000
13A	2"	36.4	137.592	0.00	0	0.00	26	75	1950	0.000	14.172
14	2"	32.7	123.606	265.00	18	4770.00	0	0	0	38.590	0.000
15	11/2"	24.6	92.988	62.00	18	1116.00	0	0	0	12.001	0.000
15A	11/2"	25.2	95.256	0.00	0	0.00	18	75	1350	0.000	14.172
16	2"	38.1	144.018	248.50	18	4473.00	0	0	0	31.058	0.000
17	11/2"	25.0	94.500	136.50	18	2457.00	0	0	0	26.000	0.000
17A	11/2"	22.4	84.672	0.00	0	0.00	17	75	1275	0.000	15.058
18	2"	26.0	98.280	210.50	18	3789.00	0	0	0	38.553	0.000
18A	11/4"	15.4	58.212	0.00	0	0.00	11	75	825	0.000	14.172
19	2"	33.0	124.740	144.25	18	2596.50	0	0	0	20.815	0.000
20	11/2"	26.0	98.280	212.25	18	3820.50	0	0	0	38.873	0.000
20A	11/4"	12.6	47.628	0.00	0	0.00	9	75	675	0.000	14.172
21	11/2"	12.5	47.250	60.00	18	1080.00	0	0	0	22.857	0.000
21A	11/4"	12.6	47.628	0.00	0	0.00	9	75	675	0.000	14.172
22	2"	32.0	120.960	157.50	18	2835.00	0	0	0	23.437	0.000
23	2"	37.5	141.750	371.25	18	6682.50	0	0	0	47.142	0.000
23A	2"	30.8	116.424	0.00	0	0.00	22	75	1650	0.000	14.172
24	11/2"	18.0	68.040	102.50	18	1845.00	0	0	0	27.116	0.000
24A	11/2"	23.8	89.964	0.00	0	0.00	18	75	1350	0.000	15.006
25	11/2"	17.4	65.772	75.00	18	1350.00	0	0	0	20.525	0.000
25A	2"	30.8	116.424	0.00	0	0.00	22	75	1650	0.000	14.172
26	2"	40.0	151.200	327.00	18	5886.00	0	0	0	38.928	0.000
27	11/2"	25.0	94.500	115.75	18	2083.50	0	0	0	22.047	0.000
27A	11/2"	21.0	79.380	0.00	0	0.00	15	75	1125	0.000	14.172
28	2"	50.0	189.000	141.50	18	2547.00	0	0	0	13.476	0.000
29	2"	50.0	189.000	141.50	18	2547.00	0	0	0	13.476	0.000
** TOTAL **		1236.9	4675.482	5311.25	504	95602.50			21375		

E.V. NO = ELECTRIC VALVE NUMBER AS PER DRAWINGS
SIZE E.V. = ELECTRIC VALVE SIZE (INCH)
SYSTEM GPM = AMOUNT OF WATER DELIVERD BY THE SYSTEM (GPM)
SYSTEM L/MIN = " " " " " " (LPM)
GR.COVER AREA = AREA OF GROUND COVER AS PER DRWNGS.(SM)
WATER REQ. = GR.COVER WATER REQUIRMENTS (L/SM/DAY)
TOT.WATER REQUIRED = GR.COVERD TOTAL WATER REQUIRMENTS (L/DAY)
TREE NOS = NUMBER OF TREES
WATER REQ = TREES WATER REQUIRMENTS (L/TREE/DAY)
TOT.WATER REQUIRED = TREES TOTAL WATER REQUIRMENTS (L/DAY)
IR.TIME.MIN GR.COVER= TOTAL IRRIGATION TIME FOR GROUND COVER(MIN)
IR.TIME.MIN TREES = TOTAL IRRIGATION TIME FOR TREES (MIN)

WATER REQUIREMENT AND IRRIGATION TIME * MAIN PALACE AREA

E.V. NO	SIZE E.V.	SYSTEM AC/GPM	SYSTEM ACTL/MIN	GR.COVR. AREA	WATR REQ	TOT.WATER REQUIRED	TREE NOS	WATR REQ	TOT.WATER REQUIRED	IR.TIME.MIN GR.COVR.	IR.TIME.MIN TREES
1	2"	40.0	151.200	192.00	18	3456.00	0	0	0	22.857	0.000
2	2"	40.0	151.200	423.00	18	7614.00	0	0	0	50.357	0.000
3	2"	39.0	147.420	595.00	18	10710.00	0	0	0	72.649	0.000
5	2"	40.0	151.200	602.00	18	10836.00	0	0	0	71.666	0.000
6	2"	36.0	136.080	0.00	0	0.00	24	75	1800	0.000	13.227
7	2"	34.8	131.544	350.00	18	6300.00	0	0	0	47.892	0.000
8	11/2"	25.0	94.500	130.00	18	2340.00	0	0	0	24.761	0.000
9	2"	34.9	131.922	500.00	18	9000.00	0	0	0	68.222	0.000
10	2"	36.0	136.080	0.00	0	0.00	24	75	1800	0.000	13.227
11	2"	39.0	147.420	0.00	0	0.00	26	75	1950	0.000	13.227
15	11/2"	20.4	77.112	91.00	18	1652.40	0	0	0	21.428	0.000
16	2"	35.5	134.190	231.00	18	4150.00	0	0	0	30.985	0.000
17	11/4"	19.0	71.820	102.00	18	1836.00	0	0	0	25.563	0.000
19	2"	40.0	151.200	267.00	18	4806.00	0	0	0	31.785	0.000
22	2"	40.0	151.200	410.00	18	7380.00	0	0	0	48.809	0.000
23	2"	30.0	113.400	0.00	0	0.00	20	75	1500	0.000	13.227
24	11/2"	25.5	96.390	0.00	0	0.00	17	75	1275	0.000	13.227
25	2"	37.0	139.860	633.00	18	11394.00	0	0	0	81.467	0.000
26	11/2"	25.0	94.500	182.00	18	3276.00	0	0	0	34.666	0.000
28	2"	40.0	151.200	370.00	18	6660.00	0	0	0	44.047	0.000
31	11/4"	12.0	45.360	0.00	0	0.00	8	75	600	0.000	13.227
22A	2"	40.0	151.200	424.00	18	7632.00	0	0	0	50.476	0.000
34	2"	40.0	151.200	480.00	18	8640.00	0	0	0	57.142	0.000
35	2"	33.0	124.740	0.00	0	0.00	22	75	1650	0.000	13.227
36	2"	40.0	151.200	639.00	18	11502.00	0	0	0	76.071	0.000
38	11/2"	25.0	94.500	197.00	18	3546.00	0	0	0	37.523	0.000
43	2"	35.1	132.678	460.00	18	8280.00	0	0	0	62.406	0.000
44	2"	36.0	136.080	0.00	0	0.00	24	75	1800	0.000	13.227
45	2"	38.5	145.530	256.00	18	4608.00	0	0	0	31.603	0.000
47	2"	38.1	144.018	270.00	18	4860.00	0	0	0	33.745	0.000
48	2"	34.5	130.410	0.00	0	0.00	23	75	1725	0.000	13.227
50	2"	40.0	151.200	470.00	18	8460.00	0	0	0	55.952	0.000
51	11/2"	25.0	94.500	208.00	18	3744.00	0	0	0	39.619	0.000
52	2"	35.5	134.190	605.00	18	10890.00	0	0	0	81.153	0.000
53	2"	38.5	145.530	230.00	18	4140.00	0	0	0	28.447	0.000
54	11/4"	15.0	56.700	0.00	0	0.00	11	75	825	0.000	14.550
56	2"	36.0	136.080	482.00	18	8676.00	0	0	0	63.756	0.000
59	11/4"	18.0	68.040	0.00	0	0.00	12	75	900	0.000	13.227
60	11/4"	16.7	63.126	110.00	18	1980.00	0	0	0	31.365	0.000
61	11/2"	18.5	73.710	0.00	0	0.00	11	75	825	0.000	11.182
62	2"	40.0	151.200	268.00	18	4824.00	0	0	0	31.904	0.000
63	2"	40.0	151.200	473.00	18	8514.00	0	0	0	56.309	0.000
64A	2"	40.0	151.200	361.00	18	6498.00	0	0	0	42.976	0.000
64	2"	40.0	151.200	361.00	18	6498.00	0	0	0	42.976	0.000
66A	2"	40.0	151.200	476.00	18	8568.00	0	0	0	56.666	0.000
66	2"	40.0	151.200	476.00	18	8568.00	0	0	0	56.666	0.000
67	2"	37.2	140.616	192.00	18	3456.00	0	0	0	24.577	0.000
68	2"	30.2	140.176	0.00	0	0.00	27	75	2025	0.000	13.666

WATER REQUIREMENT AND IRRIGATION TIME * MAIN PALACE AREA

E.V. NO	SIZE E.V.	SYSTEM AC/GPM	SYSTEM ACTL/MIN	GR.COVR. AREA	WATR REQ	TOT.WATER REQUIRED	TREE NOS	WATR REQ	TOT.WATER REQUIRED	IR.TIME.MIN GR.COVR.	IR.TIME.MIN TREES
69	2"	39.2	140.176	0.00	0	0.00	27	75	2025	0.000	13.666
49	2"	40.0	151.200	410.00	18	7380.00	0	0	0	48.809	0.000
50A	2"	40.0	151.200	470.00	18	8460.00	0	0	0	55.952	0.000
70	2"	39.2	140.176	0.00	0	0.00	27	75	2025	0.000	13.666
71	2"	40.0	151.200	504.00	18	8072.00	0	0	0	60.000	0.000
72	11/2"	25.0	94.500	160.00	18	2880.00	0	0	0	30.476	0.000
74	11/2"	23.8	89.964	192.00	18	3456.00	0	0	0	38.415	0.000
75	2"	36.0	136.080	0.00	0	0.00	24	75	1800	0.000	13.227
76	2"	34.0	128.520	476.00	18	8568.00	0	0	0	66.666	0.000
77	2"	40.0	151.200	225.00	18	4050.00	0	0	0	26.785	0.000
78	11/4"	15.8	59.724	84.00	18	1512.00	0	0	0	25.316	0.000
80	11/2"	25.0	94.500	130.00	18	2340.00	0	0	0	24.761	0.000
81	2"	37.9	143.262	367.00	18	6606.00	0	0	0	46.111	0.000
83	2"	32.5	122.850	283.00	18	5094.00	0	0	0	41.465	0.000
84	2"	31.5	119.070	0.00	0	0.00	21	75	1575	0.000	13.227
85	2"	27.0	102.060	0.00	0	0.00	18	75	1350	0.000	13.227
86	2"	40.0	151.200	536.00	18	9648.00	0	0	0	63.809	0.000
87	2"	34.8	131.544	292.00	18	5256.00	0	0	0	39.956	0.000
88	2"	40.0	151.200	374.00	18	6732.00	0	0	0	44.523	0.000
89	2"	40.0	151.200	349.00	18	6282.00	0	0	0	41.547	0.000
91	11/2"	25.5	96.390	0.00	0	0.00	17	75	1275	0.000	13.227
82	11/4"	19.0	71.820	91.00	18	1638.00	0	0	0	22.807	0.000
94	2"	33.0	124.740	0.00	0	0.00	22	75	1650	0.000	13.227
95	2"	38.4	145.152	340.00	18	6120.00	0	0	0	42.162	0.000
97	2"	40.0	151.200	425.00	18	7650.00	0	0	0	50.595	0.000
98	2"	40.0	151.200	267.00	18	4806.00	0	0	0	31.785	0.000
100	2"	39.0	147.420	0.00	0	0.00	26	75	1950	0.000	13.227
101	2"	28.7	108.486	442.00	18	7956.00	0	0	0	73.336	0.000
102	11/4"	15.5	58.590	84.60	18	1521.00	0	0	0	25.960	0.000
103	2"	40.0	151.200	385.00	18	6930.00	0	0	0	45.833	0.000
105	2"	33.9	128.142	196.20	18	3531.60	0	0	0	27.560	0.000
107	2"	39.2	148.176	677.00	18	12186.00	0	0	0	82.240	0.000
108	2"	38.3	144.774	448.00	18	8064.00	0	0	0	55.700	0.000
109	11/2"	25.0	94.500	174.00	18	3132.00	0	0	0	33.142	0.000
111	11/2"	21.0	79.380	0.00	0	0.00	14	75	1050	0.000	13.227
112	2"	28.5	107.730	0.00	0	0.00	19	75	1425	0.000	13.227
113	2"	36.5	137.970	178.00	18	3204.00	0	0	0	23.222	0.000
114	2"	37.0	139.860	351.00	18	6318.00	0	0	0	45.173	0.000
115	2"	34.5	130.410	0.00	0	0.00	23	75	1725	0.000	13.227
116	2"	40.0	151.200	390.00	18	7020.00	0	0	0	46.428	0.000
117	2"	36.8	139.104	583.00	18	10494.00	0	0	0	75.439	0.000
119	2"	34.6	130.788	204.00	18	3672.00	0	0	0	28.075	0.000
121	2"	38.7	146.286	309.00	18	5562.00	0	0	0	38.021	0.000
122	11/4"	18.0	71.020	71.00	18	1278.00	0	0	0	17.794	0.000
123	11/2"	26.0	84.500	198.00	18	3582.00	0	0	0	37.904	0.000
125	2"	38.5	145.530	333.00	18	5994.00	0	0	0	41.187	0.000
127	2"	40.0	151.200	412.00	18	7416.00	0	0	0	49.047	0.000
128	2"	25.5	96.390	0.00	0	0.00	17	75	1275	0.000	13.227

WATER REQUIREMENT AND IRRIGATION TIME * MAIN PALACE AREA

E.V. NO	SIZE E.V.	SYSTEM AC/GPM	SYSTEM ACTL/MIN	GR.COVR. AREA	WATR REQ	TOT.WATER REQUIRED	TREE NOS	WATR REQ	TOT.WATER REQUIRED	IR.TIME.MIN GR.COVR.	IR.TIME.MIN TREES
129	11/2"	21.0	79.380	0.00	0	0.00	14	75	1050	0.000	13.227
130	2"	40.1	151.578	662.00	18	11916.00	0	0	0	78.612	0.000
131	2"	27.0	102.060	0.00	0	0.00	18	75	1350	0.000	13.227
132	2"	40.0	151.200	483.00	18	8694.00	0	0	0	57.500	0.000
133	2"	27.0	102.060	0.00	0	0.00	18	75	1350	0.000	13.227
135	2"	40.0	151.200	398.00	18	7164.00	0	0	0	47.380	0.000
137	2"	36.2	136.836	443.00	18	7974.00	0	0	0	58.274	0.000
138	2"	40.0	151.200	364.00	18	6552.00	0	0	0	43.333	0.000
139	2"	28.5	107.730	0.00	0	0.00	19	75	1425	0.000	13.227
141	2"	28.5	107.730	0.00	0	0.00	19	75	1425	0.000	13.227
143	2"	34.5	130.410	0.00	0	0.00	23	75	1725	0.000	13.227
144	2"	40.0	151.200	424.00	18	7632.00	0	0	0	50.476	0.000
145	2"	39.2	148.176	525.00	18	9450.00	0	0	0	63.775	0.000
146	2"	40.0	151.200	582.00	18	10476.00	0	0	0	69.205	0.000
147	2"	40.0	151.200	436.00	18	7848.00	0	0	0	51.904	0.000
149	11/2"	22.5	85.050	0.00	0	0.00	14	75	1050	0.000	12.345
150	2"	39.0	147.420	0.00	0	0.00	26	75	1950	0.000	13.227
151	2"	40.0	151.200	350.00	18	6300.00	0	0	0	41.666	0.000
152	11/2"	25.0	94.500	500.00	18	9000.00	0	0	0	95.238	0.000
154	2"	39.2	148.176	358.00	18	6300.00	0	0	0	42.517	0.000
155	2"	37.9	143.262	450.00	18	8100.00	0	0	0	56.539	0.000
156	11/2"	24.0	90.720	0.00	0	0.00	16	75	1200	0.000	13.227
157	2"	40.0	151.200	343.00	18	6174.00	0	0	0	40.833	0.000
158	2"	37.5	141.750	0.00	0	0.00	25	75	1875	0.000	13.227
160	11/2"	26.4	99.792	130.00	18	2340.00	0	0	0	23.448	0.000
161	11/2"	19.5	73.710	0.00	0	0.00	13	75	975	0.000	13.227
162	2"	40.0	151.200	286.00	18	5148.00	0	0	0	34.047	0.000
66B	2"	40.0	151.200	476.00	18	8568.00	0	0	0	56.666	0.000
66C	2"	40.0	151.200	476.00	18	8568.00	0	0	0	56.666	0.000
86A	2"	40.0	151.200	536.00	18	9648.00	0	0	0	63.809	0.000
88A	2"	40.0	151.200	374.00	18	6732.00	0	0	0	44.523	0.000
89A	2"	40.0	151.200	349.00	18	6282.00	0	0	0	41.547	0.000
97A	2"	40.0	151.200	425.00	18	7650.00	0	0	0	50.595	0.000
103A	2"	40.0	151.200	385.00	18	6930.00	0	0	0	45.833	0.000
116A	2"	40.0	151.200	390.00	18	7020.00	0	0	0	46.428	0.000
127A	2"	40.0	151.200	413.00	18	7434.00	0	0	0	49.166	0.000
132A	2"	40.0	151.200	483.00	18	8694.00	0	0	0	57.500	0.000
135A	2"	40.0	151.200	398.00	18	7164.00	0	0	0	47.380	0.000
138A	2"	40.0	151.200	364.00	18	6552.00	0	0	0	43.333	0.000
144A	2"	40.0	151.200	424.00	18	7632.00	0	0	0	50.476	0.000
147A	2"	40.0	151.200	436.00	18	7848.00	0	0	0	51.904	0.000
147B	2"	40.0	151.200	436.00	18	7848.00	0	0	0	51.904	0.000
159A	2"	40.0	151.200	343.00	18	6174.00	0	0	0	40.833	0.000
159B	2"	40.0	151.200	343.00	18	6174.00	0	0	0	40.833	0.000
162A	2"	40.0	151.200	286.00	18	5148.00	0	0	0	34.047	0.000
80	2"	38.3	144.774	278.00	18	5004.00	0	0	0	34.564	0.000
83	2"	35.6	134.568	282.00	18	5076.00	0	0	0	37.720	0.000
104	2"	37.5	141.750	0.00	0	0.00	25	75	1875	0.000	13.227

WATER REQUIREMENT AND IRRIGATION TIME * MAIN PALACE AREA

E.V. NO	SIZE E.V.	SYSTEM AC/GPM	SYSTEM ACTL/MIN	GR.COVR. AREA	WATR REQ	TOT.WATER REQUIRED	TREE NOS	WATR REQ	TOT.WATER REQUIRED	IR.TIME.MIN GR.COVR.	IR.TIME.MIN TREES
110	2"	33.0	124.740	0.00	0	0.00	22	75	1650	0.000	13.227
120	2"	37.7	142.506	330.00	18	5940.00	0	0	0	41.602	0.000
134	11/4"	18.0	71.820	173.00	18	3114.00	0	0	0	43.358	0.000
136	2"	33.1	125.118	326.00	18	5868.00	0	0	0	46.899	0.000
151A	2"	40.0	151.200	350.00	18	6300.00	0	0	0	41.666	0.000
153	2"	34.5	130.410	0.00	0	0.00	23	75	1725	0.000	13.227
** TOTAL **		5144.4	19445.032	39730.50	1998	716148.00			58425		

APPENDIX D

Head Loss and Design Calculations: Main Site

Design Calculations: Guest Villa Site

PAGE NO. 00001

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 1							
2" PVC.PIPE	1.0	100.0	1.00	2.83	1.14	3.22620000	0.21938160000
11/4" PVC.PIPE	1.0	32.0	1.00	2.58	1.14	0.94118400	0.06400051200
1" PVC.PIPE	1.0	14.0	1.00	1.89	1.14	0.30164400	0.02051179200
3/4" PVC.PIPE	1.0	13.0	1.00	1.07	1.14	0.15857400	0.01078303200
1/2" PVC.PIPE	1.0	94.0	1.00	1.19	1.14	1.27520400	0.08671387200
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
** SUBTOTAL **						5.97379240	0.40621720320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 2							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC PIPE	1.0	27.0	1.00	2.83	1.14	0.87107400	0.05923303200
11/2" PVC.PIPE	1.0	23.0	1.00	2.65	1.14	0.69403000	0.04720444000
11/4"PVC. PIPE	1.0	30.0	1.00	2.58	1.14	0.88230000	0.06000048000
1" PVC.PIPE	1.0	7.0	1.00	1.89	1.14	0.15092200	0.01025509600
3/4" PVC.PIPE	1.0	16.0	1.00	1.07	1.14	0.19516800	0.01327142400
1/2" PVC.PIPE	1.0	26.0	1.00	1.19	1.14	0.35271600	0.02398468800
** SUBTOTAL **						3.21794640	0.21882035520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 3							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	40.0	1.00	2.83	1.14	1.29048000	0.08775264000
11/2" PVC PIPE	1.0	10.0	1.00	2.65	1.14	0.30210000	0.02054280000
11/4"PVC.PIPE	1.0	17.0	1.00	2.58	1.14	0.50000400	0.03400027200
1"PVC.PIPE	1.0	8.0	1.00	1.89	1.14	0.17236000	0.01172102400
3/4"PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12198000	0.00829464000
1/2" PVC.PIPE	1.0	47.0	1.00	1.19	1.14	0.63760200	0.04336893600
** SUBTOTAL **						3.09551040	0.21049470720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 4							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
1" PVC.PIPE	1.0	24.0	1.00	1.89	1.14	0.51710400	0.03516307200
3/4" PVC.PIPE	1.0	12.0	1.00	1.07	1.14	0.14637600	0.00995356000
1/2" PVC.PIPE	1.0	65.0	1.00	1.19	1.14	0.88179000	0.05996172000
** SUBTOTAL **						1.93886640	0.13184291520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 5							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/2" PVC.PIPE	1.0	4.0	1.00	2.65	1.14	0.12084000	0.00821712000
11/4"PVC.PIPE	1.0	34.0	1.00	2.58	1.14	1.00000800	0.06800054400

PAGE NO. 00002

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 5							
1" PVC.PIPE	1.0	24.0	1.00	1.69	1.14	0.51710400	0.03516307200
3/4" PVC. PIPE	1.0	26.0	1.00	1.07	1.14	0.31714800	0.02156606400
1/2" PVC.PIPE	1.0	34.0	1.00	1.19	1.14	0.46124400	0.03136459200
** SUBTOTAL **						2.68080240	0.18230068320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 6							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	9.0	1.00	2.83	1.14	0.29035800	0.01974434400
11/2" PVC.PIPE	1.0	15.0	1.00	2.65	1.14	0.45315000	0.03081420000
11/4" PVC.PIPE	1.0	15.0	1.00	2.58	1.14	0.44118000	0.03000024000
1" PVC.PIPE	1.0	6.0	1.00	1.89	1.14	0.12927600	0.00879076800
3/4" PVC.PIPE	1.0	14.0	1.00	1.07	1.14	0.17077200	0.01161249600
1/2" PVC.PIPE	1.0	59.0	1.00	1.19	1.14	0.80039400	0.05442679200
** SUBTOTAL **						2.35610640	0.16021523520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 7							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC. PIPE	1.0	84.0	1.00	2.83	1.14	2.71000800	0.18428054400
11/2"PVC.PIPE	1.0	13.0	1.00	2.65	1.14	0.39273000	0.02670564000
11/4"PVC.PIPE	1.0	38.0	1.00	2.58	1.14	1.11765600	0.07600060800
1" PVC.PIPE	1.0	30.0	1.00	1.89	1.14	0.64638000	0.04395384000
3/4" PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12198000	0.00829464000
1/2" PVC.PIPE	1.0	37.0	1.00	1.19	1.14	0.50194200	0.03413205600
** SUBTOTAL **						5.54205200	0.37685960400
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 8							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	13.0	1.00	2.83	1.14	0.41940600	0.02851960800
11/2" PVC.PIPE	1.0	8.0	1.00	2.65	1.14	0.24168000	0.01643424000
11/4" PVC.PIPE	1.0	4.0	1.00	2.58	1.14	0.11764800	0.00800006400
1" PVC.PIPE	1.0	10.0	1.00	1.89	1.14	0.21546000	0.01465128000
3/4" PVC.PIPE	1.0	5.0	1.00	1.07	1.14	0.06099000	0.00414732000
1/2" PVC.PIPE	1.0	97.0	1.00	1.19	1.14	1.18024200	0.08025645600
** SUBTOTAL **						2.30640240	0.15683536320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 9							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	35.0	1.00	2.83	1.14	1.12917000	0.07678356000
11/4" PVC.PIPE	1.0	20.0	1.00	2.58	1.14	0.58824000	0.04000032000
1" PVC.PIPE	1.0	37.0	1.00	1.89	1.14	0.79720200	0.05420973600
3/4" PVC.PIPE	1.0	18.0	1.00	1.07	1.14	0.21956400	0.01493035200

PAGE NO. 00003

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 9							
1/2" PVC.PIPE	1.0	74.0	1.00	1.19	1.14	1.00388400	0.06826411200
** SUBTOTAL **						3.80003640	0.25901447520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 10							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	9.0	1.00	2.83	1.14	0.29035800	0.01974434400
11/2" PVC.PIPE	1.0	17.0	1.00	2.65	1.14	0.51357000	0.03492276000
11/4" PVC.PIPE	1.0	32.0	1.00	2.58	1.14	0.94118400	0.06400051200
1" PVC.PIPE	1.0	23.0	1.00	1.89	1.14	0.49555800	0.03369794400
1" PVC.PIPE	1.0	23.0	1.00	1.89	1.14	0.49555800	0.03369794400
3/4" PVC.PIPE	1.0	12.0	1.00	1.07	1.14	0.14637600	0.00995356800
1/2" PVC.PIPE	1.0	49.0	1.00	1.19	1.14	0.66470400	0.04520191200
** SUBTOTAL **						3.61631440	0.24604537920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 11							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096900000
1" PVC.PIPE	1.0	18.0	1.00	1.89	1.14	0.38782800	0.02637230400
3/4" PVC.PIPE	1.0	18.0	1.00	1.07	1.14	0.21956400	0.01493035200
1/2" PVC.PIPE	1.0	32.0	1.00	1.19	1.14	0.43411200	0.02951961600
** SUBTOTAL **						1.25417100	0.08528362000
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 12							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	2.0	1.00	2.83	1.14	0.06452400	0.00438763200
11/2"PVC.PIPE	1.0	9.0	1.00	2.65	1.14	0.27185000	0.01848852000
11/4" PVC.PIPE	1.0	13.0	1.00	2.58	1.14	0.38235600	0.02600020800
1" PVC.PIPE	1.0	17.0	1.00	1.89	1.14	0.36628200	0.02490717600
3/4" PVC.PIPE	1.0	5.0	1.00	1.07	1.14	0.06099000	0.00414732000
1/2" PVC.PIPE	1.0	45.0	1.00	1.19	1.14	0.61047000	0.04151196000
** SUBTOTAL **						1.02748840	0.12426921120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 13							
11/4"ELEC.VALVE	1.5	1.0	1.00	2.16	1.14	0.03693600	0.00251164800
2" PVC.PIPE	1.0	73.0	1.00	2.83	1.14	2.35512600	0.16014856800
11/2" PVC.PIPE	1.0	10.0	1.00	2.65	1.14	0.30210000	0.02054280000
11/4" PVC.PIPE	1.0	28.0	1.00	2.58	1.14	0.82353600	0.05600044800
1" PVC. PIPE	1.0	30.0	1.00	1.89	1.14	0.64638000	0.04395384000
3/4" PVC.PIPE	1.0	12.0	1.00	1.07	1.14	0.14637600	0.00995356800
1/2" PVC.PIPE	1.0	15.0	1.00	1.19	1.14	0.20349000	0.01383732000
** SUBTOTAL **						4.51394400	0.30694819200

PAGE NO. 00004

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 14							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	33.0	1.00	2.83	1.14	1.06464600	0.07239592000
11/2" PVC.PIPE	1.0	19.0	1.00	2.65	1.14	0.57399000	0.03903132000
11/4" PVC.PIPE	1.0	29.0	1.00	2.58	1.14	0.85294600	0.05800046400
1" PVC. PIPE	1.0	27.0	1.00	1.89	1.14	0.58174200	0.03955045600
3/4" PVC.PIPE	1.0	48.0	1.00	1.07	1.14	0.58550400	0.03981427200
1/2" PVC.PIPE	1.0	73.0	1.00	1.19	1.14	0.99031800	0.06734162400
** SUBTOTAL **						4.72012440	0.32096845920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 15							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096908000
11/2"PVC.PIPE	1.0	17.0	1.00	2.65	1.14	0.51357000	0.03492276000
11/4"PVC.PIPE	1.0	7.0	1.00	2.58	1.14	0.20588400	0.01400011200
1" PVC.PIPE	1.0	24.0	1.00	1.89	1.14	0.51710400	0.03516307200
3/4" PVC.PIPE	1.0	13.0	1.00	1.07	1.14	0.15857400	0.01078303200
1/2" PVC.PIPE	1.0	39.0	1.00	1.19	1.14	0.52907400	0.03597703200
** SUBTOTAL **						2.15649240	0.14664148320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 16							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	11.0	1.00	2.83	1.14	0.35488200	0.02413197600
1/2" PVC.PIPE	1.0	64.0	1.00	1.19	1.14	0.86822400	0.05903923200
** SUBTOTAL **						1.29408240	0.08799760320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 17							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/4" PVC.PIPE	1.0	21.0	1.00	2.58	1.14	0.61765200	0.04200033600
1" PVC.PIPE	1.0	14.0	1.00	1.89	1.14	0.30164400	0.02051179200
3/4" PVC.PIPE	1.0	15.0	1.00	1.07	1.14	0.18297000	0.01244196000
1/2" PVC.PIPE	1.0	36.0	1.00	1.19	1.14	0.48837600	0.03320956800
** SUBTOTAL **						1.35519040	0.12615294720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 18							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
11/2" PVC.PIPE	1.0	6.0	1.00	2.65	1.14	0.18126000	0.01232568000
11/4" PVC.PIPE	1.0	21.0	1.00	2.58	1.14	0.61765200	0.04200033600
1" PVC.PIPE	1.0	10.0	1.00	1.89	1.14	0.21546000	0.01465126000
3/4" PVC.PIPE	1.0	6.0	1.00	1.07	1.14	0.07318800	0.00497678400
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67800000	0.04612440000
** SUBTOTAL **						1.81721700	0.12357075600

PAGE NO. 00005

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 19							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	32.0	1.00	2.83	1.14	1.03238400	0.07020211200
11/2" PVC.PIPE	1.0	4.0	1.00	2.65	1.14	0.12064000	0.00821712000
11/4" PVC.PIPE	1.0	10.0	1.00	2.58	1.14	0.29412000	0.02000016000
1" PVC.PIPE	1.0	6.0	1.00	1.89	1.14	0.12927600	0.00879076800
3/4" PVC.PIPE	1.0	8.0	1.00	1.07	1.14	0.09758400	0.00663571200
1/2" PVC.PIPE	1.0	105.0	1.00	1.19	1.14	1.42443000	0.09686124000
** SUBTOTAL **						3.16961040	0.21555350720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 20							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
11/2" PVC.PIPE	1.0	6.0	1.00	2.65	1.14	0.18126000	0.01232568000
11/4" PVC.PIPE	1.0	8.0	1.00	2.58	1.14	0.23529600	0.01600012800
1" PVC.PIPE	1.0	53.0	1.00	1.89	1.14	1.14193800	0.07755179400
3/4" PVC.PIPE	1.0	40.0	1.00	1.07	1.14	0.48792000	0.03317856000
1/2" PVC.PIPE	1.0	100.0	1.00	1.19	1.14	1.35660000	0.09224880000
** SUBTOTAL **						3.45437100	0.23489722800
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 21							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	50.0	1.00	2.83	1.14	1.61310000	0.10969080000
11/4" PVC.PIPE	1.0	30.0	1.00	2.58	1.14	0.88236000	0.06000048000
1" PVC.PIPE	1.0	56.0	1.00	1.89	1.14	1.20657600	0.08204716800
3/4" PVC.PIPE	1.0	25.0	1.00	1.07	1.14	0.30495000	0.02073660000
1/2" PVC.PIPE	1.0	100.0	1.00	1.19	1.14	1.35660000	0.09224880000
** SUBTOTAL **						5.43456240	0.36955024320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 22							
11/4"ELEC.VALVE	1.5	1.0	1.00	2.16	1.14	0.03693600	0.00251164800
2" PVC.PIPE	1.0	3.0	1.00	2.83	1.14	0.09678600	0.00658144800
1" PVC.PIPE	1.0	20.0	1.00	1.89	1.14	0.43092000	0.02930256000
3/4" PVC.PIPE	1.0	15.0	1.00	1.07	1.14	0.18297000	0.01244196000
1/2" PVC.PIPE	1.0	43.0	1.00	1.19	1.14	0.58333800	0.03966698400
** SUBTOTAL **						1.33095000	0.09050460000
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 23							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/2" PVC.PIPE	1.0	6.0	1.00	2.65	1.14	0.18126000	0.01232568000
11/4" PVC.PIPE	1.0	13.0	1.00	2.58	1.14	0.38235600	0.02600020800
1" PVC.PIPE	1.0	3.0	1.00	1.89	1.14	0.06463800	0.00439538400

PAGE NO. 00006

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUANTITY	1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 23							
3/4" PVC.PIPE	1.0	34.0	1.00	1.07	1.14	0.41473200	0.02820177600
1/2" PVC.PIPE	1.0	48.0	1.00	1.19	1.14	0.65116800	0.04427942400
** SUBTOTAL **						1.95870240	0.13319176320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 24							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/2" PVC.PIPE	1.0	5.0	1.00	2.65	1.14	0.15105000	0.01027140000
11/4" PVC.PIPE	1.0	27.0	1.00	2.58	1.14	0.79412400	0.05400043200
1" PVC.PIPE	1.0	29.0	1.00	1.89	1.14	0.62483400	0.04248871200
3/4" PVC.PIPE	1.0	13.0	1.00	1.07	1.14	0.15857400	0.01078303200
1/2" PVC.PIPE	1.0	46.0	1.00	1.19	1.14	0.62403600	0.04243444800
** SUBTOTAL **						2.61716640	0.17796731520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 25							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	78.0	1.00	2.83	1.14	2.51643000	0.17111764800
11/4" PVC.PIPE	1.0	6.0	1.00	2.58	1.14	0.17647200	0.01200009600
1" PVC.PIPE	1.0	32.0	1.00	1.89	1.14	0.68947200	0.04688409600
3/4" PVC.PIPE	1.0	31.0	1.00	1.07	1.14	0.37813800	0.02571338400
1/2" PVC.PIPE	1.0	150.0	1.00	1.19	1.14	2.03490000	0.13837320000
** SUBTOTAL **						5.86639440	0.39901481920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 26							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	126.0	1.00	2.83	1.14	4.06501200	0.27642081600
11/2" PVC.PIPE	1.0	20.0	1.00	2.65	1.14	0.84586000	0.05751084000
11/4" PVC.PIPE	1.0	29.0	1.00	2.58	1.14	0.85294800	0.05800046400
1" PVC.PIPE	1.0	28.0	1.00	1.89	1.14	0.60326800	0.04102358400
3/4" PVC.PIPE	1.0	32.0	1.00	1.07	1.14	0.39033600	0.02654284800
1/2" PVC.PIPE	1.0	119.0	1.00	1.19	1.14	1.61435400	0.10977607200
** SUBTOTAL **						8.44279440	0.57411001920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 27							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096908000
11/2" PVC.PIPE	1.0	6.0	1.00	2.65	1.14	0.18126000	0.01232568000
11/4" PVC.PIPE	1.0	9.0	1.00	2.58	1.14	0.26470800	0.01800014400
1" PVC.PIPE	1.0	2.0	1.00	1.89	1.14	0.04309200	0.00293025600
3/4" PVC.PIPE	1.0	20.0	1.00	1.07	1.14	0.24396000	0.01658928000
1/2" PVC.PIPE	1.0	60.0	1.00	1.19	1.14	0.81396000	0.05534928000
** SUBTOTAL **						1.75964700	0.11965599600

PAGE NO. 00007

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 28							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	13.0	1.00	2.83	1.14	0.41940600	0.02851960800
11/2" PVC.PIPE	1.0	17.0	1.00	2.65	1.14	0.51357000	0.03492276000
1" PVC.PIPE	1.0	26.0	1.00	1.89	1.14	0.56019600	0.03809332800
3/4" PVC.PIPE	1.0	12.0	1.00	1.07	1.14	0.14637600	0.00995356800
1/2" PVC.PIPEE	1.0	150.0	1.00	1.19	1.14	2.03490000	0.13837320000
** SUBTOTAL **						3.74542440	0.25468865920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 29							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	4.0	1.00	2.83	1.14	0.12904800	0.00877526400
11/2" PVC.PIPE	1.0	4.0	1.00	2.65	1.14	0.12084000	0.00821712000
11/4" PVC. PIPE	1.0	14.0	1.00	2.58	1.14	0.41176800	0.02800022400
1" PVC.PIPE	1.0	11.0	1.00	1.89	1.14	0.23700600	0.01611640800
3/4" PVC.PIPE	1.0	15.0	1.00	1.07	1.14	0.18297000	0.01244196000
1/2" PVC.PIPE	1.0	70.0	1.00	1.19	1.14	0.94962000	0.06457416000
** SUBTOTAL **						2.10222840	0.14295153120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 30							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	7.0	1.00	2.83	1.14	0.22583400	0.01535671200
11/4" PVC.PIPE	1.0	10.0	1.00	2.58	1.14	0.29412000	0.02000016000
1" PVC. PIPE	1.0	5.0	1.00	1.89	1.14	0.10773000	0.00732564000
1/2" PVC.PIPE	1.0	74.0	1.00	1.19	1.14	1.00388400	0.06826411200
** SUBTOTAL **						1.70254440	0.11577301920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 31							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	13.0	1.00	2.83	1.14	0.41940600	0.02851960800
11/2" PVC.PIPE	1.0	21.0	1.00	2.65	1.14	0.63441000	0.04313986000
11/4" PVC.PIPE	1.0	19.0	1.00	2.58	1.14	0.55882800	0.03800039400
1" PVC.PIPE	1.0	15.0	1.00	1.89	1.14	0.32319000	0.02197692000
3/4" PVC.PIPE	1.0	21.0	1.00	1.07	1.14	0.25615800	0.01741874400
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67830000	0.04612440000
** SUBTOTAL **						2.94126840	0.20000625120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 32							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
11/2" PVC.VALVE	1.0	4.0	1.00	2.65	1.14	0.12084000	0.00821712000
11/4" PVC.PIPE	1.0	5.0	1.00	2.58	1.14	0.14706000	0.01000008000
1" PVC.PIPE	1.0	43.0	1.00	1.89	1.14	0.92647800	0.06300050400

PAGE NO. 00008

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 32							
3/4" PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12198000	0.00829464000
1/2" PVC.PIPE	1.0	102.0	1.00	1.19	1.14	1.38373200	0.09409377600
** SUBTOTAL **						2.77106640	0.18843251520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 33							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	19.0	1.00	2.83	1.14	0.61297800	0.04168250400
1" PVC.PIPE	1.0	15.0	1.00	1.89	1.14	0.32319000	0.02197692000
3/4" PVC.PIPE	1.0	14.0	1.00	1.07	1.14	0.17077200	0.01161249600
1/2" PVC.PIPE	1.0	39.0	1.00	1.19	1.14	0.52907400	0.03597703200
** SUBTOTAL **						1.70099040	0.11607534720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 34							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	13.0	1.00	2.83	1.14	0.41940600	0.02851960800
11/2" PVC.PIPE	1.0	4.0	1.00	2.65	1.14	0.12004000	0.00821712000
11/4" PVC.PIPE	1.0	12.0	1.00	2.58	1.14	0.35294400	0.02400019200
1" PVC.PIPE	1.0	10.0	1.00	1.89	1.14	0.21546000	0.01465128000
3/4" PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12198000	0.00829464000
1/2" PVC.PIPE	1.0	70.0	1.00	1.19	1.14	0.94962000	0.06457416000
** SUBTOTAL **						2.25122640	0.15308339520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 35							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	125.0	1.00	2.83	1.14	4.03275000	0.27422700000
11/2" PVC.VALVE	1.0	20.0	1.00	2.65	1.14	0.60420000	0.04108560000
11/4" PVC.PIPE	1.0	72.0	1.00	2.58	1.14	2.11766400	0.14400115200
1" PVC.PIPE	1.0	52.0	1.00	1.89	1.14	1.12039200	0.07618665600
3/4" PVC.PIPE	1.0	22.0	1.00	1.07	1.14	0.26835600	0.01824820800
1/2" PVC.PIPE	1.0	125.0	1.00	1.19	1.14	1.09575000	0.11531100000
** SUBTOTAL **						9.89046900	0.67255189200
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 36							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	42.0	1.00	2.83	1.14	1.35500400	0.09214027200
11/2" PVC.PIPE	1.0	10.0	1.00	2.65	1.14	0.30210000	0.02054280000
1" PVC.PIPE	1.0	23.0	1.00	1.89	1.14	0.49555800	0.03369794400
3/4" PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12198000	0.00829464000
1/2" PVC.PIPE	1.0	35.0	1.00	1.19	1.14	0.47481000	0.03220708000
** SUBTOTAL **						2.82042840	0.19178913120

PAGE NO. 00009

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 37							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	70.0	1.00	2.83	1.14	2.25034000	0.15356712000
11/4" PVC.PIPE	1.0	22.0	1.00	2.58	1.14	0.64706400	0.04400035200
3/4" PVC.PIPE	1.0	19.0	1.00	1.07	1.14	0.23176200	0.01575981600
1/2" PVC.PIPE	1.0	26.0	1.00	1.19	1.14	0.35271600	0.02398468800
** SUBTOTAL **						3.56005840	0.24213837120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 38							
11/4"ELEC.VALVE	1.5	1.0	1.00	2.16	1.14	0.03693600	0.00251164800
11/4" PVC.VALVE	1.0	20.0	1.00	2.58	1.14	0.58824000	0.04000032000
1" PVC.PIPE	1.0	18.0	1.00	1.89	1.14	0.38702800	0.02632230400
3/4" PVC.PIPE	1.0	8.0	1.00	1.07	1.14	0.09758400	0.00663571200
1/2" PVC.PIPE	1.0	93.0	1.00	1.19	1.14	0.71899800	0.04889186400
** SUBTOTAL **						1.82958600	0.12441184800
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 39							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	3.0	1.00	2.83	1.14	0.09676600	0.00658144800
11/2" PVC.PIPE	1.0	5.0	1.00	2.65	1.14	0.15105000	0.01027140000
11/4" PVC.PIPE	1.0	57.0	1.00	2.58	1.14	1.67648400	0.11400091200
1" PVC.PIPE	1.0	20.0	1.00	1.89	1.14	0.43092000	0.02930256000
3/4" PVC.PIPE	1.0	9.0	1.00	1.07	1.14	0.10978200	0.00746517600
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67800000	0.04612440000
** SUBTOTAL **						3.21429840	0.21857229120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 40							
11/4"ELEC.VALVE	1.5	1.0	1.00	2.16	1.14	0.03693600	0.00251164800
11/4" PVC.PIPE	1.0	11.0	1.00	2.58	1.14	0.32353200	0.02200017600
1" PVC.PIPE	1.0	12.0	1.00	1.89	1.14	0.25855200	0.01758153600
3/4" PVC.PIPE	1.0	9.0	1.00	1.07	1.14	0.10978200	0.00746517600
1/2" PVC.PIPE	1.0	20.0	1.00	1.19	1.14	0.27132000	0.01844976000
** SUBTOTAL **						1.00012200	0.06800829600
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 41							
11/4"ELEC.VALVE	1.5	1.0	1.00	2.16	1.14	0.03693600	0.00251164800
11/4" PVC.PIPE	1.0	10.0	1.00	2.58	1.14	0.29412000	0.02000016000
1" PVC.PIPE	1.0	6.0	1.00	1.89	1.14	0.12927600	0.00879076800
1/2" PVC.PIPE	1.0	29.0	1.00	1.19	1.14	0.39341400	0.02675215200
** SUBTOTAL **						0.85374600	0.05805472800

PAGE NO. 00010

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 42							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	4.0	1.00	2.83	1.14	0.12904800	0.00877526400
11/4" PVC.PIPE	1.0	12.0	1.00	2.58	1.14	0.35294400	0.02400019200
1" PVC.PIPE	1.0	15.0	1.00	1.89	1.14	0.32319000	0.02197692000
3/4" PVC.PIPE	1.0	6.0	1.00	1.07	1.14	0.07318800	0.00497678400
1/2" PVC.PIPE	1.0	102.0	1.00	1.19	1.14	1.38373200	0.09409377600
** SUBTOTAL **						2.31345900	0.15731521200
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 43							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	44.0	1.00	2.83	1.14	1.41952000	0.09652790400
1" PVC.PIPE	1.0	18.0	1.00	1.89	1.14	0.38782800	0.02637230400
3/4" PVC.PIPE	1.0	44.0	1.00	1.07	1.14	0.53671200	0.03649641600
1/2" PVC.PIPE	1.0	36.0	1.00	1.19	1.14	0.48837600	0.03320956800
** SUBTOTAL **						2.90342040	0.19743258720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 44							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/4" PVC.PIPE	1.0	25.0	1.00	2.58	1.14	0.73530000	0.05000040000
1" PVC.PIPE	1.0	8.0	1.00	1.89	1.14	0.17236800	0.01172102400
3/4" PVC.PIPE	1.0	28.0	1.00	1.07	1.14	0.34154400	0.02322499200
1/2" PVC.PIPE	1.0	67.0	1.00	1.19	1.14	0.90892200	0.06180669600
** SUBTOTAL **						2.42268240	0.16474240320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 45							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096900000
1" PVC.PIPE	1.0	8.0	1.00	1.89	1.14	0.17236800	0.01172102400
3/4" PVC.PIPE	1.0	7.0	1.00	1.07	1.14	0.08538600	0.00580624800
1/2" PVC.PIPE	1.0	49.0	1.00	1.19	1.14	0.66473400	0.04520191200
** SUBTOTAL **						1.15477440	0.07852465920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 46							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	23.0	1.00	2.83	1.14	0.74202600	0.05045776800
1" PVC.PIPE	1.0	29.0	1.00	1.89	1.14	0.62483400	0.04248871200
3/4" PVC.PIPE	1.0	13.0	1.00	1.07	1.14	0.15857400	0.01078303200
1/2" PVC.PIPE	1.0	32.0	1.00	1.19	1.14	0.43411200	0.02951961600
** SUBTOTAL **						2.03052240	0.13807552320

PAGE NO. 00011

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATH
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 47							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
1 1/2" PVC.PIPE	1.0	5.0	1.00	2.65	1.14	0.15105000	0.01027140000
1 1/4" PVC.PIPE	1.0	13.0	1.00	2.58	1.14	0.52941600	0.03600028800
1" PVC.PIPE	1.0	18.0	1.00	1.89	1.14	0.38782800	0.02637230400
3/4" PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12196000	0.00829464000
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	[illegible]	[illegible]
** SUBTOTAL **						[illegible]	0.10300750720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 48							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	34.0	1.00	2.83	1.14	1.09690800	0.07458974400
1/2" PVC.PIPE	1.0	36.0	1.00	1.19	1.14	0.48837600	0.03320956800
** SUBTOTAL **						1.65626040	0.11262570720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 49							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	16.0	1.00	2.83	1.14	0.51619200	0.03510105600
3/4" PVC.PIPE	1.0	17.0	1.00	1.07	1.14	0.20736600	0.01410088800
1/2" PVC.PIPE	1.0	18.0	1.00	1.19	1.14	0.24418000	0.01660478400
** SUBTOTAL **						1.03872240	0.07063312320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 50							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	32.0	1.00	2.83	1.14	1.03238400	0.07020211200
1/2" PVC.PIPE	1.0	37.0	1.00	1.19	1.14	0.50194200	0.03413205600
** SUBTOTAL **						1.60530240	0.10916056320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 51							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	7.0	1.00	2.83	1.14	0.22583400	0.01535671200
1/2" PVC.PIPE	1.0	37.0	1.00	1.19	1.14	0.50194200	0.03413205600
** SUBTOTAL **						0.79875240	0.05431516320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 52							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	9.0	1.00	2.83	1.14	0.29035800	0.01974434400
1 1/4" PVC.PIPE	1.0	20.0	1.00	2.58	1.14	0.58824000	0.04000032000
1" PVC.PIPE	1.0	7.0	1.00	1.89	1.14	0.15082200	0.01025589600

PAGE NO. 00012

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 52							
3/4" PVC.PIPE	1.0	4.0	1.00	1.07	1.14	0.04679200	0.00331785600
1/2" PVC.PIPE	1.0	28.0	1.00	1.19	1.14	0.37984800	0.02582966400
** SUBTOTAL **						1.52903640	0.10397447520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 53							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	18.0	1.00	2.83	1.14	0.58071600	0.03948868800
11/2" PVC.PIPE	1.0	10.0	1.00	2.65	1.14	0.30210000	0.02054280000
11/4" PVC.PIPE	1.0	40.0	1.00	2.58	1.14	1.17648000	0.08000064000
1" PVC.PIPE	1.0	30.0	1.00	1.89	1.14	0.64638000	0.04395384000
3/4" PVC.PIPE	1.0	20.0	1.00	1.07	1.14	0.24396000	0.01658928000
1/2" PVC.PIPE	1.0	31.0	1.00	1.19	1.14	0.42054600	0.02859712000
** SUBTOTAL **						3.44115040	0.23399077120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 54							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	28.0	1.00	2.83	1.14	0.90333600	0.06142684800
11/4" PVC.PIPE	1.0	23.0	1.00	2.59	1.14	0.67547600	0.04600036800
1" PVC.PIPE	1.0	34.0	1.00	1.89	1.14	0.73256400	0.04981435200
3/4" PVC.PIPE	1.0	20.0	1.00	1.07	1.14	0.24396000	0.01658928000
1/2" PVC.PIPE	1.0	48.0	1.00	1.19	1.14	0.65116800	0.04427942400
** SUBTOTAL **						3.27848040	0.22293666720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 55							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	55.0	1.00	2.83	1.14	1.77441000	0.12065988000
1" PVC.PIPE	1.0	16.0	1.00	1.89	1.14	0.34473600	0.02344204800
3/4" PVC.PIPE	1.0	17.0	1.00	1.07	1.14	0.20736600	0.01410088000
1/2" PVC.PIPE	1.0	71.0	1.00	1.19	1.14	0.96318600	0.06549664800
** SUBTOTAL **						3.36067440	0.22852585920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 56							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	35.0	1.00	2.83	1.14	1.12917000	0.07678356000
11/2" PVC.PIPE	1.0	33.0	1.00	2.65	1.14	0.99693000	0.06779124000
11/4" PVC.PIPE	1.0	11.0	1.00	2.58	1.14	0.32353200	0.02200017600
1" PVC.PIPE	1.0	39.0	1.00	1.89	1.14	0.84029400	0.05713999200
3/4" PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12198000	0.00829464000
1/2" PVC.PIPE	1.0	128.0	1.00	1.19	1.14	1.73644800	0.11807846400
** SUBTOTAL **						5.21933040	0.35491446720

PAGE NO. 00013

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 57							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	36.0	1.00	2.03	1.14	1.16143200	0.07897737600
11/2" PVC.PIPE	1.0	16.0	1.00	2.65	1.14	0.48036000	0.03266048000
11/4" PVC.PIPE	1.0	16.0	1.00	2.50	1.14	0.47059200	0.03200025600
1" PVC.PIPE	1.0	36.0	1.00	1.89	1.14	0.77565600	0.05274460800
3/4" PVC.PIPE	1.0	23.0	1.00	1.07	1.14	0.20055400	0.01907767200
1/2" PVC.PIPE	1.0	43.0	1.00	1.19	1.14	0.58332000	0.03966096400
** SUBTOTAL **						3.80620000	0.25882765200
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 58							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
11/2" PVC.PIPE	1.0	4.0	1.00	2.65	1.14	0.12034000	0.00821712000
11/4" PVC.PIPE	1.0	14.0	1.00	2.50	1.14	0.41176800	0.02800022400
1" PVC.PIPE	1.0	19.0	1.00	1.89	1.14	0.40937400	0.02783740200
3/4" PVC.PIPE	1.0	22.0	1.00	1.07	1.14	0.20033600	0.01824220800
1/2" PVC.PIPE	1.0	47.0	1.00	1.19	1.14	0.63760200	0.04335693600
** SUBTOTAL **						1.99099700	0.12915219600
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 59							
2" ELEC.VALVE	2.2	1.0	1.00	2.03	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.03	1.14	0.32262000	0.02193816000
11/2" PVC.PIPE	1.0	13.0	1.00	2.65	1.14	0.39272000	0.02670564000
11/4" PVC.PIPE	1.0	13.0	1.00	2.50	1.14	0.38095000	0.02590020000
1" PVC.PIPE	1.0	10.0	1.00	1.89	1.14	0.21546000	0.01465128000
3/4" PVC.PIPE	1.0	16.0	1.00	1.07	1.14	0.19516000	0.01327142400
1/2" PVC.PIPE	1.0	55.0	1.00	1.19	1.14	0.74613000	0.05073684000
** SUBTOTAL **						2.32544840	0.15812894720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 60							
2" ELEC.VALVE	2.2	1.0	1.00	2.03	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	20.0	1.00	2.03	1.14	0.64524000	0.04387632000
11/2" PVC.PIPE	1.0	14.0	1.00	2.65	1.14	0.42294000	0.02875992000
1" PVC.PIPE	1.0	4.0	1.00	1.89	1.14	0.08618400	0.00586051200
3/4" PVC.PIPE	1.0	35.0	1.00	1.07	1.14	0.42093000	0.02862324000
1/2" PVC.PIPE	1.0	70.0	1.00	1.19	1.14	0.94962000	0.06457416000
** SUBTOTAL **						2.60189040	0.17692054720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 61							
2" ELEC.VALVE	2.2	1.0	1.00	2.82	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	59.0	1.00	2.03	1.14	1.90345800	0.12943514400
11/4" PVC.PIPE	1.0	14.0	1.00	2.50	1.14	0.41176000	0.02800022400

PAGE NO. 00014

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 61							
1" PVC.PIPE	1.0	9.0	1.00	1.89	1.14	0.19391400	0.01318615200
3/4" PVC.PIPE	1.0	20.0	1.00	1.07	1.14	0.24396000	0.01658928000
1/2" PVC.PIPE	1.0	45.0	1.00	1.19	1.14	0.61047000	0.04151196000
** SUBTOTAL **						3.43454640	0.23354915520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 62							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
11/4" PVC.PIPE	1.0	22.0	1.00	2.58	1.14	0.64706400	0.04400035200
1" PVC.PIPE	1.0	13.0	1.00	1.89	1.14	0.28009800	0.01904666400
3/4" PVC.PIPE	1.0	3.0	1.00	1.07	1.14	0.03659400	0.00248839200
1/2" PVC.PIPE	1.0	38.0	1.00	1.19	1.14	0.51550800	0.03505454400
** SUBTOTAL **						1.53062100	0.10408222800
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 63							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	52.0	1.00	2.83	1.14	1.67762400	0.11407843200
11/2" PVC.PIPE	1.0	24.0	1.00	2.65	1.14	0.72504000	0.04930272000
11/4" PVC.PIPE	1.0	12.0	1.00	2.58	1.14	0.35294400	0.02400019200
1" PVC.PIPE	1.0	15.0	1.00	1.89	1.14	0.32319000	0.02197692000
3/4" PVC.PIPE	1.0	14.0	1.00	1.07	1.14	0.17077200	0.01161249600
1/2" PVC.PIPE	1.0	27.0	1.00	1.19	1.14	0.36628200	0.02490717600
** SUBTOTAL **						3.66720900	0.24937021200
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 64							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	4.0	1.00	2.83	1.14	0.12904800	0.00877526400
11/2" PVC.PIPE	1.0	7.0	1.00	2.65	1.14	0.21147000	0.01437996000
11/4" PVC.PIPE	1.0	20.0	1.00	2.58	1.14	0.58824000	0.04000032000
1" PVC.PIPE	1.0	20.0	1.00	1.89	1.14	0.43092000	0.02930256000
3/4" PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12198000	0.00829464000
1/2" PVC.PIPE	1.0	56.0	1.00	1.19	1.14	0.75969600	0.05165932800
** SUBTOTAL **						2.31233040	0.15723846720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 65							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	3.0	1.00	2.83	1.14	0.09678600	0.00658144800
11/2" PVC.PIPE	1.0	10.0	1.00	2.65	1.14	0.30210000	0.02054280000
11/4" PVC.PIPE	1.0	7.0	1.00	2.58	1.14	0.20588400	0.01400011200
1" PVC.PIPE	1.0	5.0	1.00	1.89	1.14	0.10773000	0.00732564000
3/4" PVC.PIPE	1.0	6.0	1.00	1.07	1.14	0.07318800	0.00497678400
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67830000	0.04612440000
** SUBTOTAL **						1.53496440	0.10437757920

PAGE NO. 00015

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 66							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	8.0	1.00	2.83	1.14	0.25809600	0.01755052000
11/2" PVC.PIPE	1.0	21.0	1.00	2.65	1.14	0.63441000	0.04313988000
11/4" PVC.PIPE	1.0	20.0	1.00	2.58	1.14	0.58824000	0.04000032000
1" PVC.PIPE	1.0	23.0	1.00	1.89	1.14	0.49555800	0.03369794400
3/4" PVC.PIPE	1.0	29.0	1.00	1.07	1.14	0.35374200	0.02405445600
1/2" PVC.PIPE	1.0	80.0	1.00	1.19	1.14	1.08528000	0.07379904000
** SUBTOTAL **						3.40630240	0.23706656320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 67							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	8.0	1.00	2.83	1.14	0.25809600	0.01755052000
11/2" PVC.PIPE	1.0	8.0	1.00	2.65	1.14	0.24168000	0.01643424000
11/4" PVC.PIPE	1.0	17.0	1.00	2.58	1.14	0.50000400	0.03400027200
1" PVC.PIPE	1.0	12.0	1.00	1.89	1.14	0.25855200	0.01758153600
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417800	0.00912410400
1/2" PVC.PIPE	1.0	67.0	1.00	1.19	1.14	0.90892200	0.06180669600
** SUBTOTAL **						2.37240840	0.16132377120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 68							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	8.0	1.00	2.83	1.14	0.25809600	0.01755052000
1" PVC.PIPE	1.0	6.0	1.00	1.89	1.14	0.12927600	0.00879076000
3/4" PVC.PIPE	1.0	24.0	1.00	1.07	1.14	0.29275200	0.01990713600
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67030000	0.04612440000
** SUBTOTAL **						1.42940040	0.09719922720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 69							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	13.0	1.00	2.83	1.14	0.41940600	0.02851960800
1" PVC.PIPE	1.0	16.0	1.00	1.89	1.14	0.34473600	0.02344204800
3/4" PVC.PIPE	1.0	22.0	1.00	1.07	1.14	0.26835600	0.01824820800
1/2" PVC.PIPE	1.0	20.0	1.00	1.19	1.14	0.27132000	0.01844976000
** SUBTOTAL **						1.37479440	0.09348601920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 70							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	8.0	1.00	2.83	1.14	0.25809600	0.01755052000
11/2" PVC.PIPE	1.0	8.0	1.00	2.65	1.14	0.24168000	0.01643424000
11/4" PVC.PIPE	1.0	8.0	1.00	2.58	1.14	0.23529600	0.01600012800
1" PVC.PIPE	1.0	7.0	1.00	1.89	1.14	0.15082200	0.01025589600

PAGE NO. 00016

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 70							
1/2" PVC.PIPE	1.0	60.0	1.00	1.19	1.14	0.81396000	0.05534928000
** SUBTOTAL **						1.77083040	0.12041646720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 71							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	4.0	1.00	2.83	1.14	0.12904800	0.00877526400
11/4" PVC.PIPE	1.0	6.0	1.00	2.58	1.14	0.17647200	0.01200009600
3/4" PVC.PIPE	1.0	5.0	1.00	1.07	1.14	0.06099000	0.00414732000
1/2" PVC.PIPE	1.0	45.0	1.00	1.19	1.14	0.61047000	0.04151196000
** SUBTOTAL **						1.04795640	0.07126103520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 72							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
1" PVC.PIPE	1.0	10.0	1.00	1.89	1.14	0.21546000	0.01465128000
** SUBTOTAL **						0.60905640	0.04141583520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 72							
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67830000	0.04612440000
** SUBTOTAL **						0.67830000	0.04612440000
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 73							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	11..	. .		.14	0.. 00	0.02413197600
11/2" PVC.PIPE	1.0	11.0	1.00	2.65	1.14	0.33231000	0.02259708000
1/2" PVC.PIPE	1.0	25.0	1.00	1.19	1.14	0.33915000	0.02306220000
** SUBTOTAL **						1.09731840	0.07461765120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 74							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	35.0	1.00	2.83	1.14	1.12917000	0.07678356000
1" PVC.PIPE	1.0	6.0	1.00	1.89	1.14	0.12927600	0.00879076800
3/4" PVC.PIPE	1.0	9.0	1.00	1.07	1.14	0.10978200	0.00746517600
** SUBTOTAL **						1.43920440	0.09786589920

PAGE NO. 00017

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 74							
1/2" PVC.PIPE	1.0	22.0	1.00	1.19	1.14	0.29845200	0.02029473600
** SUBTOTAL **						0.29845200	0.02029473600
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 75							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	33.0	1.00	2.83	1.14	1.06464600	0.07239592800
11/2" PVC.PIPE	1.0	4.0	1.00	2.65	1.14	0.12064000	0.00821712000
11/4" PVC.PIPE	1.0	5.0	1.00	2.58	1.14	0.14706000	0.01000008000
1" PVC.PIPE	1.0	6.0	1.00	1.89	1.14	0.12927600	0.00879076800
3/4" PVC.PIPE	1.0	4.0	1.00	1.07	1.14	0.04879200	0.00331785600
1/2" PVC.PIPE	1.0	49.0	1.00	1.19	1.14	0.66473400	0.04520191200
** SUBTOTAL **						2.24632440	0.15275005920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 76							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	9.0	1.00	2.83	1.14	0.25009600	0.01755052800
11/4" PVC.PIPE	1.0	8.0	1.00	2.58	1.14	0.23529600	0.01600012800
1" PVC.PIPE	1.0	25.0	1.00	1.89	1.14	0.53865000	0.03662820000
3/4" PVC.PIPE	1.0	40.0	1.00	1.07	1.14	0.48792000	0.03317856000
1/2" PVC.PIPE	1.0	75.0	1.00	1.19	1.14	1.01745000	0.06918660000
** SUBTOTAL **						2.58676000	0.17603629200
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 77							
11/4"ELEC.VALVE	1.5	1.0	1.00	2.16	1.14	0.03693600	0.00251164800
2" PVC.VALVE	1.0	42.0	1.00	2.83	1.14	1.35500400	0.09214027200
11/2" PVC.PIPE	1.0	10.0	1.00	2.65	1.14	0.30210000	0.02054280000
11/4" PVC.PIPE	1.0	12.0	1.00	2.58	1.14	0.35294400	0.02400019200
1" PVC.PIPE	1.0	14.0	1.00	1.89	1.14	0.30164400	0.02051179200
3/4" PVC.PIPE	1.0	8.0	1.00	1.07	1.14	0.09758400	0.00663571200
1/2" PVC.PIPE	1.0	10.0	1.00	1.19	1.14	0.13566000	0.00922468000
** SUBTOTAL **						2.58187200	0.17556729600
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 78							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/4" PVC.PIPE	1.0	6.0	1.00	2.58	1.14	0.17647200	0.01200009600
1" PVC.PIPE	1.0	20.0	1.00	1.89	1.14	0.43092000	0.02930256000
3/4" PVC.PIPE	1.0	13.0	1.00	1.07	1.14	0.15857400	0.01078308200
1/2" PVC.PIPE	1.0	46.0	1.00	1.19	1.14	0.62403600	0.04243444800
** SUBTOTAL **						1.65455040	0.11250942720

PAGE NO. 00018

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 79							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.VALVE	1.0	13.0	1.00	2.83	1.14	0.41940600	0.02851960800
11/2" PVC.PIPE	1.0	34.0	1.00	2.65	1.14	1.02714000	0.06984552000
1" PVC.PIPE	1.0	19.0	1.00	1.89	1.14	0.40937400	0.02783743200
3/4" PVC.PIPE	1.0	16.0	1.00	1.07	1.14	0.19516800	0.01327142400
1/2" PVC.PIPE	1.0	56.0	1.00	1.19	1.14	0.75969600	0.05165932800
** SUBTOTAL **						2.88170040	0.19595970720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 80							
2"ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	18.0	1.00	2.83	1.14	0.58071600	0.03948868800
11/4" PVC.PIPE	1.0	13.0	1.00	2.58	1.14	0.38235000	0.02600020000
1" PVC.PIPE	1.0	3.0	1.00	1.89	1.14	0.06463000	0.00439538400
3/4" PVC.PIPE	1.0	18.0	1.00	1.07	1.14	0.21956400	0.01493035200
1/2" PVC.PIPE	1.0	52.0	1.00	1.19	1.14	0.70543200	0.04796937600
** SUBTOTAL **						2.02368240	0.13761040320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 81							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	8.0	1.00	2.83	1.14	0.25809600	0.01755052800
11/2" PVC.PIPE	1.0	5.0	1.00	2.65	1.14	0.15105000	0.01027140000
1" PVC.PIPE	1.0	6.0	1.00	1.89	1.14	0.12927600	0.00879076800
3/4" PVC.PIPE	1.0	35.0	1.00	1.07	1.14	0.42693000	0.02903124000
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67830000	0.04612440000
** SUBTOTAL **						1.71462840	0.11659473120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 82							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	18.0	1.00	2.83	1.14	0.58071600	0.03948868800
11/2" PVC.PIPE	1.0	5.0	1.00	2.65	1.14	0.15105000	0.01027140000
1"PVC.PIPE	1.0	6.0	1.00	1.89	1.14	0.12927600	0.00879076800
3/4" PVC.PIPE	1.0	35.0	1.00	1.07	1.14	0.42693000	0.02903124000
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67830000	0.04612440000
** SUBTOTAL **						2.03724840	0.13853289120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 83							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	3.0	1.00	2.83	1.14	0.09678600	0.00658144800
11/4" PVC.PIPE	1.0	18.0	1.00	2.58	1.14	0.52941600	0.03600028800
3/4" PVC.PIPE	1.0	29.0	1.00	1.07	1.14	0.35374200	0.02405445600
1/2" PVC.PIPE	1.0	12.0	1.00	1.19	1.14	0.16279200	0.01106985600
** SUBTOTAL **						1.21371240	0.08253244320

PAGE NO. 00019

GASSIN EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 84							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
11/4" PVC.PIPE	1.0	24.0	1.00	2.58	1.14	0.70588800	0.04800038400
1" PVC.PIPE	1.0	30.0	1.00	1.89	1.14	0.64628000	0.04395304000
3/4" PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12198000	0.00829464000
1/2" PVC.PIPE	1.0	46.0	1.00	1.19	1.14	0.62403600	0.04243444800
** SUBTOTAL **						2.49108040	0.16944786720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 85							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
1" PVC.PIPE	1.0	25.0	1.00	1.89	1.14	0.75411000	0.05127946000
3/4" PVC.PIPE	1.0	35.0	1.00	1.07	1.14	0.42693000	0.02903124000
1/2" PVC.PIPE	1.0	52.0	1.00	1.19	1.14	0.70543200	0.04796937600
** SUBTOTAL **						2.28006840	0.15504465120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 86							
11/4"ELEC.VALVE	1.5	1.0	1.00	2.16	1.14	0.03693600	0.00251164800
2" PVC.PIPE	1.0	20.0	1.00	2.83	1.14	0.64524000	0.04387632000
1" PVC.PIPE	1.0	2.0	1.00	1.89	1.14	0.04309200	0.00293025600
3/4" PVC.PIPE	1.0	8.0	1.00	1.07	1.14	0.09758400	0.00663571200
1/2" PVC.PIPE	1.0	21.0	1.00	1.19	1.14	0.28488600	0.01937224800
** SUBTOTAL **						1.10773800	0.07532618400
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 87							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	36.0	1.00	2.83	1.14	1.16143200	0.07897737600
11/2" PVC.PIPE	1.0	5.0	1.00	2.65	1.14	0.15105000	0.01027140000
11/4" PVC.PIPE	1.0	4.0	1.00	2.58	1.14	0.11764800	0.00800006400
1" PVC.PIPE	1.0	15.0	1.00	1.89	1.14	0.32319000	0.02197692000
3/4" PVC.PIPE	1.0	4.0	1.00	1.07	1.14	0.04879200	0.00331785600
1/2" PVC.PIPE	1.0	17.0	1.00	1.19	1.14	0.23062200	0.01568229600
** SUBTOTAL **						2.10371040	0.14305230720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 88							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	21.0	1.00	2.83	1.14	0.67750200	0.04607013600
1" PVC.PIPE	1.0	10.0	1.00	1.89	1.14	0.21546000	0.01465128000
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417800	0.00912410400
1/2" PVC.PIPE	1.0	54.0	1.00	1.19	1.14	0.73256400	0.04981435200
** SUBTOTAL **						1.83068040	0.12448620720

PAGE NO. 00020

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 89							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	21.0	1.00	2.83	1.14	0.67750200	0.04607013600
11/2" PVC.PIPE	1.0	11.0	1.00	2.65	1.14	0.33231000	0.02259708000
11/4" PVC.PIPE	1.0	7.0	1.00	2.58	1.14	0.20580400	0.01400011200
1" PVC.PIPE	1.0	16.0	1.00	1.89	1.14	0.34473600	0.02344204800
3/4" PVC.PIPE	1.0	24.0	1.00	1.07	1.14	0.29275200	0.01990713600
1/2" PVC.PIPE	1.0	72.0	1.00	1.19	1.14	0.97675200	0.06641913600
** SUBTOTAL **						2.90091240	0.19726204320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 90							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	8.0	1.00	2.83	1.14	0.25809600	0.01755052800
11/2" PVC.PIPE	1.0	4.0	1.00	2.65	1.14	0.12084000	0.00821712000
11/4" PVC.PIPE	1.0	14.0	1.00	2.58	1.14	0.41176800	0.02800022400
1" PVC.PIPE	1.0	10.0	1.00	1.89	1.14	0.21546000	0.01465128000
3/4" PVC.PIPE	1.0	19.0	1.00	1.07	1.14	0.23176200	0.01575981600
1/2" PVC.PIPE	1.0	44.0	1.00	1.19	1.14	0.59690400	0.04058947200
** SUBTOTAL **						1.90580640	0.12959483520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 91							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	24.0	1.00	2.83	1.14	0.77428800	0.05265158400
11/4" PVC.PIPE	1.0	19.0	1.00	2.58	1.14	0.55862800	0.03800030400
1" PVC.PIPE	1.0	4.0	1.00	1.89	1.14	0.08618400	0.00586051200
3/4" PVC.PIPE	1.0	12.0	1.00	1.07	1.14	0.14637600	0.00995356800
1/2" PVC.PIPE	1.0	102.0	1.00	1.19	1.14	1.38373200	0.09409377600
** SUBTOTAL **						3.02038440	0.20538613920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 92							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	24.0	1.00	2.83	1.14	0.77428800	0.05265158400
11/4" PVC.PIPE	1.0	15.0	1.00	2.58	1.14	0.44118000	0.03000024000
1" PVC.PIPE	1.0	8.0	1.00	1.89	1.14	0.17236800	0.01172102400
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417200	0.00912410400
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67830000	0.04612440000
** SUBTOTAL **						2.27129040	0.15444774720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 93							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	69.0	1.00	2.83	1.14	2.22607800	0.15137330400
11/2" PVC.PIPE	1.0	28.0	1.00	2.65	1.14	0.84508000	0.05751984000

PAGE NO. 00021

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 93							
11/4" PVC.PIPE	1.0	21.0	1.00	2.58	1.14	0.61765200	0.04200033600
1" PVC.PIPE	1.0	50.0	1.00	1.89	1.14	1.07730000	0.07325840000
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417800	0.00912410400
1/2" PVC.PIPE	1.0	33.0	1.00	1.19	1.14	0.44767800	0.03044210400
** SUBTOTAL **						5.40012300	0.36720836400
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 94							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096900000
11/2" PVC.PIPE	1.0	15.0	1.00	2.65	1.14	0.45315000	0.03081420000
1" PVC.PIPE	1.0	7.0	1.00	1.89	1.14	0.15082200	0.01025589600
3/4" PVC.PIPE	1.0	8.0	1.00	1.07	1.14	0.09756400	0.00663571200
1/2" PVC.PIPE	1.0	27.0	1.00	1.19	1.14	0.36620200	0.02490717600
** SUBTOTAL **						1.28050500	0.08707434000
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 95							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	27.0	1.00	2.83	1.14	0.87107400	0.05923303200
11/2" PVC.PIPE	1.0	13.0	1.00	2.65	1.14	0.39273000	0.02670564000
11/4" PVC.PIPE	1.0	19.0	1.00	2.58	1.14	0.55862800	0.03800030400
1" PVC.PIPE	1.0	7.0	1.00	1.89	1.14	0.15082200	0.01025589600
3/4" PVC.PIPE	1.0	15.0	1.00	1.07	1.14	0.18297000	0.01244196000
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67830000	0.04612440000
** SUBTOTAL **						2.90570040	0.19756762720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 96							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	41.0	1.00	2.83	1.14	1.32274200	0.08994645600
11/2" PVC.PIPE	1.0	6.0	1.00	2.65	1.14	0.18126000	0.01232568000
11/4" PVC.PIPE	1.0	12.0	1.00	2.58	1.14	0.35294400	0.02400019200
1" PVC.PIPE	1.0	24.0	1.00	1.89	1.14	0.51710400	0.03516307200
3/4" PVC.PIPE	1.0	18.0	1.00	1.07	1.14	0.21956400	0.01493035200
1/2" PVC.PIPE	1.0	57.0	1.00	1.19	1.14	0.77326200	0.05258101600
** SUBTOTAL **						3.43785240	0.23377396320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 97							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE		3.0	1.00	2.83	1.14	0.74202600	0.05045776000
11/2" PVC.PIPE	1.0	12.0	1.00	2.65	1.14	0.36252000	0.02465136000
11/4" PVC.PIPE	1.0	8.0	1.00	2.58	1.14	0.23529600	0.01600012800
1" PVC.PIPE	1.0	6.0	1.00	1.89	1.14	0.12927600	0.00879076800

PAGE NO. 00022

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 97							
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417800	0.00912410400
1/2" PVC.PIPE	1.0	88.0	1.00	1.19	1.14	1.19300800	0.08117094400
** SUBTOTAL **						2.06000040	0.19502946720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 98							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
11/2" PVC.PIPE	1.0	5.0	1.00	2.65	1.14	0.15105000	0.01027140000
1" PVC.PIPE	1.0	63.0	1.00	1.89	1.14	1.35739800	0.09230306400
3/4" PVC.PIPE	1.0	29.0	1.00	1.07	1.14	0.35374200	0.02405445600
1/2" PVC.PIPE	1.0	59.0	1.00	1.19	1.14	0.80039400	0.05442679200
** SUBTOTAL **						3.05618040	0.20782020720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 99							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	27.0	1.00	2.83	1.14	0.87107400	0.05923303200
1" PVC.PIPE	1.0	30.0	1.00	1.89	1.14	0.64638000	0.04395384000
3/4" PVC.PIPE	1.0	38.0	1.00	1.07	1.14	0.46352400	0.03151963200
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.67830000	0.04612440000
** SUBTOTAL **						2.73025440	0.18566729920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 100							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	34.0	1.00	2.83	1.14	1.09690800	0.07458974400
1" PVC.PIPE	1.0	4.0	1.00	1.89	1.14	0.08618400	0.00586051200
3/4" PVC.PIPE	1.0	7.0	1.00	1.07	1.14	0.08538600	0.00580624800
1/2" PVC.PIPE	1.0	25.0	1.00	1.19	1.14	0.47461000	0.03228708000
** SUBTOTAL **						1.81426440	0.12336997920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 101							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/2" PVC.PIPE	1.0	20.0	1.00	2.65	1.14	0.60420000	0.04108560000
11/4" PVC.PIPE	1.0	41.0	1.00	2.58	1.14	1.20589200	0.08200065600
1" PVC.PIPE	1.0	45.0	1.00	1.89	1.14	0.96957000	0.06593076000
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417800	0.00912410400
1/2" PVC.PIPE	1.0	29.0	1.00	1.19	1.14	0.39341400	0.02675215200
** SUBTOTAL **						3.57180240	0.24280256320

PAGE NO. 00023

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 102							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	26.0	1.00	2.83	1.14	0.83081200	0.05703921600
11/4" PVC.PIPE	1.0	13.0	1.00	2.58	1.14	0.38235600	0.02600020800
1" PVC.PIPE	1.0	27.0	1.00	1.89	1.14	0.58174200	0.03955845600
3/4" PVC.PIPE	1.0	15.0	1.00	1.07	1.14	0.18297000	0.01244196000
1/2" PVC.PIPE	1.0	41.0	1.00	1.19	1.14	0.55620600	0.03782200800
** SUBTOTAL **						2.61306240	0.17768824320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 103							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	60.0	1.00	2.83	1.14	1.93572000	0.13162896000
11/2" PVC.PIPE	1.0	20.0	1.00	2.65	1.14	0.60420000	0.04106560000
11/4" PVC.PIPE	1.0	7.0	1.00	2.58	1.14	0.20508400	0.01400011200
1" PVC.PIPE	1.0	12.0	1.00	1.89	1.14	0.25855200	0.01758153600
3/4" PVC.PIPE	1.0	13.0	1.00	1.07	1.14	0.15857400	0.01078303200
1/2" PVC.PIPE	1.0	30.0	1.00	1.19	1.14	0.40698000	0.02767464000
** SUBTOTAL **						3.64088640	0.24758027520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 104							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	97.0	1.00	2.83	1.14	3.12941400	0.21280015200
11/2" PVC.PIPE	1.0	23.0	1.00	2.65	1.14	0.69483000	0.04724644000
1" PVC.PIPE	1.0	4.0	1.00	1.89	1.14	0.08616400	0.00586051200
3/4" PVC.PIPE	1.0	6.0	1.00	1.07	1.14	0.07316800	0.00497670400
1/2" PVC.PIPE	1.0	58.0	1.00	1.19	1.14	0.78682800	0.05350430400
** SUBTOTAL **						4.94142040	0.32921658720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 105							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
1" PVC.PIPE	1.0	27.0	1.00	1.89	1.14	0.58174200	0.03955845600
3/4" PVC.PIPE	1.0	42.0	1.00	1.07	1.14	0.51231600	0.03483748800
1/2" PVC.PIPE	1.0	77.0	1.00	1.19	1.14	1.04456200	0.07103157600
** SUBTOTAL **						2.20961640	0.15025391520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 106							
11/4"ELEC.VALVE	1.5	1.0	1.00	2.16	1.14	0.03693600	0.00251164800
2" PVC.PIPE	1.0	46.5	1.00	2.83	1.14	1.50018300	0.10201244400
11/2" PVC.PIPE	1.0	9.0	1.00	2.65	1.14	0.27189000	0.01848852000
11/4" PVC.PIPE	1.0	13.0	1.00	2.58	1.14	0.38235600	0.02600020800
1" PVC.PIPE	1.0	13.0	1.00	1.89	1.14	0.28009800	0.01904666400
3/4" PVC.PIPE	1.0	7.0	1.00	1.07	1.14	0.08538600	0.00580624800

PAGE NO. 00024

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 106							
1/2" PVC.PIPE	1.0	11.0	1.00	1.19	1.14	0.14922600	0.01014736800
** SUBTOTAL **						2.70607500	0.18401310000
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 107							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	59.0	1.00	2.83	1.14	1.90345800	0.12943514400
11/2" PVC.PIPE	1.0	5.0	1.00	2.65	1.14	0.15105000	0.01027140000
11/4" PVC.PIPE	1.0	11.0	1.00	2.56	1.14	0.32353200	0.02200017600
1" PVC.PIPE	1.0	13.0	1.00	1.89	1.14	0.28009800	0.01904666400
3/4" PVC.PIPE	1.0	12.0	1.00	1.07	1.14	0.14637600	0.00995356800
1/2" PVC.PIPE	1.0	87.0	1.00	1.19	1.14	1.18024200	0.08025645600
** SUBTOTAL **						4.03611300	0.27445568400
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 108							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	56.0	1.00	2.83	1.14	1.80667200	0.12285369600
11/2" PVC.PIPE	1.0	29.0	1.00	2.65	1.14	0.97609000	0.05957412000
11/4" PVC.PIPE	1.0	6.0	1.00	2.56	1.14	0.17647200	0.01200009600
1" PVC.PIPE	1.0	5.0	1.00	1.89	1.14	0.10773000	0.00732564000
3/4" PVC.PIPE	1.0	12.0	1.00	1.07	1.14	0.14637600	0.00995356800
1/2" PVC.PIPE	1.0	72.0	1.00	1.19	1.14	0.97675200	0.06641913600
** SUBTOTAL **						4.16106840	0.28295265120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 109							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096908000
11/4" PVC.PIPE	1.0	45.0	1.00	2.56	1.14	1.32354000	0.09000072000
1" PVC.PIPE	1.0	25.0	1.00	1.89	1.14	0.53865000	0.03662820000
1/2" PVC.PIPE	1.0	20.0	1.00	1.19	1.14	0.27132000	0.01844976000
** SUBTOTAL **						2.36579640	0.16087415520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 110							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
11/4" PVC.PIPE	1.0	39.0	1.00	2.56	1.14	1.14706800	0.07800062400
1" PVC.PIPE	1.0	17.0	1.00	1.89	1.14	0.36628200	0.02490717600
3/4" PVC.PIPE	1.0	7.0	1.00	1.07	1.14	0.08538600	0.00580624800
1/2" PVC.PIPE	1.0	31.0	1.00	1.19	1.14	0.42054600	0.02859712800
** SUBTOTAL **						2.41287840	0.16407573120

PAGE NO. 00025

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 111							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	7.0	1.00	2.83	1.14	0.22563400	0.01535671200
11/2" PVC.PIPE	1.0	30.0	1.00	2.65	1.14	0.90630000	0.06162840000
11/4" PVC.PIPE	1.0	5.0	1.00	2.58	1.14	0.14706000	0.01000000000
1" PVC.PIPE	1.0	13.0	1.00	1.89	1.14	0.29009800	0.01904666400
1/2" PVC.PIPE	1.0	30.0	1.00	1.19	1.14	0.40698000	0.02767464000
** SUBTOTAL **						2.03724040	0.13853289120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 112							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096908000
11/2" PVC.PIPE	1.0	2.0	1.00	2.65	1.14	0.06042000	0.00410856000
11/4" PVC.PIPE	1.0	14.0	1.00	2.58	1.14	0.41176800	0.02800022400
1" PVC.PIPE	1.0	14.0	1.00	1.89	1.14	0.30164400	0.02051179200
3/4" PVC.PIPE	1.0	9.0	1.00	1.07	1.14	0.10978200	0.00746517600
1/2" PVC.PIPE	1.0	38.0	1.00	1.19	1.14	0.51550600	0.03505454400
** SUBTOTAL **						1.61178900	0.10960165200
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 113							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	9.0	1.00	2.83	1.14	0.29035800	0.01974434400
11/2" PVC.PIPE	1.0	3.0	1.00	2.65	1.14	0.09063000	0.00616284000
11/4" PVC.PIPE	1.0	47.0	1.00	2.58	1.14	1.38236400	0.09400075200
1" PVC.PIPE	1.0	20.0	1.00	1.89	1.14	0.60320000	0.04102356400
3/4" PVC.PIPE	1.0	17.0	1.00	1.07	1.14	0.20736600	0.01410088800
1/2" PVC.PIPE	1.0	80.0	1.00	1.19	1.14	1.08528000	0.07379904000
** SUBTOTAL **						3.73026240	0.25365784320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 114							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/2" PVC.PIPE	1.0	3.0	1.00	2.65	1.14	0.09063000	0.00616284000
11/4" PVC.PIPE	1.0	3.0	1.00	2.58	1.14	0.08823600	0.00600004800
1" PVC.PIPE	1.0	24.0	1.00	1.89	1.14	0.51710400	0.03516307200
3/4" PVC.PIPE	1.0	41.0	1.00	1.07	1.14	0.50011800	0.03400802400
1/2" PVC.PIPE	1.0	86.0	1.00	1.19	1.14	1.16667600	0.07933396800
** SUBTOTAL **						2.62731240	0.17865724320

PAGE NO. 00026

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 115							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	7.0	1.00	2.83	1.14	0.22583400	0.01535671200
11/2" PVC.PIPE	1.0	5.0	1.00	2.65	1.14	0.15105000	0.01027140000
1" PVC.PIPE	1.0	15.0	1.00	1.89	1.14	0.32319000	0.02197692000
3/4" PVC.PIPE	1.0	17.0	1.00	1.07	1.14	0.20736600	0.01410088800
1/2" PVC.PIPE	1.0	60.0	1.00	1.19	1.14	0.81396000	0.05534928000
** SUBTOTAL **						1.79237040	0.12188159520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 116							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
11/2" PVC.PIPE	1.0	19.0	1.00	2.65	1.14	0.57399000	0.03903132000
11/4" PVC.PIPE	1.0	22.0	1.00	2.50	1.14	0.64706400	0.04400035200
1" PVC.PIPE	1.0	12.0	1.00	1.89	1.14	0.25855200	0.01758153600
3/4" PVC.PIPE	1.0	4.0	1.00	1.07	1.14	0.04079200	0.00331785600
1/2" PVC.PIPE	1.0	47.0	1.00	1.19	1.14	0.63760200	0.04335693600
** SUBTOTAL **						2.55959640	0.17405255520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 117							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096908000
11/4" PVC.PIPE	1.0	6.0	1.00	2.58	1.14	0.17647200	0.01200009600
1" PVC.PIPE	1.0	12.0	1.00	1.89	1.14	0.25855200	0.01758153600
3/4" PVC.PIPE	1.0	25.0	1.00	1.07	1.14	0.30495000	0.02073660000
1/2" PVC.PIPE	1.0	43.0	1.00	1.19	1.14	0.58333800	0.03966090400
** SUBTOTAL **						1.55559840	0.10578069120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 118							
11/4"ELEC.VALVE	1.5	1.0	1.00	2.16	1.14	0.03693600	0.00251164800
2" PVC. PIPE	1.0	121.0	1.00	2.83	1.14	3.90370200	0.26545173600
11/2" PVC.PIPE	1.0	16.0	1.00	2.65	1.14	0.48336000	0.03286848000
11/4" PVC.PIPE	1.0	18.0	1.00	2.58	1.14	0.52941600	0.03600028800
1" PVC.PIPE	1.0	24.0	1.00	1.89	1.14	0.51710400	0.03516307200
3/4" PVC.PIPE	1.0	29.0	1.00	1.07	1.14	0.35374200	0.02405445600
1/2" PVC.PIPE	1.0	100.0	1.00	1.19	1.14	1.35660000	0.09224880000
** SUBTOTAL **						7.18086000	0.48829048000
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 119							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	13.0	1.00	2.83	1.14	0.41940600	0.02851960800
1" PVC.PIPE	1.0	15.0	1.00	1.89	1.14	0.32319000	0.02197692000

PAGE NO. 00027

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 119							
3/4" PVC.PIPE	1.0	5.0	1.00	1.07	1.14	0.06099000	0.00414732000
1/2" PVC.PIPE	1.0	50.0	1.00	1.19	1.14	0.78002800	0.05350430400
** SUBTOTAL **						1.66139040	0.11297454720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 120							
2"ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096908000
3/4" PVC.PIPE	1.0	1.0	1.00	1.07	1.14	0.01219800	0.00082964000
1/2" PVC.PIPE	1.0	40.0	1.00	1.19	1.14	0.54264000	0.03689952000
** SUBTOTAL **						0.89690640	0.06098963520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 121							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096908000
11/4" PVC.PIPE	1.0	19.0	1.00	2.58	1.14	0.55862800	0.03800030400
1" PVC.PIPE	1.0	5.0	1.00	1.89	1.14	0.10773000	0.00732564000
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417800	0.00912410400
1/2" PVC.PIPE	1.0	73.0	1.00	1.19	1.14	0.99031800	0.06734162400
** SUBTOTAL **						2.02334040	0.13758714720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 122							
2"ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	11.0	1.00	2.83	1.14	0.35486200	0.02413197600
11/2" PVC.PIPE	1.0	9.0	1.00	2.65	1.14	0.27109000	0.01848852000
11/4" PVC.PIPE	1.0	9.0	1.00	2.58	1.14	0.26470800	0.01800014400
1" PVC.PIPE	1.0	21.0	1.00	1.89	1.14	0.45246600	0.03076768800
3/4" PVC.PIPE	1.0	5.0	1.00	1.07	1.14	0.06099000	0.00414732000
1/2" PVC.PIPE	1.0	90.0	1.00	1.19	1.14	1.22094000	0.08302392000
** SUBTOTAL **						2.69685240	0.18338596320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 123							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	38.0	1.00	2.83	1.14	1.22595600	0.08336500800
11/4" PVC.PIPE	1.0	5.0	1.00	2.58	1.14	0.14706000	0.01000008000
1" PVC.PIPE	1.0	29.0	1.00	1.89	1.14	0.62483400	0.04248871200
3/4" PVC.PIPE	1.0	24.0	1.00	1.07	1.14	0.29275200	0.01990713600
1/2" PVC.PIPE	1.0	20.0	1.00	1.19	1.14	0.27132000	0.01844976000
** SUBTOTAL **						2.63289840	0.17903709120

PAGE NO. 00028

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 124							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/2" PVC.PIPE	1.0	44.0	1.00	2.65	1.14	1.32924000	0.09038832000
1" PVC.PIPE	1.0	4.0	1.00	1.89	1.14	0.08610400	0.00585051200
1/2" PVC.PIPE	1.0	43.0	1.00	1.19	1.14	0.58333800	0.03966698400
** SUBTOTAL **						2.26331040	0.15390510720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 125							
2"ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	4.0	1.00	2.83	1.14	0.12904800	0.00877526400
11/4" PVC.PIPE	1.0	9.0	1.00	2.58	1.14	0.26470800	0.01800014400
1" PVC.PIPE	1.0	32.0	1.00	1.89	1.14	0.68947200	0.04688409600
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417200	0.00912410400
1/2" PVC.PIPE	1.0	45.0	1.00	1.19	1.14	0.61047000	0.04151196000
** SUBTOTAL **						1.89085240	0.12912196320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 126							
2"ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	14.0	1.00	2.83	1.14	0.45166800	0.03071342400
11/4" PVC.PIPE	1.0	24.0	1.00	2.58	1.14	0.70588800	0.04800038400
1" PVC.PIPE	1.0	3.0	1.00	1.89	1.14	0.06463800	0.00439538400
3/4" PVC.PIPE	1.0	23.0	1.00	1.07	1.14	0.28055400	0.01907767200
1/2" PVC.PIPE	1.0	58.0	1.00	1.19	1.14	0.78682000	0.05350430400
** SUBTOTAL **						2.36055240	0.16051756320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 127							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	8.0	1.00	2.83	1.14	0.25809600	0.01755052800
11/2" PVC.PIPE	1.0	4.0	1.00	2.65	1.14	0.12084000	0.00821712000
11/4" PVC.PIPE	1.0	14.0	1.00	2.58	1.14	0.41176800	0.02800022400
1" PVC.PIPE	1.0	10.0	1.00	1.89	1.14	0.21546000	0.01465128000
3/4" PVC.PIPE	1.0	20.0	1.00	1.07	1.14	0.24396000	0.01658928000
1/2" PVC.PIPE	1.0	57.0	1.00	1.19	1.14	0.77328200	0.05258181600
** SUBTOTAL **						2.09436240	0.14241664320
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 128							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	29.0	1.00	2.83	1.14	0.93539800	0.06362066400
11/2" PVC.PIPE	1.0	9.0	1.00	2.65	1.14	0.27189000	0.01848852000
11/4" PVC.PIPE	1.0	14.0	1.00	2.58	1.14	0.41176800	0.02800022400
1" PVC.PIPE	1.0	11.0	1.00	1.89	1.14	0.23700600	0.01611640800

PAGE NO. 00029

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 128							
3/4" PVC.PIPE	1.0	13.0	1.00	1.07	1.14	0.15857400	0.01078303200
1/2" PVC.PIPE	1.0	48.0	1.00	1.19	1.14	0.65116800	0.04427942400
** SUBTOTAL **						2.73690040	0.18611466720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 129							
2"ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	15.0	1.00	2.83	1.14	0.40899000	0.03290724000
3/4" PVC.PIPE	1.0	6.0	1.00	1.07	1.14	0.07318800	0.00497678400
1/2" PVC.PIPE	1.0	60.0	1.00	1.19	1.14	0.81396000	0.05534928000
** SUBTOTAL **						1.44205440	0.09805969920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 130							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	7.0	1.00	2.83	1.14	0.22583400	0.01535671200
11/2" PVC.PIPE	1.0	18.0	1.00	2.65	1.14	0.54378000	0.03697704000
11/4" PVC.PIPE	1.0	16.0	1.00	2.58	1.14	0.47059200	0.03200025600
1" PVC.PIPE	1.0	22.0	1.00	1.09	1.14	0.47401200	0.03223281600
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417800	0.00912410400
1/2" PVC.PIPE	1.0	81.0	1.00	1.19	1.14	1.09884600	0.07472152800
** SUBTOTAL **						3.01021840	0.20523885120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 131							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	33.0	1.00	2.83	1.14	1.06464600	0.07239592800
11/2" PVC.PIPE	1.0	10.0	1.00	2.65	1.14	0.30210000	0.02054280000
1" PVC.PIPE	1.0	25.0	1.00	1.99	1.14	0.53865000	0.03663020000
3/4" PVC.PIPE	1.0	18.0	1.00	1.07	1.14	0.21956400	0.01493035200
1/2" PVC.PIPE	1.0	65.0	1.00	1.19	1.14	0.88179000	0.05996172000
** SUBTOTAL **						3.07772640	0.20928539520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 132							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	9.0	1.00	2.83	1.14	0.29035800	0.01974434400
11/4" PVC.PIPE	1.0	10.0	1.00	2.58	1.14	0.29412000	0.02000016000
1" PVC.PIPE	1.0	8.0	1.00	1.89	1.14	0.17236800	0.01172102400
3/4" PVC.PIPE	1.0	11.0	1.00	1.07	1.14	0.13417800	0.00912410400
1/2" PVC.PIPE	1.0	23.0	1.00	1.19	1.14	0.31201800	0.02121722400
** SUBTOTAL **						1.27401840	0.08663325120

PAGE NO. 00030

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 133							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
11/4" PVC.PIPE	1.0	34.0	1.00	2.58	1.14	1.00000800	0.06800054400
1" PVC.PIPE	1.0	55.0	1.00	1.89	1.14	1.18503000	0.08058204000
3/4" PVC.PIPE	1.0	17.0	1.00	1.07	1.14	0.20736600	0.01410088000
1/2" PVC.PIPE	1.0	89.0	1.00	1.19	1.14	1.20737400	0.08210143200
** SUBTOTAL **						3.99337440	0.27154945920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 134							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	74.0	1.00	2.83	1.14	2.38738800	0.16234238400
** SUBTOTAL **						2.45836440	0.16716877920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 135							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	2.0	1.00	2.83	1.14	0.06452400	0.00438763200
11/2"PVC.PIPE	1.0	2.0	1.00	2.65	1.14	0.06042000	0.00410856000
11/4" PVC.PIPE	1.0	13.0	1.00	2.58	1.14	0.38235600	0.02600020800
1" PVC.PIPE	1.0	18.0	1.00	1.89	1.14	0.38782800	0.02637230400
3/4" PVC.PIPE	1.0	3.0	1.00	1.07	1.14	0.03659400	0.00248839200
1/2" PVC.PIPE	1.0	60.0	1.00	1.19	1.14	0.81396000	0.05534928000
** SUBTOTAL **						1.79703900	0.12219865200
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 136							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	4.0	1.00	2.83	1.14	0.12904800	0.00877526400
11/2" PVC.PIPE	1.0	12.0	1.00	2.65	1.14	0.36252000	0.02465136000
11/4" PVC.PIPE	1.0	24.0	1.00	2.58	1.14	0.70588800	0.04800038400
3/4" PVC.PIPE	1.0	33.0	1.00	1.07	1.14	0.40253400	0.02737231200
1/2" PVC.PIPE	1.0	59.0	1.00	1.19	1.14	0.80039400	0.05442679200
** SUBTOTAL **						2.47136040	0.16805250720
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 137							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
11/4" PVC.PIPE	1.0	4.0	1.00	2.58	1.14	0.11764800	0.00800006400
1" PVC.PIPE	1.0	16.0	1.00	1.89	1.14	0.34473600	0.02344204800
3/4" PVC.PIPE	1.0	10.0	1.00	1.07	1.14	0.12198000	0.00829464000
1/2" PVC.PIPE	1.0	57.0	1.00	1.19	1.14	0.77328200	0.05258181600
** SUBTOTAL **						1.75122240	0.11908312320

PAGE NO. 00031

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	FQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 138							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	14.0	1.00	2.83	1.14	0.45166800	0.03071342400
11/4" PVC.PIPE	1.0	36.0	1.00	2.58	1.14	1.05062200	0.07200057600
1" PVC.PIPE	1.0	14.0	1.00	1.89	1.14	0.30184400	0.02051179200
3/4" PVC.PIPE	1.0	5.0	1.00	1.07	1.14	0.06099000	0.00414732000
1/2" PVC.PIPE	1.0	14.0	1.00	1.19	1.14	0.10992400	0.01291483200
** SUBTOTAL **						2.12403440	0.14511433920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 139							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC.PIPE	1.0	34.0	1.00	2.83	1.14	1.09690800	0.07458974400
11/2" PVC.PIPE	1.0	20.0	1.00	2.65	1.14	0.60420000	0.04108560000
11/4" PVC.PIPE	1.0	40.0	1.00	2.58	1.14	1.17048000	0.08000064000
1" PVC.PIPE	1.0	20.0	1.00	1.89	1.14	0.60378000	0.04102256400
3/4" PVC.PIPE	1.0	15.0	1.00	1.07	1.14	0.18297000	0.01244196000
1/2" PVC.PIPE	1.0	140.0	1.00	1.19	1.14	1.89924000	0.12914832000
** SUBTOTAL **						5.61444300	0.38170216400
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 140							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	7.0	1.00	2.83	1.14	0.22583400	0.01535671200
11/2" PVC.PIPE	1.0	29.0	1.00	2.65	1.14	0.87609000	0.05957412000
11/4" PVC.PIPE	1.0	2.0	1.00	2.58	1.14	0.05882400	0.00400003200
1" PVC.PIPE	1.0	76.0	1.00	1.89	1.14	1.62749600	0.11104972800
3/4" PVC.PIPE	1.0	22.0	1.00	1.07	1.14	0.26835600	0.01824020800
1/2" PVC.PIPE	1.0	82.0	1.00	1.19	1.14	1.11241200	0.07564401600
** SUBTOTAL **						4.24999840	0.28899921120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 141							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	26.0	1.00	2.83	1.14	0.83881200	0.05703921600
11/2" PVC.PIPE	1.0	10.0	1.00	2.65	1.14	0.30210000	0.02054280000
11/2" PVC.PIPE	1.0	12.0	1.00	2.65	1.14	0.36252000	0.02465136000
1" PVC.PIPE	1.0	7.0	1.00	1.89	1.14	0.15082200	0.01025589600
1/2" PVC.PIPE	1.0	74.0	1.00	1.19	1.14	1.00388400	0.06826411200
** SUBTOTAL **						2.72911440	0.18557977920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 142							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	5.0	1.00	2.83	1.14	0.16131000	0.01096900000
11/2" PVC.PIPE	1.0	10.0	1.00	2.65	1.14	0.30210000	0.02054280000

PAGE NO. 00032

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 142							
11/4" PVC.PIPE	1.0	8.0	1.00	2.58	1.14	0.23529600	0.01600012800
1" PVC.PIPE	1.0	18.0	1.00	1.99	1.14	0.38782800	0.02637230400
3/4" PVC.PIPE	1.0	17.0	1.00	1.07	1.14	0.20736600	0.01410088800
1/2" PVC.PIPE	1.0	62.0	1.00	1.19	1.14	0.84109200	0.05719425600
** SUBTOTAL **						2.20596840	0.15000565120
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 143							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
11/2" PVC.PIPE	1.0	3.0	1.00	2.65	1.14	0.09063000	0.00616284000
1" PVC.PIPE	1.0	24.0	1.00	1.89	1.14	0.51710400	0.03516307200
3/4" PVC.PIPE	1.0	48.0	1.00	1.07	1.14	0.58550400	0.03981427200
1/2" PVC.PIPE	1.0	31.0	1.00	1.19	1.14	0.42054600	0.02859712800
** SUBTOTAL **						1.66514100	0.11322958800
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 144							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	3.0	1.00	2.83	1.14	0.09678600	0.00659144800
11/4" PVC.PIPE	1.0	5.0	1.00	2.58	1.14	0.14705000	0.01000000000
1" PVC.PIPE	1.0	4.0	1.00	1.89	1.14	0.08610400	0.00586051200
3/4" PVC.PIPE	1.0	6.0	1.00	1.07	1.14	0.07313	[illegible]
1/2" PVC.PIPE	1.0	10.0	1.00	1.19	1.14	0.13566	[illegible]
** SUBTOTAL **						0.60985440	0.04147009920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 145							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	10.0	1.00	2.83	1.14	0.32262000	0.02193816000
11/2" PVC.PIPE	1.0	20.0	1.00	2.65	1.14	0.60420000	0.04108560000
11/2" PVC.PIPE	1.0	17.0	1.00	2.65	1.14	0.51357000	0.03492276000
1" PVC.PIPE	1.0	17.0	1.00	1.89	1.14	0.36628200	0.02490717600
3/4" PVC.PIPE	1.0	5.0	1.00	1.07	1.14	0.06099000	0.00414732000
1/2" PVC.PIPE	1.0	70.0	1.00	1.19	1.14	1.05814800	0.07195406400
** SUBTOTAL **						2.99678640	0.20378147520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 146							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	15.0	1.00	2.83	1.14	0.48393000	0.03290724000
11/2" PVC.PIPE	1.0	4.0	1.00	2.65	1.14	0.12084000	0.00821712000
11/4" PVC.PIPE	1.0	12.0	1.00	2.58	1.14	0.35294400	0.02400019200
1" PVC.PIPE	1.0	11.0	1.00	1.89	1.14	0.23700600	0.01611640800
3/4" PVC.PIPE	1.0	6.0	1.00	1.07	1.14	0.07316000	0.00497678400
1/2" PVC.PIPE	1.0	72.0	1.00	1.19	1.14	0.97675200	0.06641913600
** SUBTOTAL **						2.31560040	0.15746307520

PAGE NO. 00033

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 147							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC.PIPE	1.0	19.0	1.00	2.83	1.14	0.61297800	0.04168250400
1" PVC.PIPE	1.0	5.0	1.00	1.89	1.14	0.10773000	0.00732564000
3/4" PVC.PIPE	1.0	30.0	1.00	1.07	1.14	0.36594000	0.02488392000
1/2" PVC.PIPE	1.0	20.0	1.00	1.19	1.14	0.27132000	0.01844976000
** SUBTOTAL **						1.42894440	0.09716821920
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 148							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00349227600
2" PVC PIPE	1.0	21.0	1.00	2.83	1.14	0.67750200	0.04607013600
11/2"PVC PIPE	1.0	3.0	1.00	2.65	1.14	0.09063000	0.00616284000
11/4"PVC PIPE	1.0	16.0	1.00	2.58	1.14	0.47059200	0.03200025600
1" PVC PIPE	1.0	17.0	1.00	1.89	1.14	0.36628200	0.02490717600
3/4" PVC PIPE	1.0	8.0	1.00	1.07	1.14	0.09758400	0.00663571200
1/2" PVC PIPE	1.0	27.0	1.00	1.19	1.14	0.36628200	0.02490717600
** SUBTOTAL **						2.12022900	0.14417557200
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 149							
11/2"ELEC.VALVE	1.7	1.0	1.00	2.65	1.14	0.05135700	0.00348227600
2" PVC PIPE	1.0	2.0	1.00	2.83	1.14	0.06452400	0.00438763200
11/2" PVC PIPE	1.0	11.0	1.00	2.65	1.14	0.33231000	0.02259708000
3/4" PVC PIPE	1.0	9.0	1.00	1.07	1.14	0.10979200	0.00746517500
1/2" PVC PIPE	1.0	50.0	1.00	1.19	1.14	0.67030000	0.04612440000
** SUBTOTAL **						1.23827300	0.08406656400
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 150							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/4"PVC PIPE	1.0	17.0	1.00	2.58	1.14	0.50000400	0.03400027200
1" PVC PIPE	1.0	5.0	1.00	1.89	1.14	0.10773000	0.00732564000
3/4" PVC PIPE	1.0	8.0	1.00	1.07	1.14	0.09758400	0.00663571200
1/2" PVC PIPE	1.0	55.0	1.00	1.19	1.14	0.74613000	0.05073684000
** SUBTOTAL **						1.71599640	0.11668775520
* HEAD LOSS FOR AREA CONTROLED BY ELEC.VALVE NO: 151							
2" ELEC.VALVE	2.2	1.0	1.00	2.83	1.14	0.07097640	0.00482639520
2" PVC PIPE	1.0	6.0	1.00	2.83	1.14	0.19357200	0.01316289600
11/2"PVC PIPE	1.0	20.0	1.00	2.65	1.14	0.60420000	0.04108560000
1" PVC PIPE	1.0	3.0	1.00	1.89	1.14	0.06463800	0.00439538400
3/4"PVC PIPE	1.0	5.0	1.00	1.07	1.14	0.06099000	0.00414732000
1/2"PVC PIPE	1.0	38.0	1.00	1.19	1.14	0.51550800	0.03505454400
** SUBTOTAL **						1.50986440	0.10267213920
** TOTAL **						395.21629440	26.87470584000

PAGE NO. 00001

GASSIM EMIRATES PALACE * HEAD LOSS CALCULATIONS * MAIN PALACE SITE

DESCRIPTION	EQL	QUNTITY	F1	F/C150	F/C140	HL/PSI	HL/ATM
* HEAD LOSS IN MAIN LINE: M							
6" PVC MAIN	1.0	120.0	1.00	0.88	1.14	1.20304000	0.00186112000
4" PVC MAIN	1.0	515.0	1.00	0.96	1.14	5.63616000	0.38325888000
** SUBTOTAL **						6.84000000	0.46512000000
** TOTAL **						6.84000000	0.46512000000

GASSIN EMIRATES PALACE COMPLEX PROJECT * MAIN SITE
HEAD LOSS CALCULATUONS

USING THE ATTACHED DETAILED HEADLOSS CALCULATIONS.

HEAD LOSS DUE TO FRICTION:

1- AREA CONTROLED BY ELEC.VALVE NO:35	= .673
2- MAIN LINE	= .465
3- FITTINGS 100%	=1.138
TOTAL	2.276 ATM

EQL = EQUIVALENT LENGTH OF PIPE IN FEET
F1 = FACTOR TO CONVERT BASE FOOTAGE TO FOOTAGE EQUIVALENT TO PVC PIPE
F/C150 = HEAD LOSS PER 100 FEET:PSI FOR C=150
F/C140 = FACTOR TO CHANGE HEAD LOSS FROM C=150 TO C=140
HL/PSI = HEAD LOSS IN PSI
HL/ATM = HEAD LOSS IN ATMOSPHERE

FORMULA

HL/PSI = EQL*QT*F1*(HL:C150/100)*HL:C140
HL/ATM = HL/PSI*0.068

DESIGN DATA

V=6 ft/sec
C=140

$HL=.2083(100/C)^{1.85} *_Q{}^{1.85} /_c{}^{4.8655}$
Q =KVA (TABLES ATTACHED BASED ON THESE FORMULAS)

Q= FLOW (gpm)
V= INITIAL VELOCITY ft/sec
A= CROSSECTIONAL AREA (square inch)
K= FACTOR
d= INSIDE DIAMETER (inch)

PUMP DESIGN

DATA

W= 100gpm =442 qm/hr
F1= 2.276 atm
F2= .5 atm
F3=30% * F1+F2+F4
F4= 2 atm

PUMP HEAD REQUIRED =(F1+F2)+F4
= 2.276+.5 + 2
= 4.776

F3 = 1.434

TOTAL HEAD = 4.78+ 1.44
= 6.22 (atm)

USE PUMP WITH FLOW = 100 qm/hr and HEAD = 7 (ATM)

F1 = TOTAL HEAD LOSS DUE TO FRICTION
F2 = TOTAL HEAD LOSS DUE TO ELEVATION
F3 = SAFTEY FACTOR
F4 = NOZZLE PESSURE

WATER REQUIREMENT DATA

PALM TREES : 80 L/TREE/DAY
SHADE TREES : 60 L/TREE/DAY
SHRUBS : 20 L/SM/DAY
GROUND COVER : 18 L/SM/DAY
GRASS : 12 L/SM/DAY

FOR DESIGN THE WATER REQUIREMENT USED .

TREES : 75 L/TREE/DAY
SHRUBS AND
GROUND COVER : 18 L/SM/DAY

PIPE SIZING AND HEADLOSS DATA

*TOTAL WATER REQUIREMENT PER DAY = 116 cm PER DAY
= 116*4.4=510 GPM
IRRIGATION TIME = 8 HOURS
INITIAL VELOCITY MAIN LINE = 4 FEET PER SECOND
C (friction coefficient) = 140

FOR PIPE SIZING AND HEADLOSS CALCULATIONS HAZEN AND WILLIAMS FORMULAS ARE USED OR THE ATTACHED TABLES

SAMPLE CALCULATIONS:
Q (flow) = 510/8=64 gpm
C = 140
V (velocity) = 4 fps
L (length of pipe)= 1584 ft

USING TABLE 4, WE GET
3" PIPE
f (headloss per 100 ft)=.512 lb/sq.in. FOR C=150
TOTAL HEADLOSS = 1584/100*.512=8.11 lb/sq.in. FOR C=150

USING TABLE 4b,
TOTAL HEADLOSS = 8.11*1.14 = 9.24 lb/sq.in. FOR C=140
TOTAL HEADLOSS = 9.24*0.068 = .628 atm

Table Losses Same for all Controlled OD SDR 13.5 thermoplastic pipe. For PE pipe, convert losses to equivalent of C = 140

TABLE 4

PRESSURE LOSS

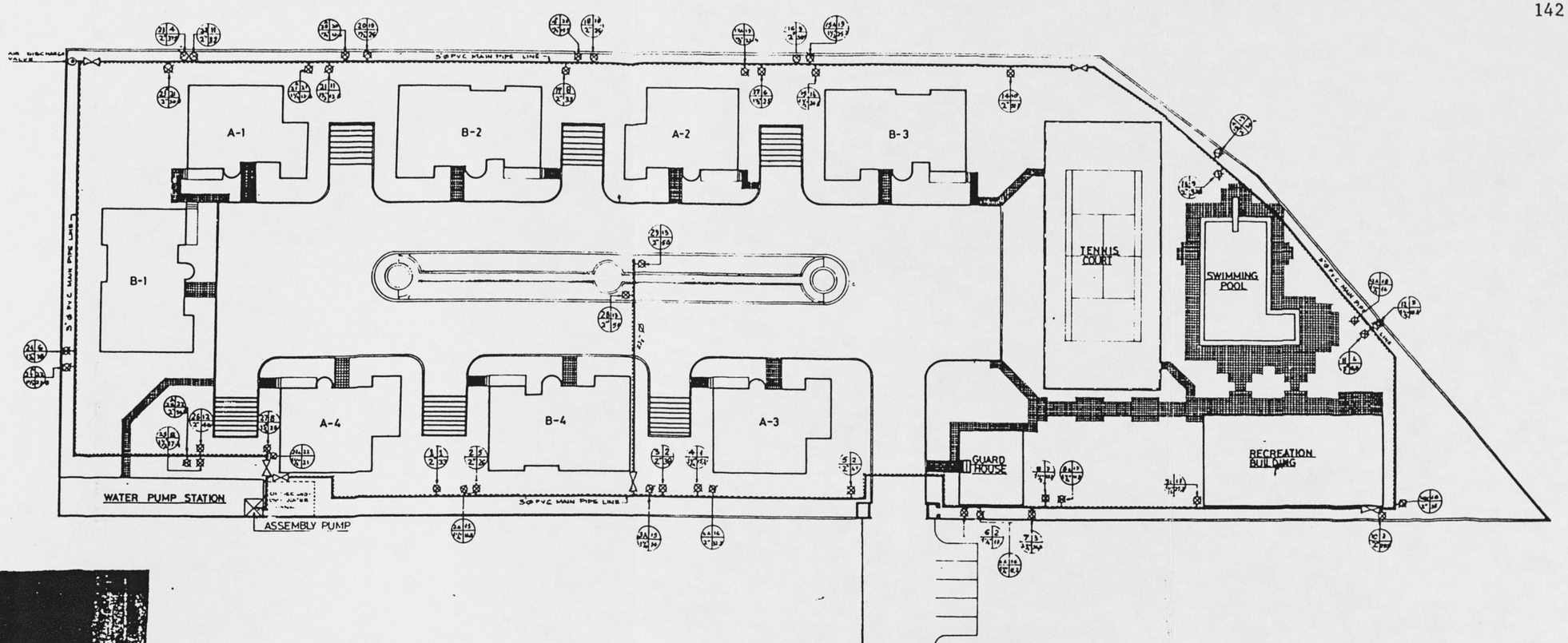
C = 150

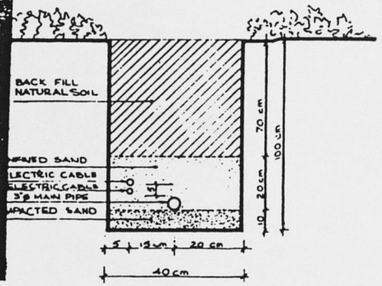
315 psi PR SDR 13.5 PVC PIPE

Pipe Sizes: Nominal											Losses per 100 ft: lb/in²
gpm	1/2 in	3/4 in	1 in	1-1/4 in	1-1/2 in	2 in	gpm	2-1/2 in	3 in	4 in	6 in
1	0.248	0.082	0.027	0.008	0.004	0.001	105	3.15	1.21	0.356	0.054
2	0.896	.296	096	031	016	005	110	3.44	1 32	.388	.059
3	1.90	0.626	204	065	. 033	011	115	3.73	1 43	421	064
4	3.23	1 07	347	110	057	019	120	4.04	1.55	455	069
5	4.88	1.61	524	116	086	029	125	4 35	1 67	491	075
6	6.84	2.26	734	233	120	040	130	4 68	1 79	528	081
7	9.09	3.00	0.976	310	159	053	135	5.02	1 92	566	086
8	11 64	3.84	1 25	397	204	068	140	5.37	2.06	606	092
9	14.48	4 78	1 55	493	254	085	145	5.73	2.19	646	099
10	17 59	5.81	1 89	0.599	0.308	0.103	150	6.10	2.34	0.688	0.105
11	20 98	6.93	2.25	715	368	123	160		2 63	775	118
12	24 65	8.14	2.65	840	432	144	170		2.95	867	132
13		9.44	3.07	0.974	501	167	180		3.27	0.964	147
14		10.82	3.52	1 12	575	192	190		3.62	1.07	163
15		12.30	4 00	1 27	653	218	200		3.98	1.17	179
16		13.86	4 51	1 43	736	246	210		4 35	1 28	196
17		15.50	5.04	1 60	823	275	220		4 75	1.40	213
18		17 23	5.60	1.78	0.915	305	230			1 52	231
19		19.04	6.19	1 96	1 01	338	240			1.64	250
20		20.94	6.81	2.16	1 11	0.371	250			1 77	0.270
22			8.12	2.58	1 33	443	260			1.90	290
24			9.54	3.03	1 56	520	270			2.04	311
26	2-1/2 in		11 06	3.51	1.81	603	280			2.18	333
28			12.69	4.03	2.07	692	290			2.33	355
30	0.311		14.42	4.57	2.35	786	300			2.48	378
32	350			5.15	2.65	886	325			2.88	439
34	391			5.77	2.97	0.991	350			3.30	503
36	435	3 in		6.41	3.30	1 10	375			3.75	572
38	481			7 08	3.64	1 22	400				644
40	529	0.203		7.79	4 01	1 34	425				721
42	579	222		8.52	4 39	1 46	450				801
44	631	242		9.29	4 78	1 60	475				885
46	685	262	4 in	10.09	5.19	1.73	500				0.973
48	741	284		10.91	5.61	1 88	550				1.16
50	0.799	0.306	0.090		6.05	2.02	600				1.36
52	.859	329	.097		6.51	2.17	650				1.58
54	.921	.353	.104		6.98	2.33	700				1.81
56	0.985	.378	.111		7.47	2.49	800				2.32
58	1.05	.403	.119		7.97	2.66	900				
60	1.12	429	.126		8.48	2.83	1000				
62	1.19	456	.134		9.01	3.01	1100				
64	1.26	483	.142			3.19	1200				
66	1.34	512	151			3.38	1300				
68	1.41	541	.159			3.57	1400				
70	1.49	0.571	0.168			3.77	1500				
75	1.69	648	.191			4.28	2000				
80	1.91	730,	.215			4.82	2500				
85	2.13	817	241			5.40	3000				
90	2.37	0.908	267			6.00	3500				
95	2.62	1.00	298			6.63	4000				
100	2.88	1.10	0.325			7.29	5000				

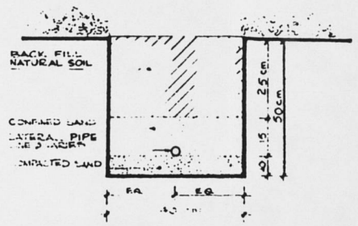
APPENDIX E

Irrigation Drawings: Guest Villa Site and Main Site





MAIN PIPE LINE



LATERAL PIPE LINE

PUMP: OSNA (MULTI STAGE PUMP)
TYPE: 328/6C
SUCTION: 1½"
MOTOR: BAUKNECHT ASYNCRON MOTOR 2 POLE
220-380 VOLTS, 3 PHASES, 60 CYS, 3.450 RPM
PRESSURE TANK: MADE IN GERMANY
GALVANIZED STEEL TANK WITH CERTIFICATION
PRESSURE SWITCHES:
ADJUSTABLE IN A CERTAIN RANGE, OUT IN AND OUT OFF PRESSURE
CONTROL PANNEL: DUPLEX. CASCADE.
CONTROL FOR TWO PUMPS, OVER LOAD. PROTECTION FOR EACH PUMP TIME AND PHASE DROP RELEASE
HAND STOP. AUTO SWITCH FOR EACH PUMP
POWER SUPPLY: 3x220/380 VOLTS + NEUTRAL + EARTH

OTHER EQUIPMENTS
1 - STEEL PLATFORM
2 - CHECK VALVE 1½"
2 - BALL VALVE 1½"
1 - LEVEL INDICATOR WITH PRESSUR GAUGE
1 - SAFETY VALVE
1 - DRAIN VALVE
1 - AIR RENEWING DEVICE"

ELECTRICAL LEGEND

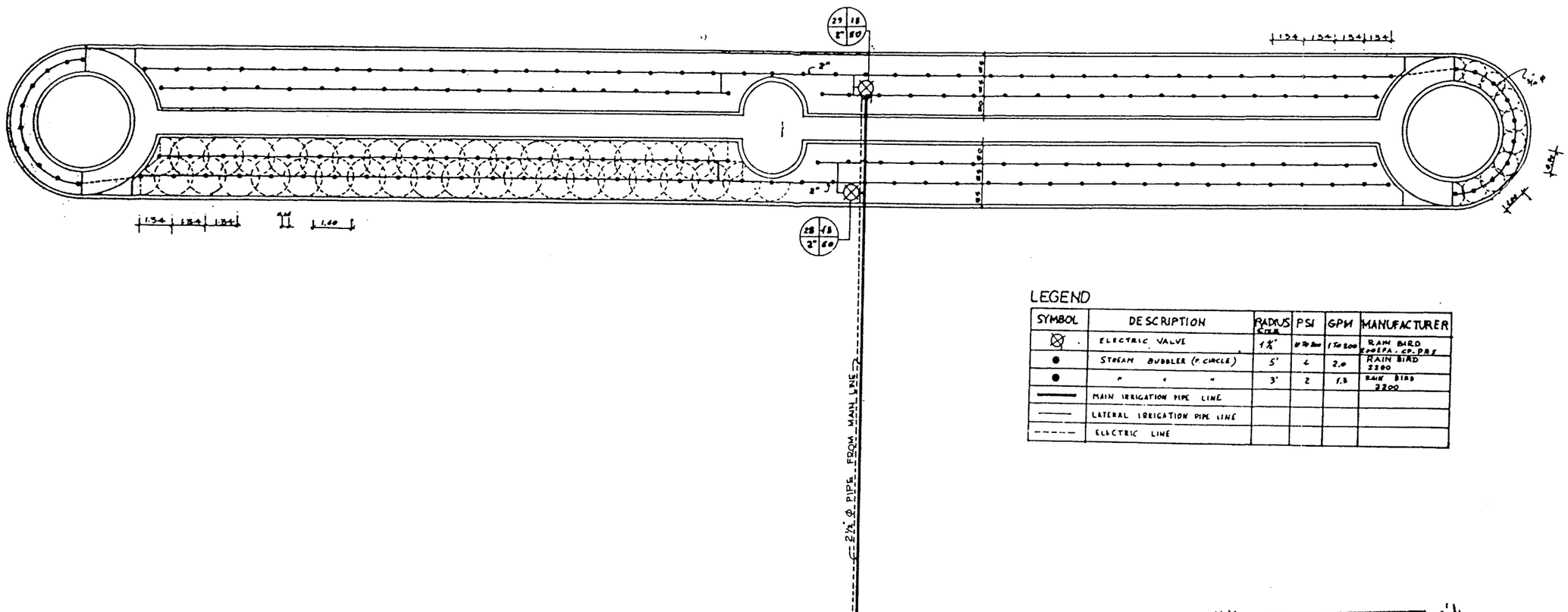
CONTROL STATION	ELECTRO VALVES
STATION_1	1-4
" 2	3-5-6
" 3	7-10
" 4	11-23
" 5	2-12
" 6	17-24
" 7	8
" 8	19-25-27
" 9	13-16
" 10	14-18-20
" 11	21-22
" 12	26
" 13	28-29
" 14	15
" 15	2A-3A
" 16	4A-6A
" 17	8A-9A
" 18	10A-12A
" 19	13A-15A-17A
20	18A-20A
21	21A-23A
22	24A-25A-21A

LEGEND

SYMBOL	DESCRIPTION
⊠	ELECTRIC VALVE
———	3" Ø MAIN PIPE LINE
- - - - - - -	ELECTRIC CABLE RUN CALSE
Ⓐ	AIR DISCHARGE VALVE
⊕	VALVE # CONTROLLER STATION SIZE GPM
⋈	GATE VALVE

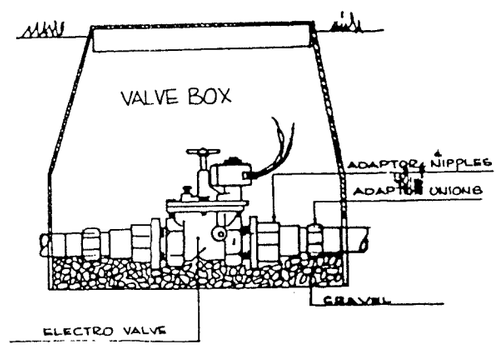
ABDULLAH F. AL-[illegible] & ARCHITECTURE WORKS SALES
P.O. Box [illegible]
Tel. [illegible]

GARDEN CITY



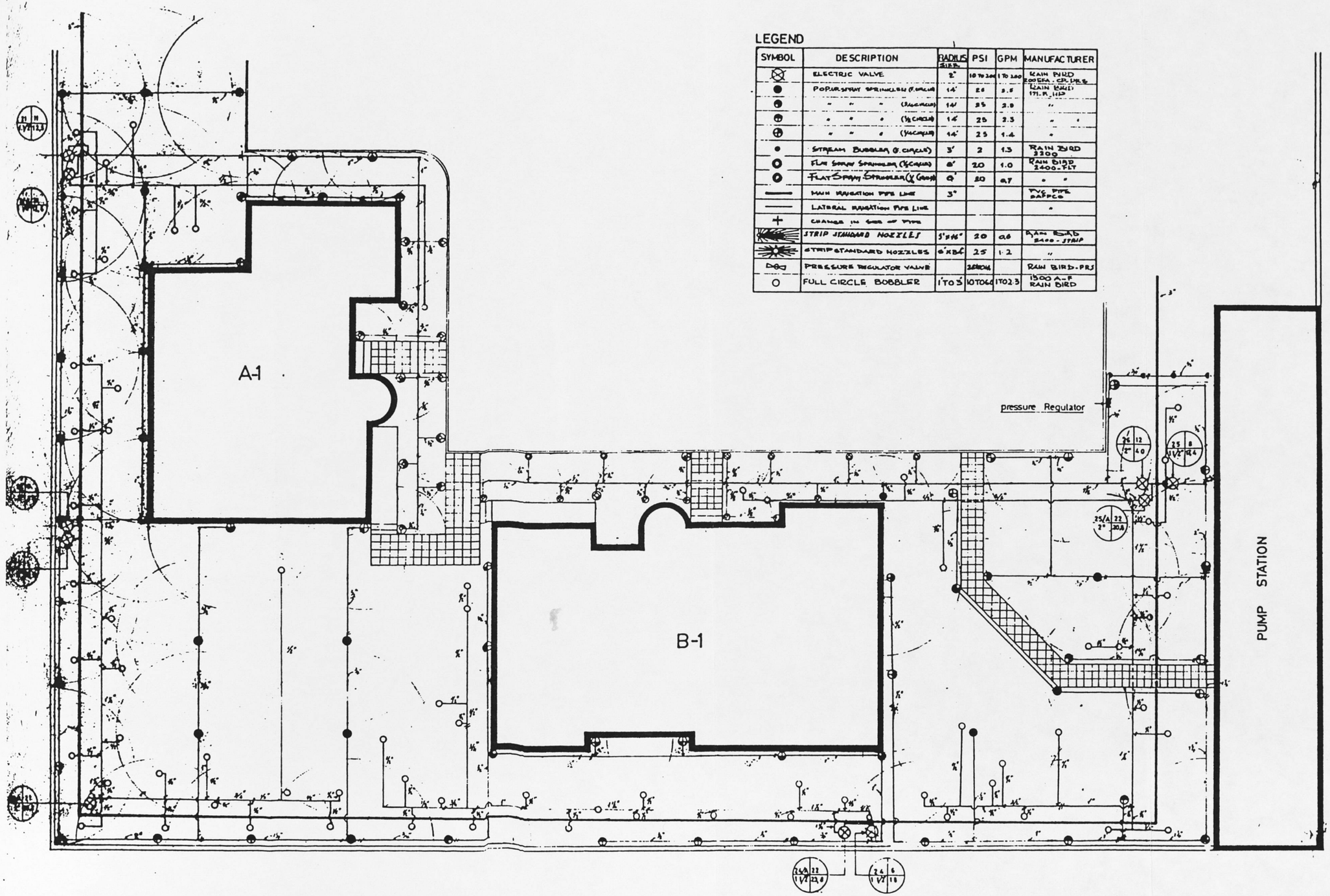
LEGEND

SYMBOL	DESCRIPTION	RADIUS	PSI	GPM	MANUFACTURER
⊗ .	ELECTRIC VALVE	1½"			RAIN BIRD 100EPA. CP-PRS
●	STREAM BUBBLER (1 CIRCLE)	5'	4	2.0	RAIN BIRD 2300
●	" " "	3'	2	1.5	RAIN BIRD 2300
———	MAIN IRRIGATION PIPE LINE				
——	LATERAL IRRIGATION PIPE LINE				
- - - - -	ELECTRIC LINE				



LEGEND

SYMBOL	DESCRIPTION	RADIUS FEET	PSI	GPM	MANUFACTURER
⊠	ELECTRIC VALVE	2"	10 TO 200	1 TO 200	RAIN BIRD 200 EFA - CP. DRLS
●	POPUP SPRAY SPRINKLER (FULL CIRCLE)	14'	25	3.5	RAIN BIRD 1711-R, H.D
◑	" " " (HALF CIRCLE)	14'	25	2.0	"
◔	" " " (⅓ CIRCLE)	14'	25	2.3	" "
◕	" " " (¼ CIRCLE)	14'	25	1.4	" "
•	STREAM BUBBLER (FULL CIRCLE)	3'	2	1.3	RAIN BIRD 3200
○	FLAT SPRAY SPRINKLER (FULL CIRCLE)	8'	20	1.0	RAIN BIRD 2400-FLT
◯	FLAT SPRAY SPRINKLER (½ CIRCLE)	9'	20	0.7	" "
———	MAIN IRRIGATION PIPE LINE	3"			PVC PIPE DAFPCO
———	LATERAL IRRIGATION PIPE LINE				"
+	CHANGE IN SIZE OF PIPE				
	STRIP STANDARD NOZZLES	5'x54"	20	0.6	RAIN BIRD 2400 - STRIP
	STRIP STANDARD NOZZLES	6'x8'-6"	25	1.2	"
D⊠	PRESSURE REGULATOR VALVE		25 TO 45		RAIN BIRD - PRS
○	FULL CIRCLE BOBBLER	1' TO 3'	10 TO 60	1 TO 2.3	1500 A-F RAIN BIRD



REVISIONS		
NO	DATE	DESCRIPTION
1	7.2.83	

SCALE	1:100
DATE	28 FEB 83
DRAWN	A. AMICO
CLIENT	HRH PRINCE ABDULLAH BIN ABDUL AZIZ

ABDULLAH F. AL-KRAIDEES

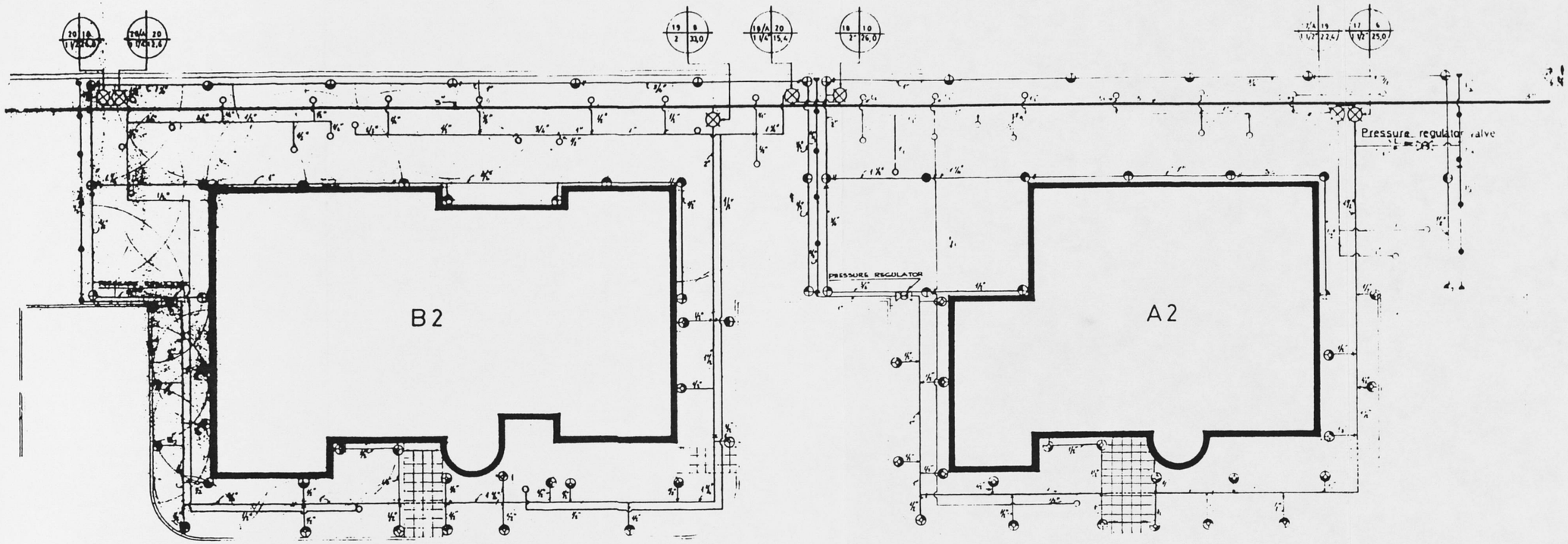
CONSTRUCTION - LANDSCAPING

HABIB SALAME

BUREAU D'ARCHITECTURE

CONSULTANT	SAUD CONSULT
TITLE	IRRIGATION LAYOUT
LOCATION	GUEST VILLA A1 / B1

AK 101 10A



NOTE: SEE DRAWING NO 11A FOR LEGEND

NO	DATE	DESCRIPTION
1	17.2.83	

SCALE	1:100
DATE	28 FEB.83
DRAWN	L.AMICO
CLIENT	HRH PRINCE ABDULLAH BIN ABDUL AZIZ

ABDULLAH F. AL-KRAIDEES EST.

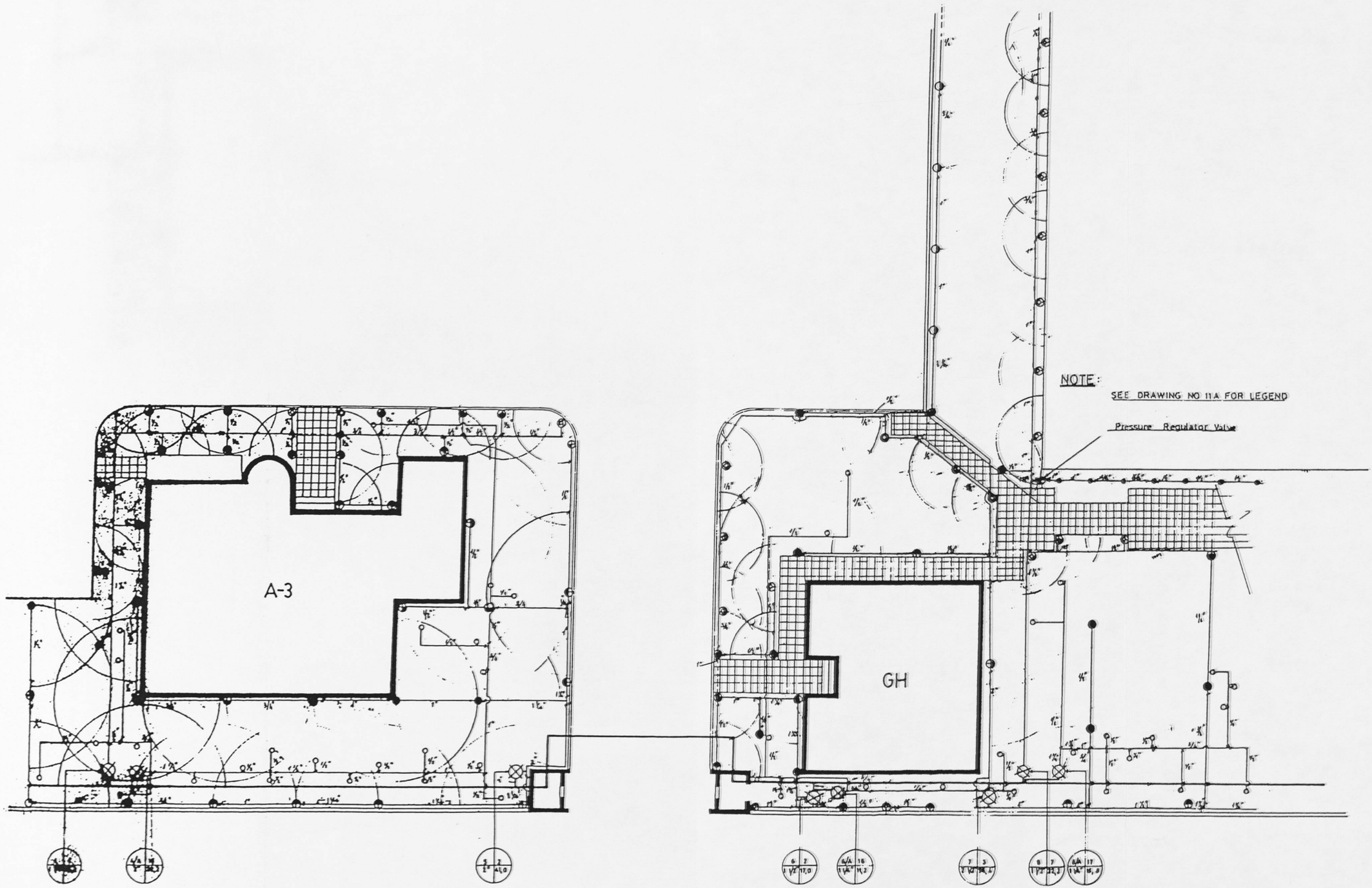
CONSTRUCTION - LANDSCAPING

HABIB SALAMÉ

BUREAU D'ARCHITECTURE

CONSULTANT	SAUD CONSULT
TITLE	IRRIGATION LAYOUT
LOCATION	GUEST VILLA A2 / B2

AK 101 13A



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SCALE	1:100
DATE	17-2-83
DRAWN	
CLIENT	HRH PRINCE [illegible] BIN ABDUL [illegible]

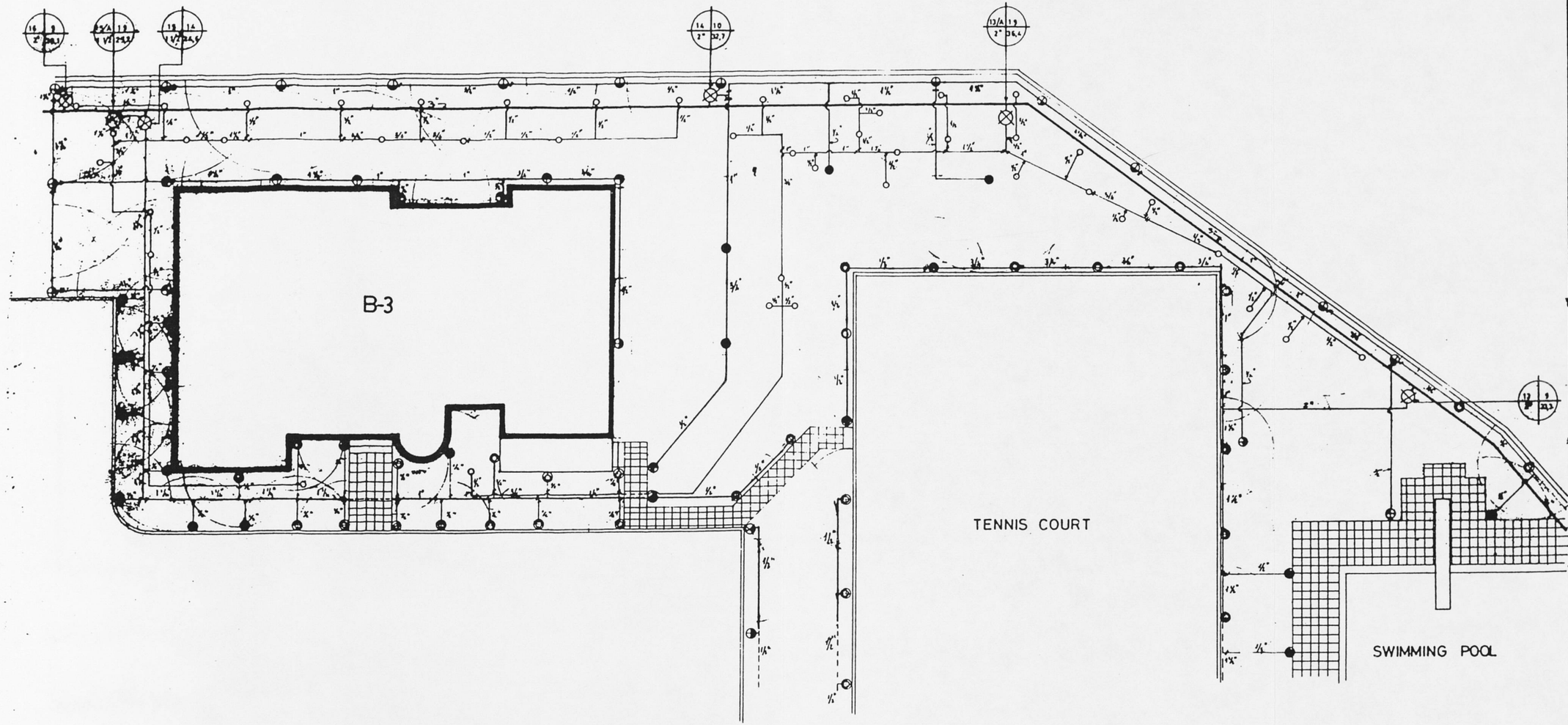
ABDULLAH FAL-KHADEES EST.

CONSTRUCTION, LANDSCAPING

HABIB SALAME

BUREAU D'ARCHITECTURE

CONSULTANT	SAUD CONSULT
TITLE	IRRIGATION LAYOUT
LOCATION	[illegible] A3/104



NOTE:
SEE DRAWING NO. 11A FOR LEGEND

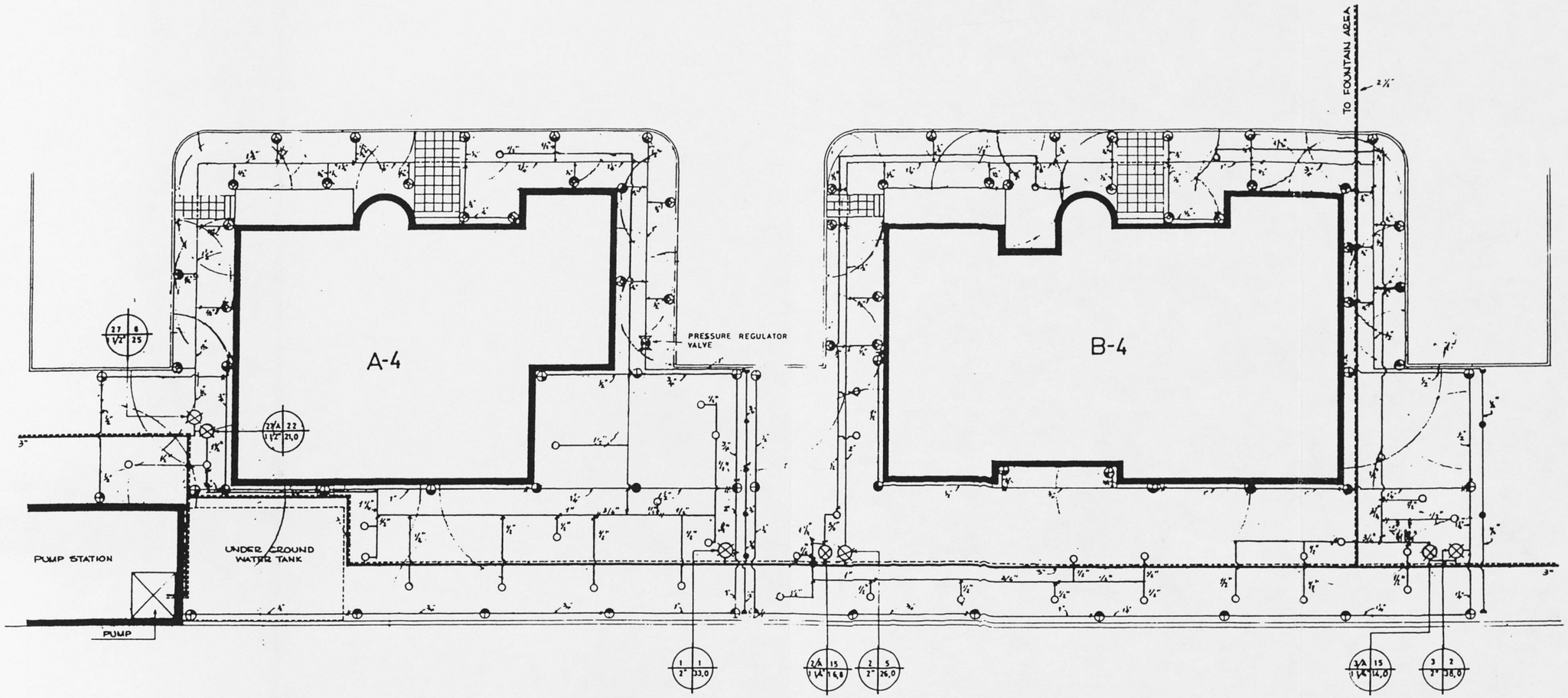
DESCRIPTION

SCALE

CONSTRUCTION - LANDSCAP

CONSULTANT SAUD CONSUL

TITLE IRRIGATION LAY



LEGEND

SYMBOL	DESCRIPTION	RADIUS	PSI	GPM	MANUFACTURER
⊗	ELECTRIC VALVE	2"	40 TO 200	1 TO 200	RAIN BIRD 200 SEA, CP, PRB
●	POPUP SPRAY SPRINKLER (FCIRCLE)	14'	25	3.5	RAIN BIRD 1711-E-HP
◕	" (¾CIRCLE)	14'	25	2.5	"
◓	" (½ CIRCLE)	14'	25	2.3	"
⊕	" (¼ CIRCLE)	14'	25	1.4	"
•	STREAM BUBBLER (F CIRCLE)	3'	2	1.3	RAIN BIRD 2200
◕	FLAT SPRAY SPRINKLER (¾ CIRCLE)	8'	20	1.0	RAIN BIRD 2400-PLT
◔	" (¼ CIRCLE)	8'	20	0.7	"
———	MAIN IRRIGATION PIPE LINE	3"			PVC PIPE RAPPCO
——	LATERAL IRRIGATION PIPE LINE				"
- - - - -	ELECTRIC CABLE				
⊢	CHANGE IN SIZE OF PIPE				
⊢⊣	PRESSURE REGULATOR VALVE		25		RAIN BIRD

REVISIONS

NO	DATE	DESCRIPTION
1	17.382	

SCALE	1:100
DATE	28 FEB. 83
DRAWN	L.AMIGO
CLIENT	HRH PRINCE ABDULAZIZ BIN ABDUL AZIZ

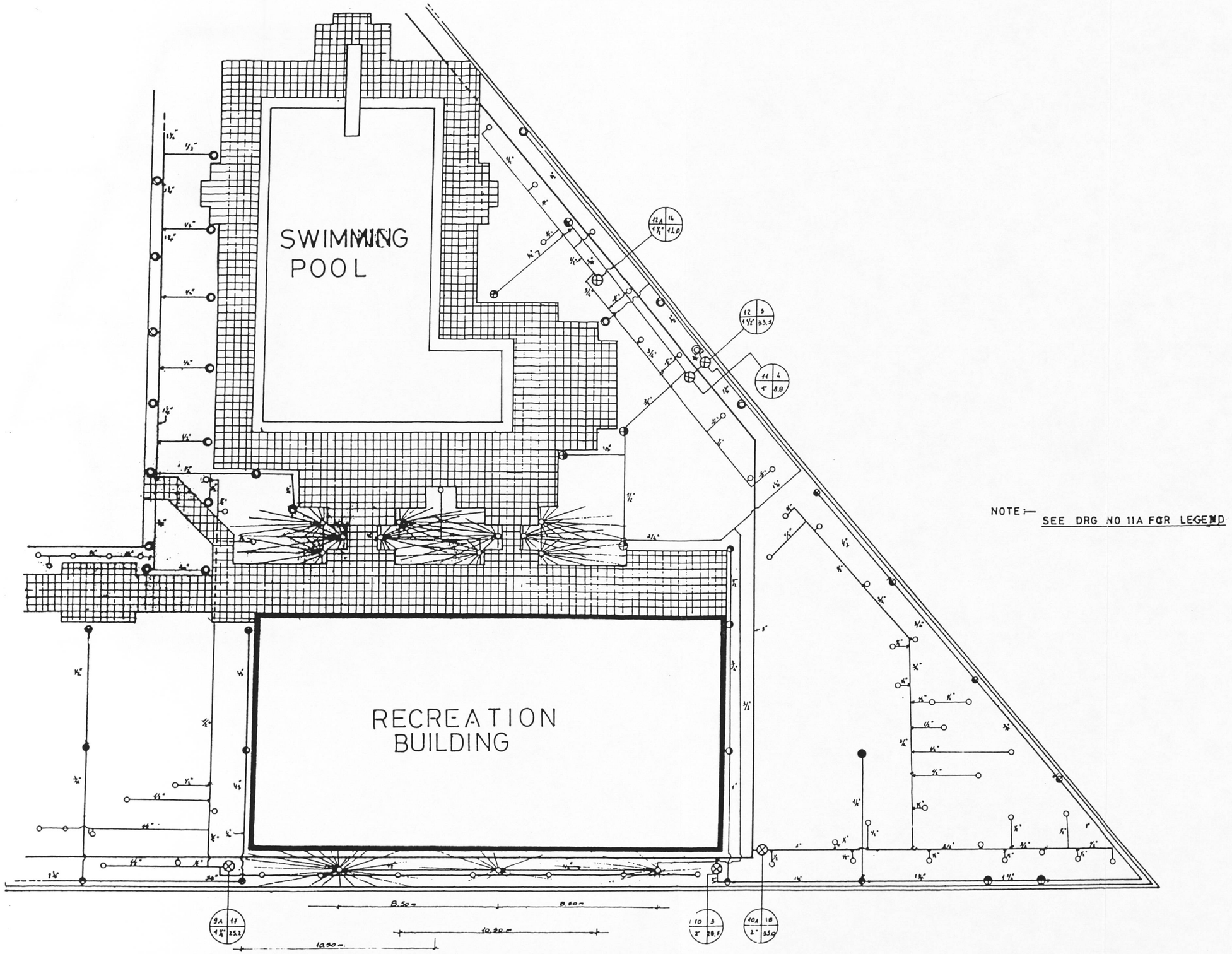
ABOULLAH F. AL KRAIDEES EST.

CONSTRUCTION-LANDSCAPE

HABIB SALAME

BUREAU D'ARCHITECTURE

CONSULTANT	SAUD CONSULT
TITLE	IRRIGATION LAYOUT
LOCATION	GUEST VILLAS A4/B4
A/C	101



REVISIONS

NO	DATE	DESCRIPTION

SCALE	1:100
DATE	23 FEB. 83
DRAWN	L. AMICO
CLIENT	HRH PRINCE ABDUL BIN ABDUL AZIZ

ABDULLAH F. AL KHADEER

HABIB SALAM

BUREAU D'ARCHITECTURE

CONSULTANT	SAUDI CONSULT
TITLE	IRRIGATION LAYOUT
LOCATION	GUEST VILLA RECREATION BLDG

SERVICE ENTRANCE_2

MAJLIS

DRIVERS QTR

GARAGE

MAIN KITCHEN

SERVANT QTRS

WAREHOUSE

SERVANT QTRS

PANNEL CONTROL-3

SERVICE ENTRANCE_1

PANNEL CONTROL-4

MAIN ENTRANCE

CONFERENCE HALL

POOL & LEISURE FACILITIES

GUEST VILLA

GUEST VILLA

GUEST VILLA

MAIN PALACE

TENNIS COURT

MOSQUE

TENNIS COURT

LAKE

PUMP STATION

PANNEL CONTROL-5

SERVICE ENTRANCE_3

PANNEL CONTROL-1

PANNEL CONTROL-2

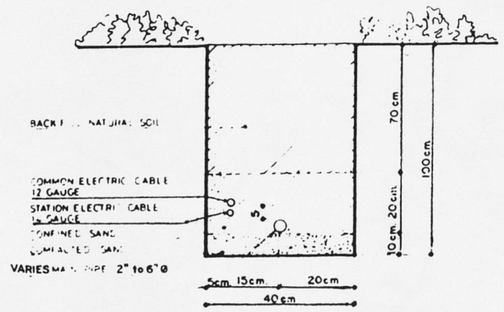
PALACE ENTRANCE

LEGEND

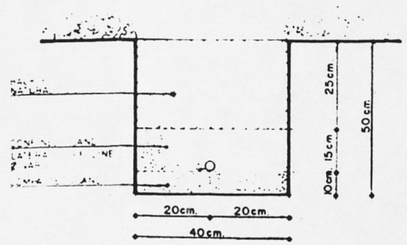
- ELECTRIC VALVE
- MAIN IRRIGATION PIPE LINE
- ELECTRIC CABLE
- PANNEL CONTROL
- MANUAL VALVE

LEGEND

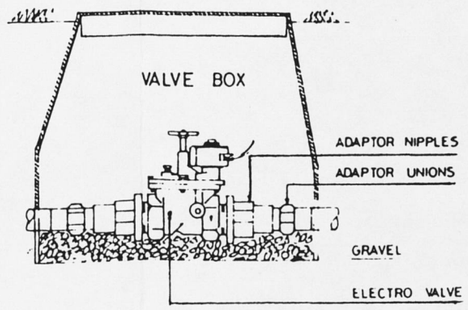
SYMBOL	DESCRIPTION	RADIUS	PSI	GPM	MANUFACTURER	REMARK
●	POP. UP SPRINKLERS (FULL CIRCLE)	35'	25	3.2	RAIN BIRD	15103
◕	—DO— ¾ CIRCLE	35'	25	2.4	—DO—	—DO—
◓	— DO — ½ CIRCLE	35'	25	1.6	— DO —	— DO —
◔	— DO— ¼ CIRCLE	35'	25	0.8	— DO —	— DO —
○	POP UP SPRAY SPRINKLER (FULL CIRCLE)	14'	25	3.5	—DO—	1716-HP
◕	— DO— ¾ CIRCLE	14'	25	2.9	— DO —	— DO—
◓	— DO— ½ CIRCLE	14'	25	2.3	— DO—	—DO—
◔	—DO— ¼ CIRCLE	14'	25	1.4	—DO—	—DO—
•	FLAT SPRAY SPRINKLER (FULL CIRCLE)	9'	25	2.3	DO	2400 FLT
◕	— DO— ¾ CIRCLE	9'	25	1.8	—DO —	—DO —
◓	— DO — ½ CIRCLE	9'	25	1.2	—DO —	—DO—
◔	— DO— ¼ CIRCLE	9'	25	0.8	— DO—	—DO—
	END STRIP STANDARD NOZZLE	6X17'	25	0.6	— DO —	2400
	CENTRE STRIP STANDARD NOZZLE	6X34'	25	1.2	DO	DO
—o—	BUBBLER	1.5'	25	1.5	— DO —	1300 AF
	STREAM BUBBLER FULL CIRCLE	3'	2	1.3	— DO —	2200
	—DO— , ½ CIRCLE	3'	2	1.1	—DO —	DO
	MAIN IRRIGATION PIPE LINE	—	—	—	PVC PIPE SAPPCO	—
	LATERAL IRRIGATION PIPE LINE	—	—	—	— DO —	—
-----	ELECTRIC CABLE	—	—	—	—	—
	CHANGE IN SIZE OF PIPE	—	—	—	—	—
⊗	ELECTRIC VALVE	—	—	—	RAIN BIRD	EFA-CP PRS
	VALVE # / SIZE — # STATIONS / # PANNEL CONTROL / GPM	—	—	—	—	—



MAIN PIPE LINE



LATERAL PIPE LINE



ELECTRICAL LEGEND

CONTROL STN.NO 1	ELECTRO VALVES
STATION 1	79 – 80 – 92
— DO — 2	81 - 88 - 88A
— DO — 3	83 - 89 - 89A
— DO — 4	84 - 85 - 91-94
— DO — 5	86 – 86A
— DO — 6	87 - 90 - 93
— DO — 7	109 - 119
— DO — 8	111-112 - 115 - 118
— DO — 9	114 - 116-116A-120
— DO — 10	117
— DO — 11	113
— DO — 12	108

ELECTRICAL LEGEND

CONTROL STN.NO.2	ELECTRO VALVES
STATION 1	1-8-15-17
— DO — 2	3 - 5 - 9
— DO — 3	2 - 7
— DO — 4	6 - 10 - 11
— DO — 5	43 - 56
— DO — 6	44-48-54-59
— DO — 7	45-47-53-60
— DO — 8	50 – 50A
— DO — 9	49
— DO — 10	51
— DO — 11	52
— DO — 12	—

ELECTRICAL LEGEND

CONTROL STN.NO.3	ELECTRO VALVES
STATION 1	16 – 19 – 26
— DO — 2	22 – 22A-28
— DO — 3	25 – 36
— DO — 4	23 - 24 - 31- 35
— DO — 5	34 – 63
— DO — 6	38 - 62 - 65
— DO — 7	64 – 64A
— DO — 8	61- 68 – 69 - 70
— DO — 9	66-66A-66B-66C
— DO — 10	67 - 77
— DO — 11	71 - 76
— DO — 12	72 - 74

ELECTRICAL LEGEND

CONTROL STN.NO.4	ELECTRO VALVES
STATION 1	95 – 103 – 103A
— DO — 2	97 - 97A
— DO — 3	98 - 105
— DO — 4	75 - 100 – 104
— DO — 5	101 - 130
— DO — 6	102
— DO — 7	107
— DO — 8	131 - 133 – 139
— DO — 9	132 - 132A - 137
— DO — 10	134 - 138-138A-136
— DO — 11	135-135A-144-144A
— DO — 12	141 - 143

ELECTRICAL LEGEND

CONTROL STN.NO.5	ELECTRO VALVES
STATION 1	121 - 123 - 125
— DO — 2	127 - 127A
— DO — 3	128 - 129
— DO — 4	122 - 160
— DO — 5	147-147A-147B-155
— DO — 6	149-150-153 - 156
— DO — 7	151 - 151A - 154
— DO — 8	145 – 146
— DO — 9	157 – 159A-159B
— DO — 10	158 - 161
— DO — 11	162 - 162A
— DO — 12	152

151

No	DATE	

SCALE	
DATE	APRIL '83
DRAWN	LA/RS
CLIENT	HRH PRINCE ABDULILAH BIN ABDUL AZIZ

ABDULLAH F. AL-KRAIDEES EST

CONSTRUCTION - LANDSCAPING

HABIB SALAME

BUREAU D'ARCHITECTURE

IRRIGATION

CONSULTANT	SAUD CONSULT
TITLE	GASSIM M.P. SITE
LOCATION	GENERAL

AK 1 0 1 0 4 5

SECTOR LINE

MATCHING LINE

SECTOR LINE

TENNIS COURT

MATCHING LINE

TO E.V. NO. 51

SECTOR LINE

PALACE ENTRANCE

REVISIONS

NO	DATE	DESCRIPTION

SCALE	1:200
DATE	APRIL '83
DRAWN	LA/RS
CLIENT	HRH PRINCE ABDULLAH BIN ABDUL AZIZ

ABOULLAH F AL KRAIDEES EST

CONSTRUCTION LANDSCAPING

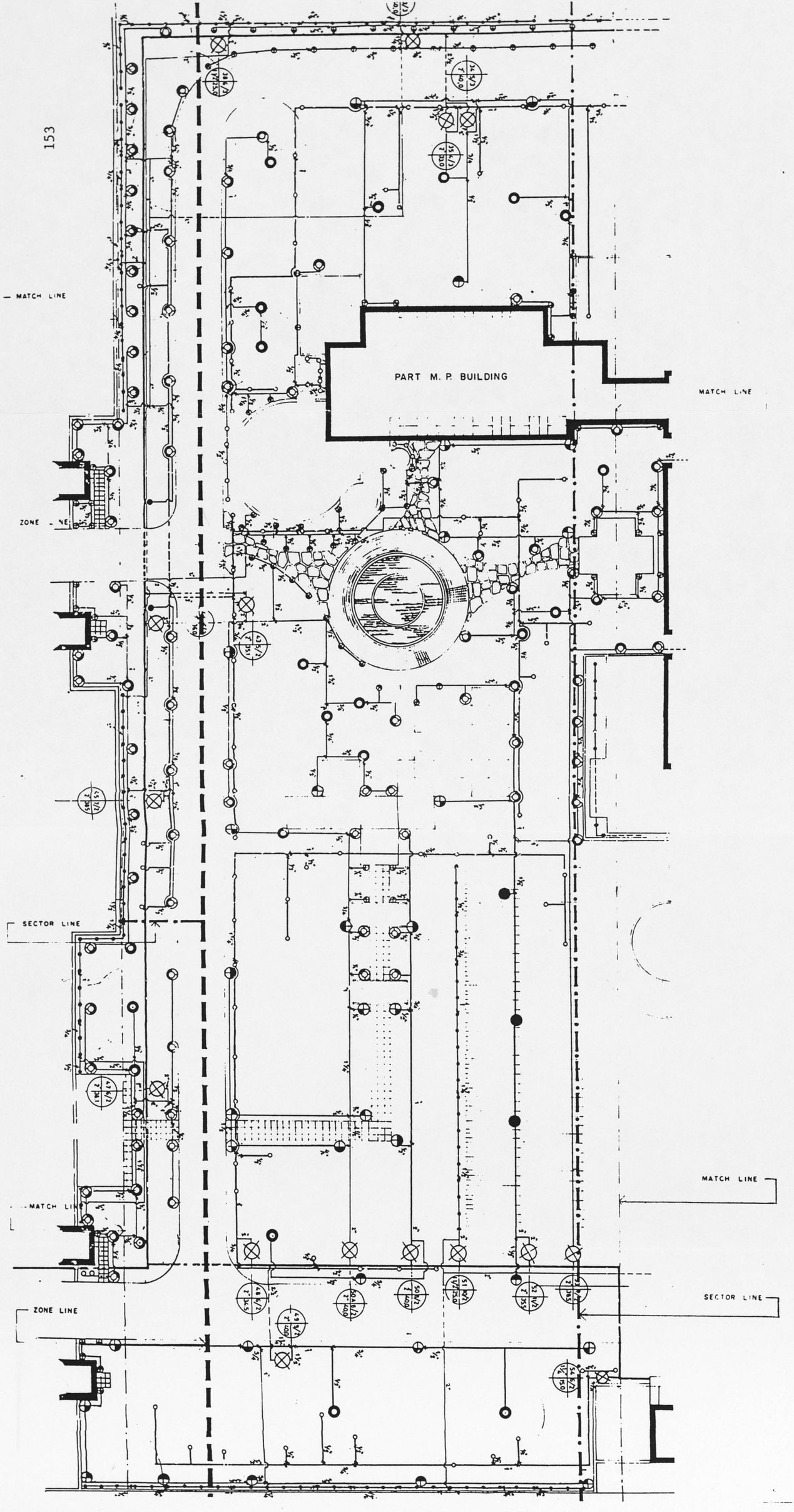
HABIB SALAME

BUREAU D ARCHITECTURE

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	GASSIM M.P. SITE
LOCATION	ZONE SECTOR

AK 1 0 1 0



REVISIONS

SCALE	1:200
DATE	APRIL '83
DRAWN	LA/RS
CLIENT	HRH PRINCE ABDULILAH BIN ABDUL AZIZ

ABDULLAH F. AL-RRAIDEES - EST

CONSTRUCTION LANDSCAPING

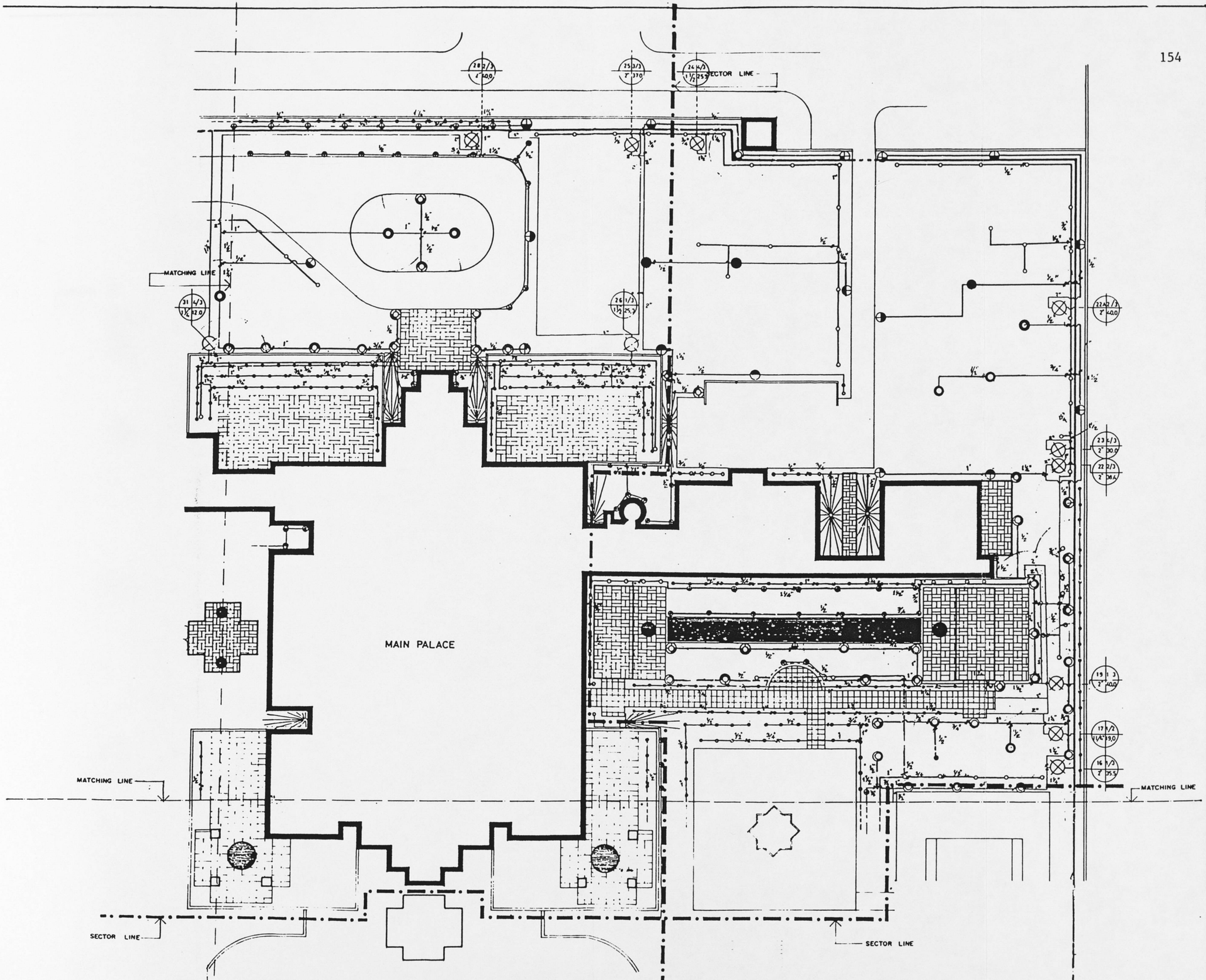
HABIB SALAME

BUREAU D'ARCHITECTURE

IRRIGATION

[illegible]	SAUDI [illegible]
TITLE	[illegible] MP BUILDING
LOCATION	ZONE 2 SECTOR 2

AK 1 0 1 0 3 E



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SCALE	1:200
DATE	APRIL '83
DRAWN	LA/RS
CLIENT	HRH PRINCE ABDULLAH BIN ABDUL AZIZ

ABDULLAH F. AL-KRAIDEES EST.

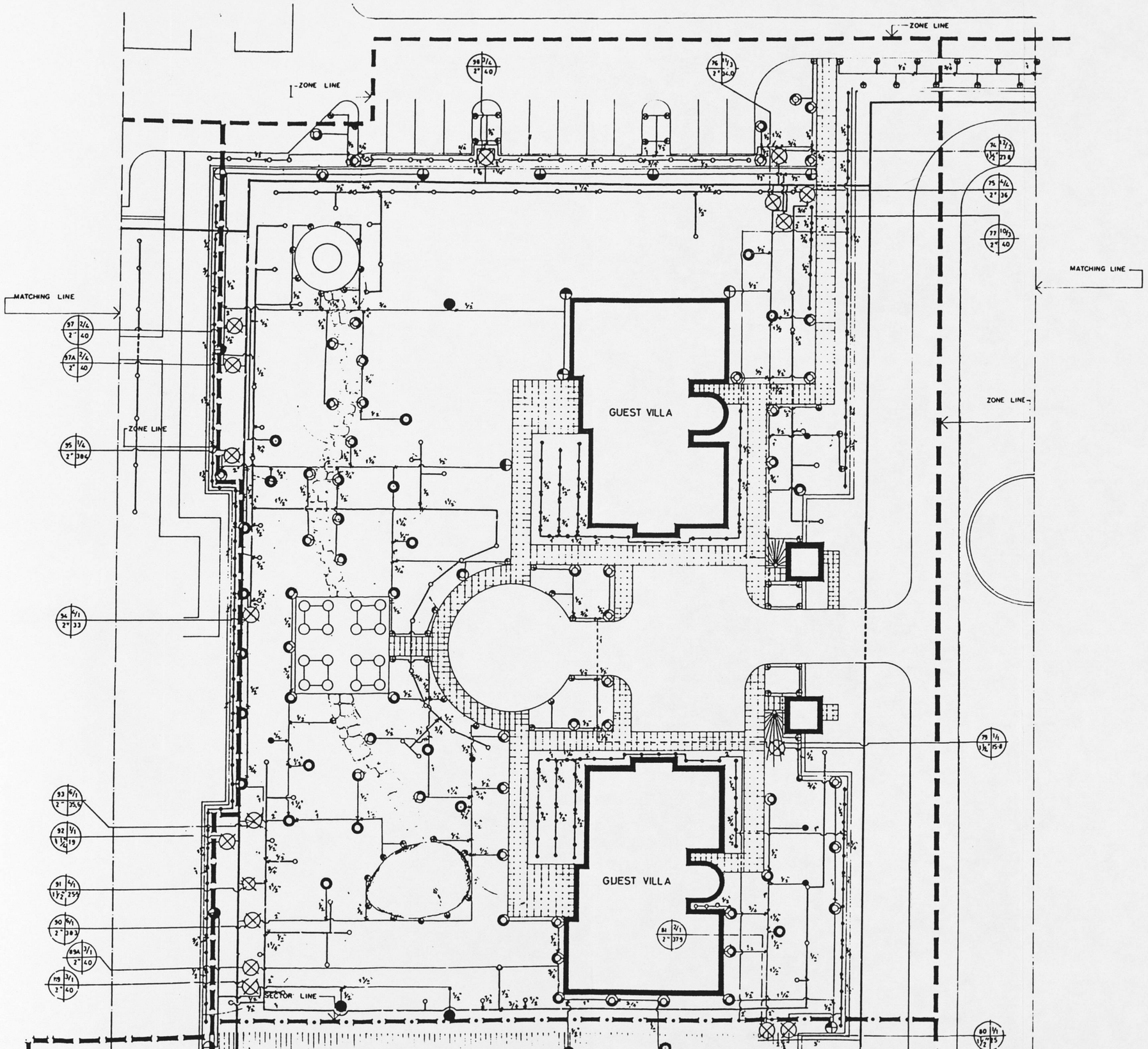
CONSTRUCTION - LANDSCAPING

HABIB SALAME

BUREAU D'ARCHITECTURE

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	GASSIM M.P. SITE
LOCATION	ZONE 2 SECTOR 4 & 5



REVISIONS

NO	DATE	DESCRIPTION

SCALE	1 : 200
DATE	APRIL '83
DRAWN	LA / RS
CLIENT	HRH PRINCE ABDULILAH BIN ABDUL AZIZ

ABDULLAH F AL KRAIDEES EST.

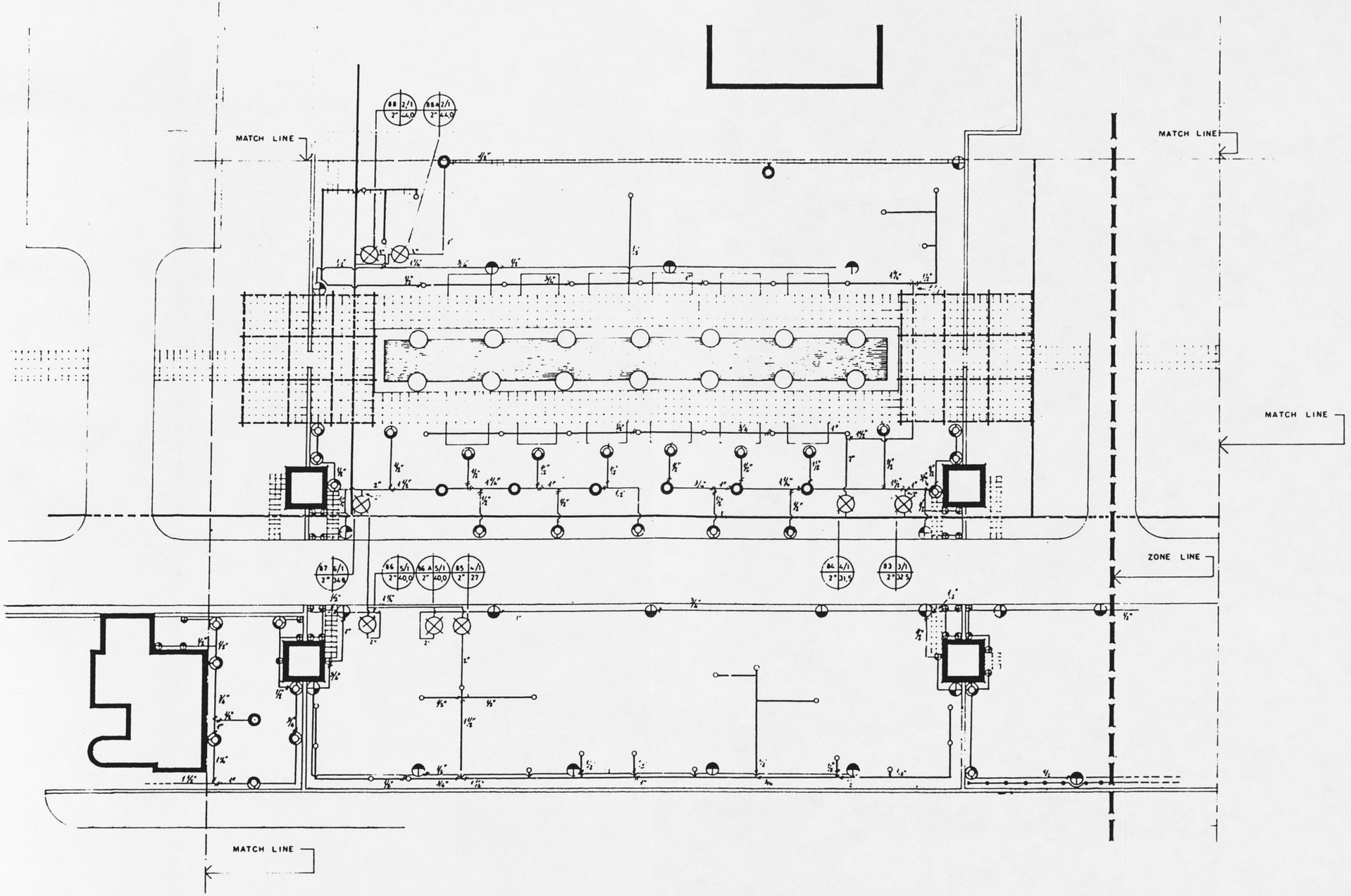
CONSTRUCTION LANDSCAPING

HABIB SALAME

BUREAU D ARCHITECTURE

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	GASSIM M.P. SITE
LOCATION	ZONE 3 SECTOR 6



REVISIONS

NO	DATE	DESCRIPTION

SCALE	1:200
DATE	APRIL '83
DRAWN	LA/RS
CLIENT	HRH PRINCE ABDULLAH BIN ABDUL AZIZ

ABDULLAH F AL KRAIDEES EST.

CONSTRUCTION LANDSCAPING

HABIB SALAME

BUREAU D ARCHITECTURE

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	GASSIM M.P. SITE
LOCATION	ZONE 3 SECTOR 7

AK 1 0 1 0 4 1

WAREHOUSE

SERVANTS QUARTER

SECTOR LINE

ZONE LINE

ZONE LINE

REVISIONS

NO	DATE

SCALE	1 200
DATE	APRIL '83
DRAWN	LA/RS
CLIENT	H.R.H. PRINCE ABDUL-ILAH BIN ABDUL AZIZ

ABDULLAH F. AL-KRAIDEES EST

CONSTRUCTION - LANDSCAPING

HABIB SALAME

BUREAU D'ARCHITECTURE

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	GAS&IM M P SITE
LOCATION	ZONE 4 SECTOR 8

SERVICE ENTRANCE 2

SECTOR LINE

GARAGE

MAIN KITCHEN

SERVANTS Q'TRS

MATCH LINE

MATCH LINE

CONNECTION TO MAIN LINE

CONN. TO MAIN LINE

ZONE LINE

ZONE LINE

REVISIONS

No	DATE

SCALE	1:200
DATE	APRIL' 83
DRAWN	LA / RS
CLIENT	HRH PRINCE ABDULLAH BIN ABDUL AZIZ

ABDULLAH F AL KRAIDEES ES

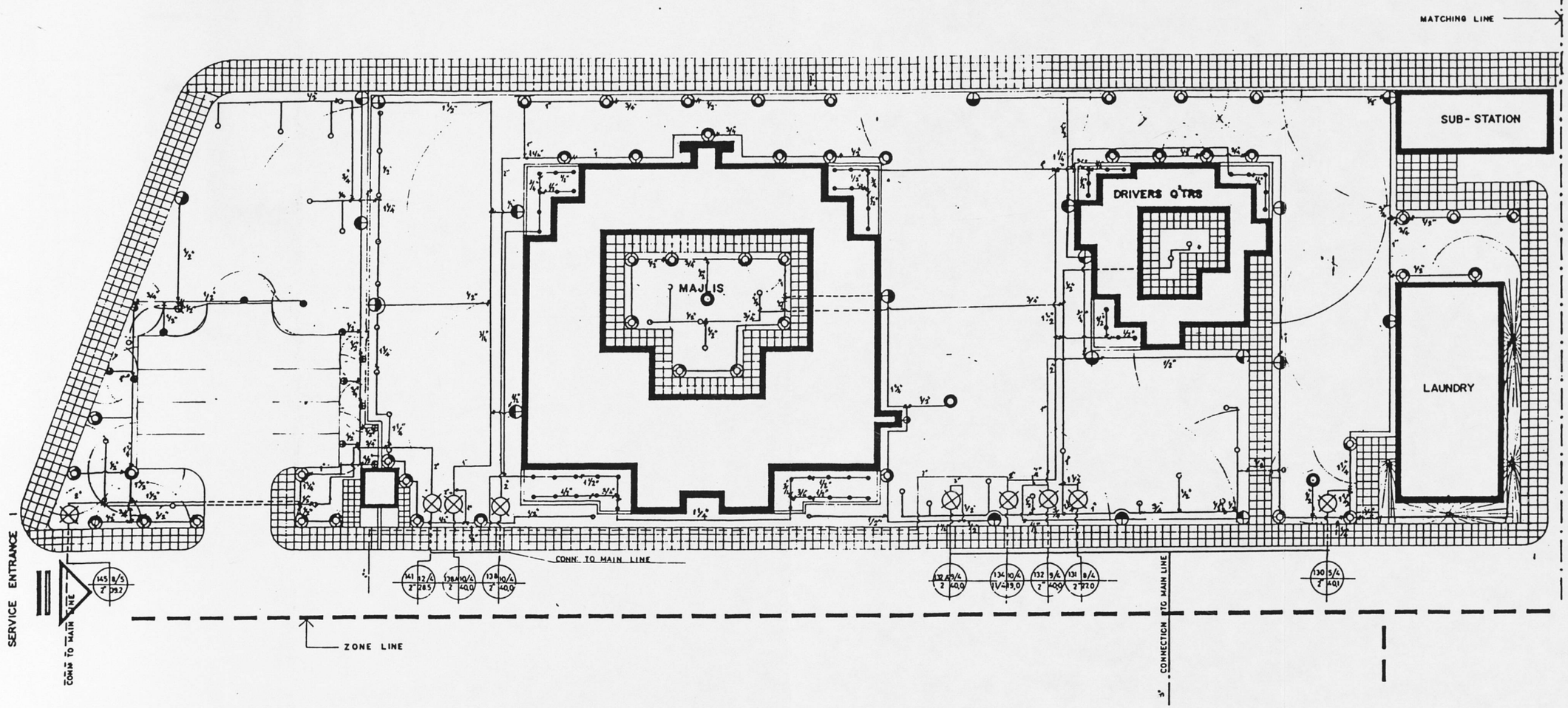
CONSTRUCTION LANDSCAPIN

HABIB SALAME

BUREAU D ARCHITECTURE

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	QASSIM M.P. SITE
LOCATION	ZONE 4 PART SECTORS 9/



NO.	DATE

SCALE	1:200
DATE	APRIL' 83
DRAWN	LA/RS.
CLIENT	H.R.H. PRINCE ABDUL-IL BIN ABDUL AZIZ

ABDULLAH F. 'AL-KRAIDEES EST.

CONSTRUCTION LANDSCAPING

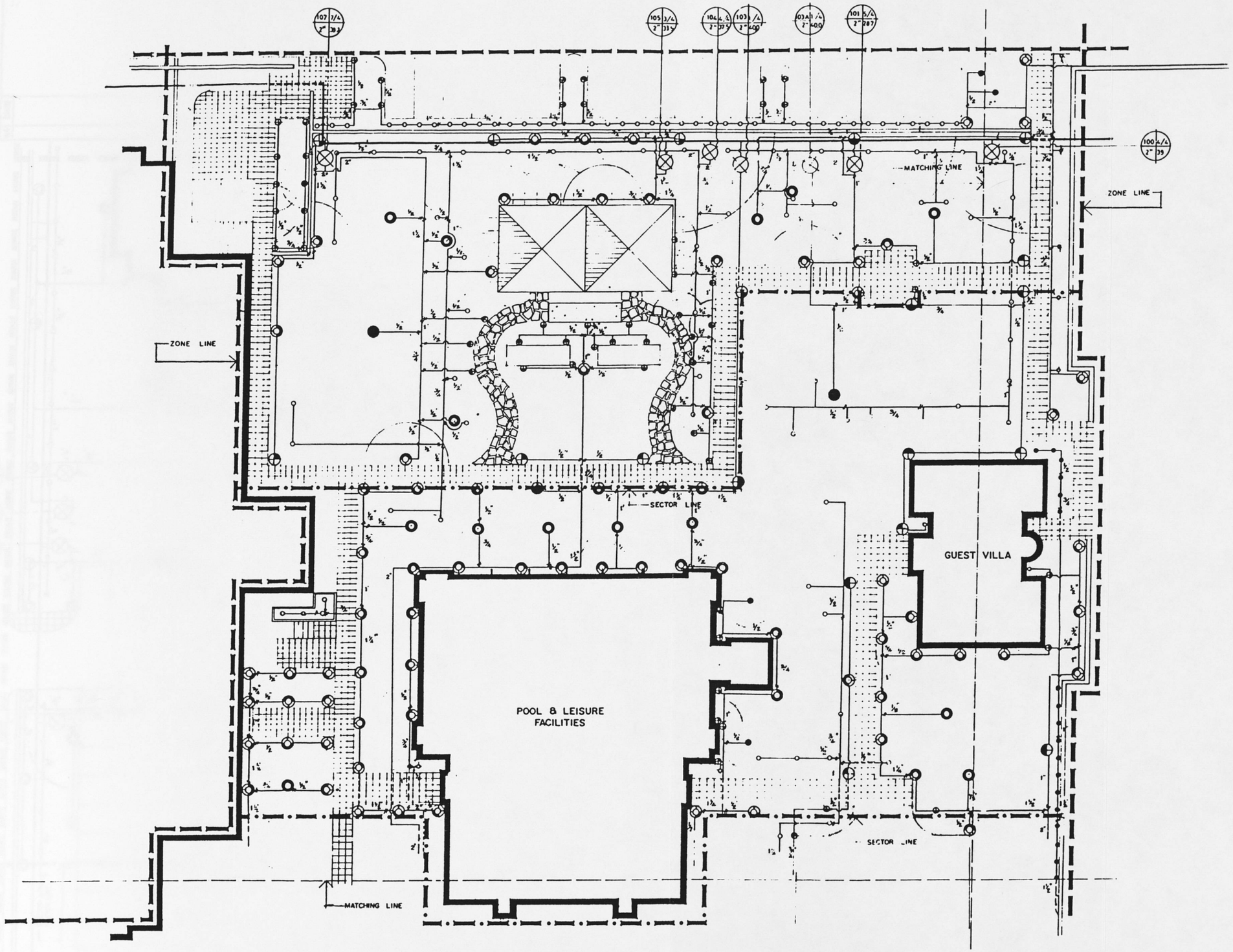
HABIB SALAME

BUREAU D' ARCHITECTURE

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	QASSIM M.P. SITE
LOCATION	ZONE A PART SECTOR 10

AK 1 0 1 0 6



NO	DATE

SCALE	1 200
DATE	APRIL'83
DRAWN	LA/RS
CLIENT	H R H PRINCE ABDUL-ILAH BIN ABDUL AZIZ

ABDULLAH F AL-KRAIDEES EST

CONSTRUCTION - LANDSCAPING

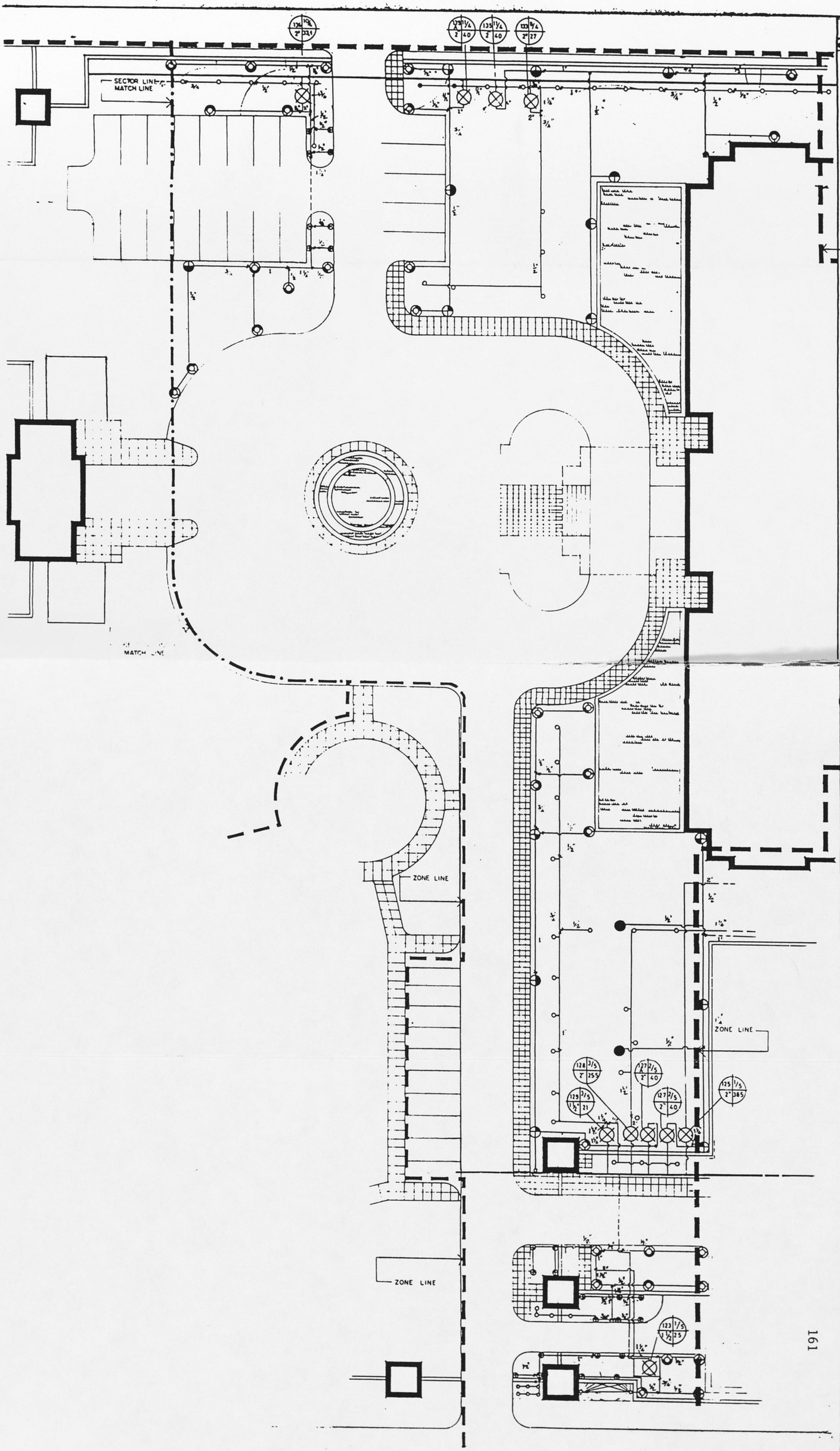
HABIB SALAME

BUREAU D ARCHITECTURE

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	GASSIM M.P. SITE
LOCATION	ZONE 5 SECTOR 11 & 12

AK 1 0 1 0 4 2



REVISIONS

SCALE	1 : 200
DATE	APRIL '83
DRAWN	LA/RS
CLIENT	H.R.H PRINCE ABDUL-I BIN ABDUL AZIZ

ABDULLAH F. 'AL-KRAIDEES ES

CONSTRUCTION - LANDSCAPING

HABIB SALAME

BUREAU D'ARCHITECTUR

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	[illegible] M. PIBITE
LOCATION	[illegible]

A R [illegible]

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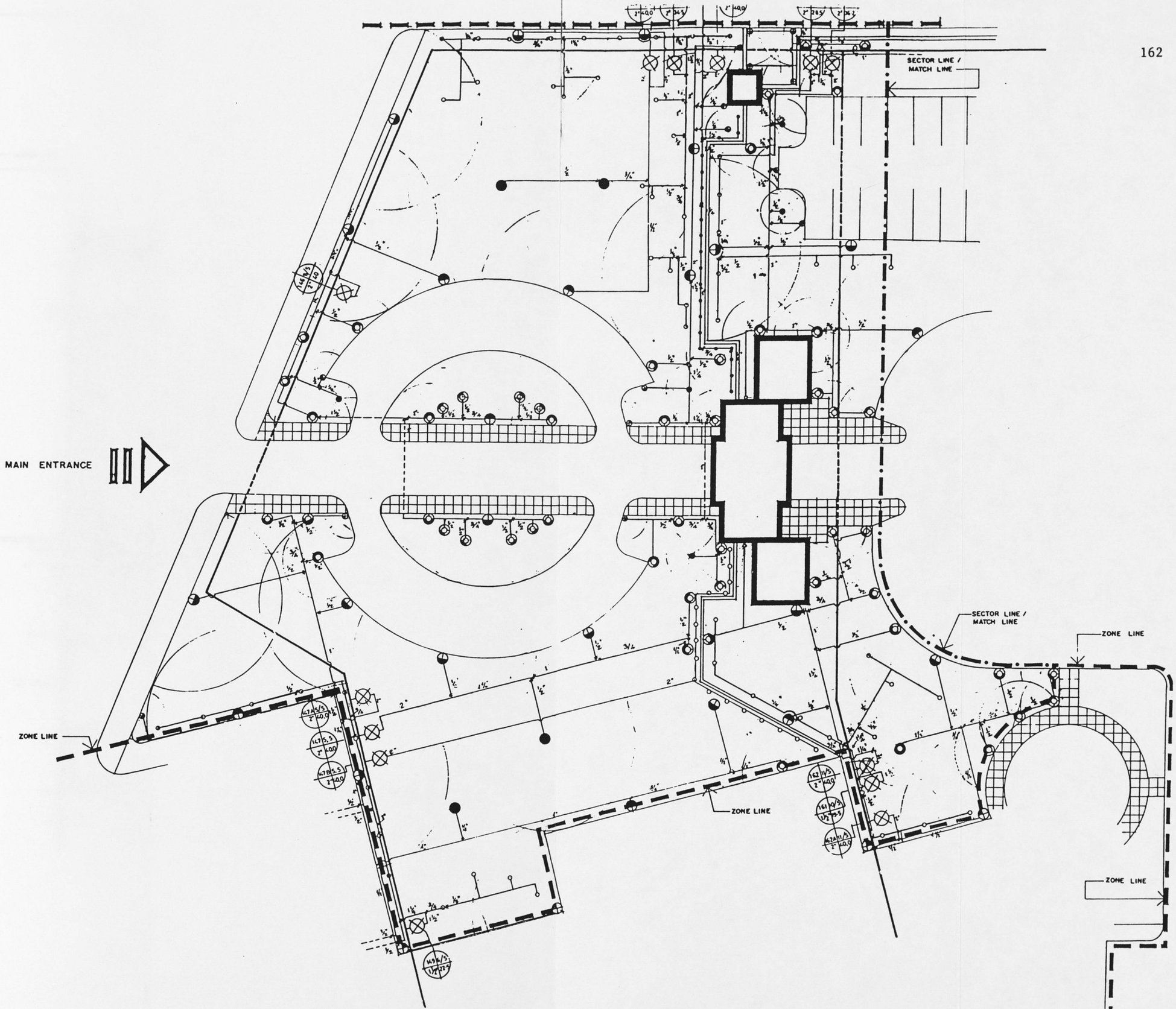


No.	DATE

SCALE	1:200
DATE	APRIL '83
DRAWN	LA/RS
CLIENT	H.R.H. PRINCE ABDUL-M BIN ABDUL AZIZ

ABDULLAH F. AL-KRAIDEES EST

CONSTRUCTION - LANDSCAPING

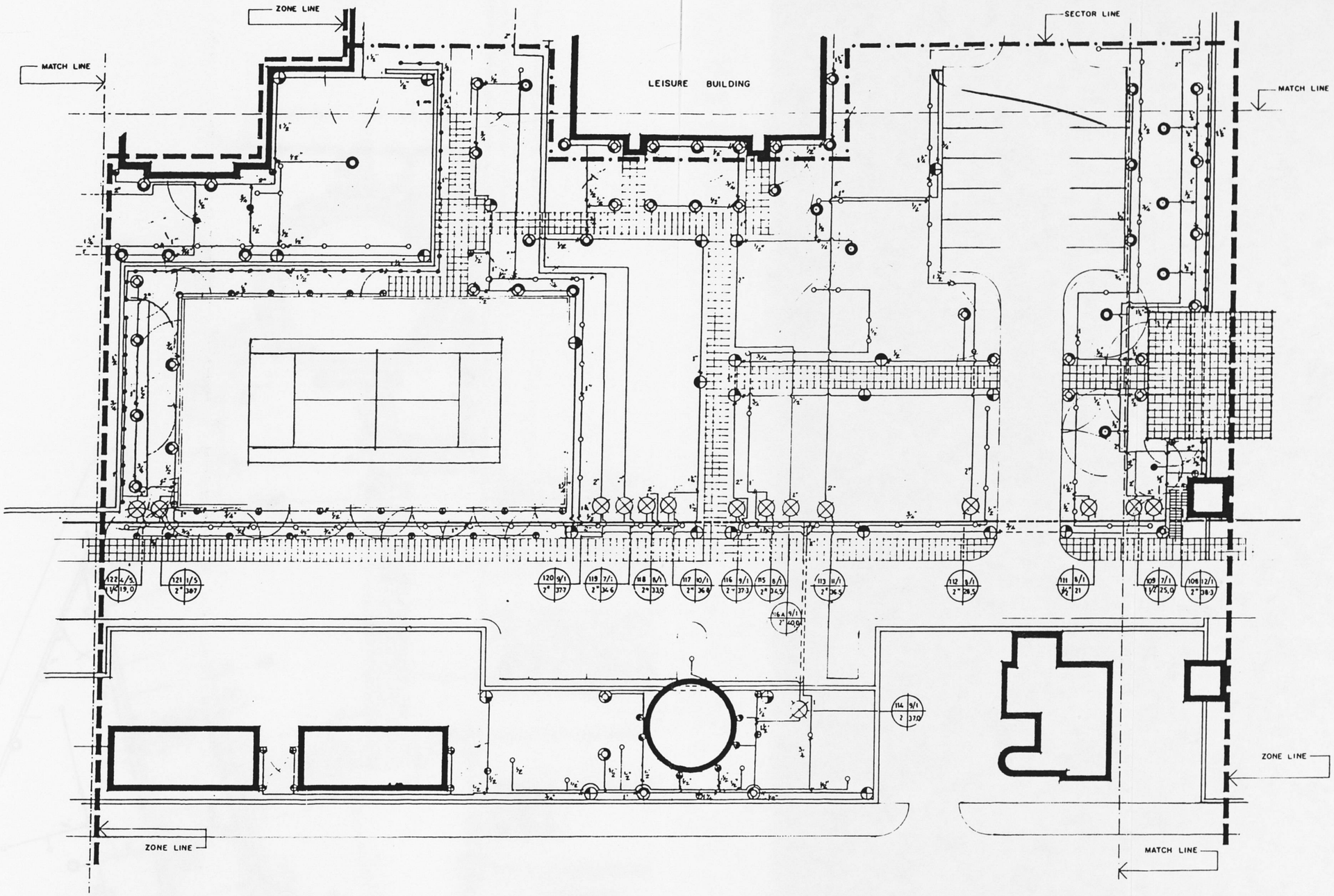
HABIB SALAM

BUREAU D'ARCHITECTURE

IRRIGATION

CONSULTANT	SAUDCONSULT
TITLE	GASSIM M.P. SITE
LOCATION	ZONE - 6 SECTOR 15

AK 1 0 1 0 4



REVISION

N°	DATE

SCALE	
DATE	APRIL
DRAWN	LAZ
CLIENT	H.R.H. PRES... BIN...

ABDULLAH F.° AL-...

CONSTRUCTION - L...

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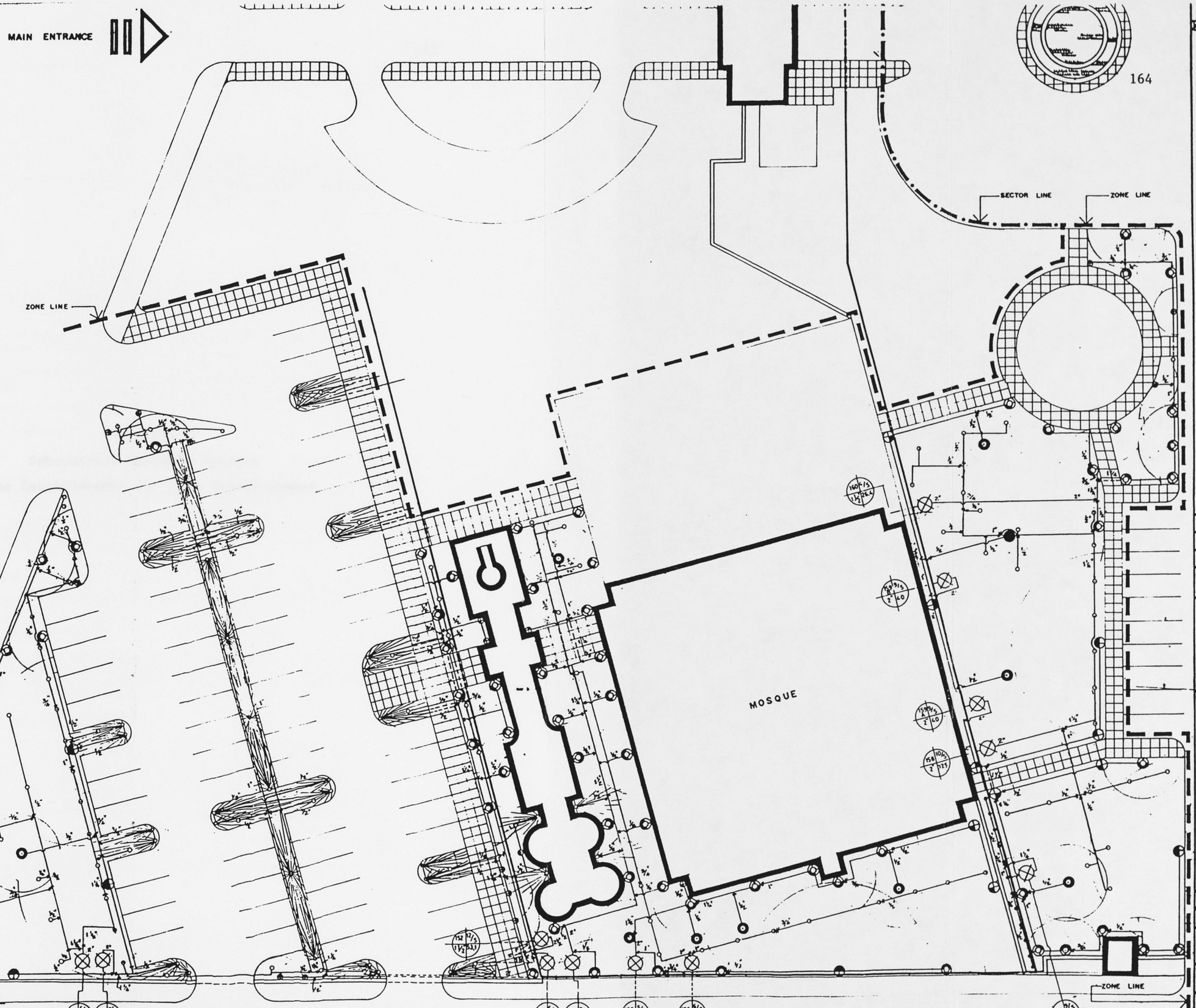
CONSULTANT	
TITLE	
LOCATION	


MAIN ENTRANCE
ZONE LINE
SECTOR LINE
ZONE LINE
MOSQUE
ZONE LINE
REMARKS
SCALE
DATE
DRAWN
CLIENT
H.R.H. PRI
BIN
ABDULLAH F. AL-KH
CONSTRUCTION - LA
BUREAU D'ARCH
IRRIGAT
CONSULTANTS
TITLE
LOCATION
SECT

APPENDIX F

Subcontract Document Between Al-Raha Establishment and Obal Establishment

بسم الله الرحمن الرحيم

مؤسسة الرها للتجارة
ALRAHA EST. FOR TRADING
LANDSCAPING DIVISION
لصاحبها : الأمير فيصل بن فهد الفيصل

Tel. : 4760840 - 4778676
P. O. Box : 15374
Telex : 200692 ALRAHA SJ

تلفون : ٤٧٦٠٨٤٠ — ٤٧٧٨٦٧٦
ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ الرها اس جي

SUBCONTRACT DOCUMENT

For: Design and Installation of Water Irrigation system at Main Site and Eight Guest Villa Site.

At: Qassim Emirate Palace Complex for H.R.H. Prince Abdulilah Bin Abdulaziz

Between: Al Raha Establishment

And: Obal Establishment

This contract is made and entered into effect on _____ 1403H, corresponding to _____ 1982 by and between Al Raha Establishment for Trading, P.O. Box 15374, Riyadh, represented by Mr. _____ (_____), hereinafter referred to as "THE FIRST PARTY" and Obal Irrigation Est., P.O. Box 16220, Riyadh, represented for the purpose of this contract by Mr. _____ (_____) hereinafter referred to as "THE SECOND PARTY".

ARTICLE 1 : PREAMBLE

The hereabove preamble is considered as an integral part of this contract.

ARTICLE 2: SCOPE OF THE CONTRACT

The Second Party undertakes to execute, complete and maintain the irrigation works for the Project to the satisfaction of the First Party, the consultant and the Client, and in accordance with the conditions, specifications and drawings set by the client, and the terms of this contract.

ARTICLE 3: SECOND PARTY'S OBLIGATIONS

3-1 The Second Party undertakes to provide, upon the preceding and following conditions, everything which is necessary for the completion of the works described overleaf, in accordance with the drawings, specifications and/or instruction supplied to him from time to time, and to deliver up the Works to the First Party complete in every particular, to the satisfaction of the First Party and of the Architect or Engineer appointed under the Principal Contract.

بسم الله الرحمن الرحيم

مؤسسة الرها للتجارة
ALRAHA EST. FOR TRADING
LANDSCAPING DIVISION
لصاحبها : الأمير فيصل بن فهد الفيصل

Tel. : 4760840 - 4778676
P. O. Box : 15374
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تلفون : ٤٧٦٠٨٤٠ ـ ٤٧٧٨٦٧٦
ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ الرها اس جي

3-2 The works are to be commenced within 7 days after the Second Party is instructed to proceed, and are to be completed by the time or times stated, the works are to be executed in such order, manner, and time as the First Party may direct, so as to ensure completion of the works under the Principal Contract by the completion date or dates thereof or such extended date or dates (if any) as may be fixed by the Architect or Engineer. If the Second Party fails to complete the works, or any section thereof, within the period or periods specified or any extended period or period hereinbefore mentioned, he shall pay to the First Party any loss or damage suffered or incurred by the First Party and caused by the failure of the Second Party as aforesaid. The First Party shall give reasonable notice to the Second Party at the earliest opportunity that such loss or damage is being or has been suffered or incurred.

3-3 The Second Party undertakes (a) to maintain at his own expense, the works, both during the progress of the works and until the Architect or Engineer has passed these finally and (b) to make good at his own expense, to the Architect's or Engineer's satisfaction, any defects of other faults arising therein, at a time to be decided by the First Party, but before the expiry of the Defects Liability period of the Principal Contract.

3-4 The Second Party will be permitted the free use of any temporary welfare accomodation and/or services (including First Aid facilities and treatment) which the First Party or Employer may provide on the site in connection with the works, provided that any such use or treatment shall be at the sole risk of the Second Party, who shall indemnify the First Party and Employer and/or their employees against any claim for loss, damage, or personal injury arising therefrom.

3-5 In no circumstances whatsoever shall any cutting away be done without the prior written authority of the First Party's Agent or General Foreman. The Second Party shall be responsible for any damage occasioned as a result of any cutting away carried out without this prior authority having been obtained.

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بسم الله الرحمن الرحيم

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ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ الرها اس جي

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3-6 The Works, materials, tools, plant, scaffolding, machinery and buildings of the Second Party, the subject of or used in connection with this sub-contract, whether at his workshop or on the site, shall be at the Second Party's risk for every description of loss or damage (other than that excepted under Clause 7 hereof) and the Second Party shall be responsible for and shall with all possible speed make good at his own expense (except as provided in Clause 7 hereof) any loss or damage that may occur, andindemnify the First Party and Employer against all claims. The Second Party shall also indemnify the First Party and the employer against all claims and/or costs in respect of:

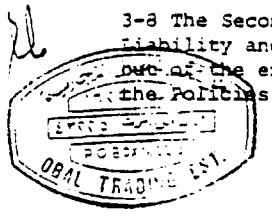
(i) any injury, loss or damage to persons, or to the new and/or old and adjoining premises, or their occupants, or to the First Party's or other Second Party's plant or materials caused by the Second Party's works or by the execution thereof by his workmen;

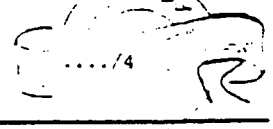
(ii) any breach, non-observance, non-performance, negligence, by the Second Party, his servants, or agents of the Provisions of the Principal Contract or any of them;

(iii) any act, omission, default, or neglect of the Second Party, his servants, or agents, which involves the First Party in any liability under the Principal Contract.

3-7 The Second Party shall not be responsible for loss or damage caused by fire to the works or to any materials (other than the temporary buildings, plant, tools, scaffolding and machinery provided by the Second Party, or any scaffolding or other plant which is loaned to him by the First Party), properly upon the site and in connection with and for the purpose of this Sub-contract. In the event of any such loss or damage, the Second Party shall, if and when directed by the First Party in writing, proceed immediately with the rectifications or replacement of the damaged work and materials, and the erection and completion of the works in full accordance with the terms, provisions and conditions hereof.

3-8 The Second Party shall adequately insure against all Employer's Liability and Third Party (Including Third Party Fire) risks arising out of the execution of the Works, and produce on demand, if requested, the Policies of such insurances, together with receipts for premiums.





SAUDI ARABIA - RIYADH - C. R. 18934
المملكة العربية السعودية ــ الرياض ــ س.ت ١٨٩٣٤

بسم الله الرحمن الرحيم

مؤسسة الرحا للتجارة
ALRAHA EST. FOR TRADING
LANDSCAPING DIVISION
لصاحبها : الأمير فيصل بن فهد الفيصل

Tel. : 4760840 - 4778676
P. O. Box : 15374
Telex : 200692 ALRAHA SJ

تلفون : ٤٧٦٠٨٤٠ ـ ٤٧٧٨٦٧٦
ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ ألرها اس جي

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3.9 The First Party may summarily determine this Sub-Contract either whole or in part without payment or compensation to the Sub-Contractor, other than that to whom it may be entitled under the terms and conditions of this Sub-contract for work already executed, if the Second Party:

a) fails within seven days' notice in writing from the First Party to proceed diligently with the Works to the reasonable satisfaction of the First Party and at all times in such a manner as will not, in the opinion of the First Party, prejudice the completion of the whole or any portion of the work under the Principal Contract in accordance therewith.

b) refuses, delays, or fails within similar notice or other extended time notified by the First Party in writing forthwith to rectify any defective workmanship and/or materials to the Architects's or Engineer's satisfaction.

c) fails to complete and deliver up the whole or any portion of the works by the time or times specified, or by such extended time or times as may be allowed by the First Party.

d) fails to withdraw immediately at the request of the First Party, any one or more of his employees to whom the First Party objects or whose presence on the works may contravene the conditions of this or the Principal Contract, or may cause labor disputes in the Second Party's or any other trade, and to replace such employees immediately by others against whom there is no such objection.

e) makes any arrangements with his creditors, has a Receiving Order made against him, executes a Bill of Sale, or commits an act of bankruptcy; or, being a limited company, goes into liquidation, or has a Receiver appointed.

f) fails within seven days' notice in writing from the First Party to comply with any of the obligations on the part of the Second Party herein contained.

The First party may without prejudice to the provisions of Clauses 3 and 4 hereof claim damages against the Second Party in respect of any breach of the provisions of sub-clauses, (a), (b), (c), (d), (e) and (f) hereof.

بسم الله الرحمن الرحيم

مؤسسة الرها للتجارة
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ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ الرها اس جي

3-10 The Client may make, at any time during the progress of the works such increases or decreases in quantities and/or alterations in the details of the works, which he may find to be necessary or desirable. Such increases or decreases and alterations shall not invalidate the contract and the Second Party agrees to accept and execute the works as altered. On the other hand, any additional works done by the Second Party without the prior approval of the First Party and the Consultant shall not be taken into consideration and the Second Party shall have no right to claim for it.

3-11 The Second Party undertakes to remove all their wastes, surplus materials and garbage from the site day by day and keep the whole project site clean and not to cause damage to any of the other works, materials and equipment. Failure to do so, the First Party may act after a twenty four hour notice with remedial actions and charge the relevant costs to the Second Party.

3-12 The Second Party shall not have the right to approach or communicate with the Employer or the Engineer since his relationship is to be confined only to the First Party.

3-13 The Second Party must have the work started and performed under his personal supervision and does not have the right to sub-let any part of the works to any other subcontractor except after the written approval of the First Party.

3-14 The timely delivery of the works completed in accordance with the intermediate and final deadlines stated in the schedule of works, is an essential element in this contract THEREFORE in case of delay in any phase of the program the First Party will have the right to act directly with his own personnel and equipment and/or with personnel of another company to expedite the works in order to regain the delay, charging the cost of such operations to the Second Party on the current payment certificates and on any other due for any reason.

3-15 When the works subject of this contract is complete, the works will be provisionally handed over to the First Party who will issue a report in which possible defects will be indicated, as well as the ways to eliminate them. The report's only task is to determine the completion date. Subsequently, within 360 days from the previous date, the final inspection of works will take place. Such inspection will be considered acceptance of work unless any defects have been reported by that final inspection.

SAUDI ARABIA - RIYADH - C. R. 18934
المملكة العربية السعودية — الرياض — س.ت ١٨٩٣٤

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تلكس : ٢٠٠٦٩٢ الرها اس جي

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3-16 The Second Party must furnish samples of workmanship and or materials as requested by the First Party. Such samples will be furnished within the scope of this agreement to the first party free of charge and upon acceptance will establish the minimum quality required for the successful execution of works.

3-17 The Second Party shall not have the right to claim for price changes because of any occuring fluctuation whether in the wages of the workers or material prices.

3-18 No overtime is to be worked with the Second Party's first obtaining the consent in writing of the First Party. No payment for authorized overtime or nightwork will be made unless the Second Party is so advised in writing by the First Party, and, if the Second Party is so advised, he will be reimbursed only the net additional rate or time incurred, including any net additional cost of Employer's Liability and Third Party Insurances.

3-19 No variations shall vitiate this Sub-contract, but the Second Party shall not undertake work involving a variation or extra work without previous written authority from the First Party.

Variations or extra work so authorized shall be assessed on the basis of the Schedule of Rate attached hereto or referred to herein, or, where no Schedule exists, at a rate or value to be agreed between the Second Party and the First Party and/or the Employer's Surveyor.

No day work will be permitted except where, in the opinion of the First Party or the Employer's Surveyor, it would be unfair to value such work at other than daywork rates.

Where work is agreed to be carried out on a daywork basis, payments for such work will be made upon the net cost of wages and/or allowances properly payable to workmen actually and necessarily engaged upon the work, plus the percentage addition for labor stated overleaf, and upon the net cost of materials provided by the Second Party, plus the percentage addition stated overleaf. If no percentage is stated, the addition to labor and to materials shall be agreed between the First Party and the Second Party, and failing agreement shall, subject to any provision to the contrary in the Principal Contract, be determined by the Employer's Surveyor.

The foregoing percentages shall be held to include all plant, tools, supervision and overhead and profit charges.

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بسم الله الرحمن الرحيم

مؤسسة الرها للتجارة
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LANDSCAPING DIVISION
لصاحبها : الأمير فيصل بن فهد الفيصل

Tel. : 4760840 - 4778676
P. O. Box : 15374
Telex : 200692 ALRAHA SJ

تلفون : ٤٧٦٠٨٤٠ ـ ٤٧٧٨٦٧٦
ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ الرها اس جي

Where the Second Party considers he has claim to daywork, due notice must be given to the First Party prior to its execution in order to facilitate checking the time and materials expended thereon, and all day work sheets shall be rendered on the day the work is executed.

The signature of the First Party's Foreman will not be recognized as authorizing a variation or extra order, nor be considered conclusive evidence either as to hours works, or materials supplied, unless written confirmation is received from the First Party.

3-20 Attention is drawn to holidays announced by the Ministry of Labor and the Contract may be closed on such days.

3-21 The Second Party is reminded that he and his employees have a duty to observe all labor regulations of the Kingdom of Saudi Arabia and the further safety site discipline and regulations of the First Party as currently in force.

3-22 The Second Party is to provide at his own expense, any temporary site office, or workshop accomodation, together with the necessary equipment, lighting, power, fuel, etc. All or any of the facilities mentioned hereabove are subject to approval by the First Party before any action is taken by the Second Party.

3-23 Upon request by the First Party, detailed drawings, design calculations and any other information pertinent to the study, design and execution of the irrigation works will be submitted by the Second Party to the First Party.

3-24 Within three days after signing the contract, the Second Party should turn in a program of drawings submittal to the First Party. Each drawing submitted for approval must consist of one sepia and three blueprints. The First Party has the right to request any drawing performed by the Second Party at any stage of the contract period regardless of the quantity requested, and it is the obligation of the Second Party to provide it within a reasonable time limit.

OBAL TRADING EST.

بسم الله الرحمن الرحيم

مؤسسة الرحاب للتجارة
ALRAHA EST. FOR TRADING
LANDSCAPING DIVISION
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ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ ألرها سي جي

3-25 The Second Party is fully responsible for the irrigation design. Within 30 days after signing this contract, the Second Party shall submit to the First Party all the necessary shop drawings and specifications related to his work. Within 14 days after receiving the shop drawings and specifications from the Second Party, the First Party will return the drawings approved or refused back to the Second Party. It is understood that the Second Party is solely responsible for any delay in his submitting the said documents or for the refusal by the consultant of all or any part thereof. In case of violation of Articles 3-24 and 3-25, i.e. any submission of drawings which does not conform to the program of drawing submittal, will result in a 500 S.R. (Five Hundred Saudi Riyal) per each day of delay, to be paid by the Second Party.

3-26 The Second Party should carry out at his own expense any type of test requested by the consultant or the First Party on site, and shall bear the responsibility for any failure that might occur at any stage of the work execution.

3-27 Within one month of signing this contract, the Second Party shall submit to the approval of the consultant - through the First Party - a schedule of execution of the irrigation works, as well as the list of Manpower needed for the execution of the works, all as per the Project's works program by which the Second Party shall abide. Should the Second Party by unable to cope with the works of the Project, the First Party has the right and freedom to complete the works by alternative means at the responsibility and expense of the Second Party.

3-28 The Second Party should be present at the site location in person or through his authorized representative to receive and execute the First Party instructions.

3-29 The Second Party must attend to the site coordination meetings called for by the First Party. He should fully cooperate with the Project Manager and other contractors to solve any problem which might arise during construction.

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بسم الله الرحمن الرحيم

مؤسسة الرها للتجارة
ALRAHA EST. FOR TRADING
LANDSCAPING DIVISION
لصاحبها : الأمير فيصل بن فهد الفيصل

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ص.ب : ١٥٣٧٤
تلكس : ٢٠٠٦٩٢ رها اس جي

3-30 If the Second Party's work contradicts with other contractor work, the Second Party shall notify the First Party in writing. He should also give his suggestions to avoid this contradiction. The solution adopted by the First Party shall be respected by all contractors and they may not object to it.

3-31 The Second Party shall comply with all written instructions and decisions taken by the First Party within the framework of this contract. The Second Party shall present a detailed weekly program of his attended works at the last day of the preceeding week.

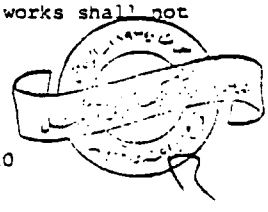
3-32 At most two weeks after completion of the works, "as built" drawings shall be provided by the Second Party to the First Party. for approval.

3-33 The First Party may exercise the same powers over the Second Party's plant, materials, and property on the site, or on any materials or fabricated work lying at the Second Party's works or workshops which have been bought or fabricated for the purpose of this sub-contract, as are given to the Employer under the principal contract over the Contractor's plant, materials and property, in like circumstances.

3-34 The second phase of work amounts to S.R. 1,050,000.00 (Only One Million Fifty Thousand Saudi Riyals) and shall not commence until written notice is received from the First Party. It is understood that in the event that the expenditure under this phase of the works is not authorized, the Second Party will have no claim for recompensation or reimbursement of any nature.

During the preparation of these prices, the Second Party was aware if all the details and specifications required by the First Party for a very high standard job.

Any modifications thereafter, in the details, specifications and materials for the contracted items described in the proposal are already included in these prices, and the total cost of works shall not increase.



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3-35 Itemized payment divisions

- Materials delivered to site	50%
- Excavation and backfill for piping layout and valve boxes	10%
- Installation of pipes and valves	10%
- Installation of irrigation heads and pump assembly	10%
- Installation of automatic control system	10%
- Maintenance and guarantee on all materials and equipments found defective for a period of one year	10%

The itemized payment division mentioned hereabove should be developed in more details within one week after signing the contract.

3-36 The maintenance period is one full year - 365 days - The maintenance which will be performed by the Second party, will commence after the completion and acceptance of works executed.

3-37 A detailed schedule of works should be submitted by the Second Party to the First Party within one week of signing the contract.

3-38 The Second Party is requested to insert his fully inclusive hourly daywork rates as detailed below.

(i) Labor

Craftmen @ 75 S.R. per hour

Laborers/Mates @ 30 S.R. per hour

(ii) Materials and Plant

Materials Invoice Cost + ----- + 20 %

Plant Charges + ----- + 20 %

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ARTICLE 4: DUTIES OF THE FIRST PARTY

In exchange for the fulfillment by the Second Party of its obligations under the present contract, the First Party shall undertake or arrange for the following at his own expense :

4-1 To coordinate between subcontractors working on the site, in order to avoid interference or interruption.

4-2 To transmit to the Second Party any necessary instructions or documents related to this contract.

4-3 To fulfill its payments' obligations as described hereunder.

ARTICLE 5: CONTRACT PRICE AND TERMS OF PAYMENT

CONTRACT PRICE

5-1

(i) The total lump sum price of this contract as shown in the attached priced bill of quantities is S.R. 3,000,000.00. (Only Three Million Saudi Riyals). This amount shall be the total dues to the Second Party for executing, completing, and maintaining the works in question in accordance with the main contract conditions between the First Party and the Client.

(ii) The whole project is divided into two phases. The total price of the first phase is S.R. 1,950,000.00 (One Million Nine Hundred and Fifty_____ Thousand Saudi Riyals). The total price of the second phase is S.R. 1,050,000.00 (One million Fifty Thousand Saudi Riyals).

5-2

TERMS OF PAYMENT

(a) 20% Advance payment against bank gaurantee.
(b) 60% Monthly progressive payment divisions versus the works executed stated in the contract Annex.
(c) 10% Final payment to be paid one month after the completion and and acceptance of works executed.
(d) 10% Final payment to be paid one month after the one year maintenance which starts upon completion and acceptance of works executed.

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- 3% Performance Bond to be submitted upon signing the contract and remains valid for 360 days after completion and acceptance of works executed.

ARTICLE 6: PENALTIES

In the event of Second Party failing to fulfill its contractual obligations as defined in Article 3 above, the Second Party will be liable for a penalty of:

1% (One Per cent) per complete week of the total value of the Landscaping works delayed. However, the amount of such penalty shall - in no case - exceed 10% (Ten per cent) of the contract value.

Any unjustified delay in payment will give the right to the Second Party to claim for indemnities accordingly.

ARTICLE 7: VALIDITY OF THE CONTRACT:

7-1 This contract shall become ineffective as from the date of its signature by authorized signatories of both parties and until the full consummation of the rights and obligations of both parties herein stated.

7-2 In case the Second Party breaches any of its contractual obligations in a way which will be considered by the First Party as reflecting an inability to complete the said obligations, the First Party reserves the right:

(i) Either to cancel this contract at sole responsibility of Second Party,
(ii) Or to carry out the above-mentioned obligations at the Second Party's responsibility and expense.

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ARTICLE 8: DISPUTES

This contract is governed by the Saudi Law and any dispute arising out of or in connection with it, will be submitted to the committee of settlement of the Commercial Disputes in Riyadh or any other commission which may replace it. The decision shall in every case be binding and conclusive on the parties hereto.

ARTICLE 9: ANNEXES

9-0 Addendum
9-1 Description of Phases 1 and 2.
9-2 Irrigation water system specifications.
9-3 Bill of quantities for Guest Villa and Main Palace Site.
9-4 Sketches.
9-5 Price breakdown.
9-6 Irrigation drawings of Main Site and Guest Villa Site.
9-7 Schedule of Works.
9-8 Performance Bond Guarantee
9-9 Advance Payment Guarantee
9-10 Power of Attorney of the representative of the Second Party.

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ARTICLE 10

This agreement has been in 2 originals, each party has received and retained one copy dult signed by tne representatives of both parties.

FIRST PARTY

NAME

SEAL

SECOND PARTY

NAME

SIGN.

SEAL

GLOSSARY

Al Kraidees Establishment	The landscape contractor of the project.
Abou-Mansour, Zahi	Project manager of all the landscaping activities of the Gassim Emirate Palace Complex project.
Agromousse	An organic material similar in appearance to white foam, which is mixed with agricultural soil in order to improve its water retention capacities.
Al-Raha Establishment	The internship company. The landscape subcontractor of the project, responsible for the design and execution of all the project's landscaping activities.
Amico, Luigi	Obal Establishment irrigation design engineer.
Gassim	A region in Saudi Arabia which is approximately three hundred miles Northwest of Riyadh, Saudi Arabia.
Gassim Emirate Palace Complex	The internship project. It consists of two sites which are two miles apart: the Guest Villa Site and the Main Site.
Guest Villa Site	It consists of eight guest villas and a recreation area which is comprised of one tennis court, one swimming pool, and a recreational building. The area of the guest villa site is approximately 12,000 m^2 or 120,000 ft^2.

Hardscaping	A landscaping activity which consists of all the exterior civil works of the project - namely, the design and construction of fountains, pergolas, and walkways.
Landscaping Activities	They consist of four major activities: Hardscaping, Softscaping, Electrical, and Irrigation.
Main Site	It consists of the Palace Bldg., the Majlis, the Palace Mosque, the Conference Hall, three main Guest Villas, Servant Quarters, Leisure and Recreational facilities, a Power Plant, Water Treatment Plant, a Main Kitchen, and a Palace Warehouse and Stores. The total area of the Main Site is approximately one million square feet.
Modern Design Establishment	The subcontractor in charge of the design and execution of the hardscaping and electrical activities.
Obal Establishment	The subcontractor in charge of the design and execution of the irrigation networks.
Saleh, Mahmoud	Obal Establishment irrigation design engineer.
Saud Consult	The consulting engineering firm for the project.
Softscaping	A landscaping activity which consists of designing, supplying and planting the different types of plants needed for the project.
Spectronics	The management consulting firm of Al-Raha Establishment.

Woochang Construction Company	The main contractor in charge of the study, design, and construction of the Gassim Emirate Palace Complex.

V I T A

Name:	Roger Elias Zard Aboujaoude
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Parents:	Mr. Elias Georges and Mrs. Juliette Zard Aboujaoude
Education:	B.S., Mechanical Engineering, Texas A&M University, August 1980.
	M. Eng., Mechanical Engineering, Texas A&M University, August 1981.
Experience:	October 1982 - June 1983 Engineer (Doctor of Engineering Internship) Al-Raha Establishment Riyadh, Saudi Arabia.
	January 1982 - May 1982 Graduate Teaching Assistant Mechanical Engineering Department Texas A&M University.
	September 1980 - December 1981 Graduate Research Assistant Mechanical Engineering Department Texas A&M University..