

ISSUES IN IMPLEMENTING AGRICULTURAL REUSE IN SOUTHWEST FLORIDA:
A CASE HISTORY OF THE
CITY OF SARASOTA - HI HAT RANCH REUSE SYSTEM

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HISTORY/BACKGROUND

The City of Sarasota Wastewater Treatment Plant disposed of its secondary treated effluent in the past via direct discharge into Sarasota Bay. In 1985, the City had agreed with EPA to cease discharge to Sarasota Bay by July 1988. The City relied upon development of a 2,500 acre land treatment system for a means of alternate disposal, however, this option was eliminated when FDER denied the construction permits for the project in 1986. In order to resolve the regulatory time restraint, the City entered into a consent decree with EPA in 1988 for the project.

The City then began a fast paced yet comprehensive evaluation of alternative effluent disposal/reuse options with the aid of a task force that included the City, FDER, the Southwest Florida Water Management District, and the City's legal and engineering consultants. The task force ultimately recommended that the City pursue an aggressive urban/agricultural reuse project. The City's goal was two-fold: 1) to modify the existing treatment plant so that reclaimed water suitable for unrestricted public access could be produced and, 2) to identify a site with sufficient reuse capacity to meet the City's flow. To achieve the first task, the City upgraded the wastewater treatment plant to a 13 mgd advanced secondary plant with the ability to treat to AWT quality for periods of wet weather discharge.

The second task was to locate a sufficient reuse site. A decision was made to limit the site investigation of the first phase of the reuse program to only large potential reuse customers that could meet the City's design flow rate. With assistance provided by the Sarasota County Agricultural Extension Agency, a list of potential customers was compiled via a telephone survey. Landowners who expressed interest in receiving reclaimed water were sent non-binding letters of intent as means of better assuring their sincerity in the project.

Following the survey, it was apparent that the most advantageous reuse customer interested in the project was the Hi Hat Ranch, which consisted of approximately 12,000 $\pm$ acres of mostly improved pasture and close to 400 acres of citrus. This site had a particular advantage, in that it was located in the vicinity of the 36-inch diameter reuse force main that had been designed for the earlier proposed land treatment project and could therefore be constructed in a timely manner to suit implementation of this agricultural irrigation project.

The City then began negotiations with the owners of the Hi Hat which centered around:

- Management of the reclaimed water (how could the ranch receive additional reclaimed water when needed and what would the City do with the water during low crop demand periods).
- Water quality assurance (beneficial nutrients, heavy metals, etc.)
- Long term availability of reclaimed water and the potential impacts on the site (i.e., impacts on future land use).

Hi Hat Ranch Reuse Project

The Hi Hat Ranch is located approximately twelve miles east of the City of Sarasota (Figure 1). The ranch consists of approximately 12,000 acres of farmland, with the majority of the land being devoted to the grazing of beef cattle on improved pasture land and the remaining land being utilized for orange grove production and vegetable farming.

The ranch was irrigated in the past via a ridge and furrow irrigation system, which was supplied water from onsite irrigation wells. The farmer chose to minimize the use of this system approximately 15 years ago, however, when the cost of electricity increased to such a point that they could no longer justify the pumping costs for pasture irrigation. The ranch did, however, continue irrigating the citrus groves with onsite wells. In 1988, reclaimed water from the city was offered to the ranch for irrigational purposes.

Following negotiations, a 20-year reuse agreement was eventually finalized, in which the guidelines and responsibilities for each party were laid out. Also included in the agreement, following extensive modeling and historical plant flow data, was the establishment of the maximum flow rate the site could be guaranteed each month by the City and the minimum average daily flow that the site expected to receive.

General Reuse Project Description

The Hi Hat reuse system is basically divided into three components which are as follows:

- The distribution system (force mains, valves, etc.) which distributes the reclaimed water at the ranch.
- The ridge and furrow system for pasture land irrigation and the micro-jet irrigation system for the citrus grove.
- The storage system, which consists of a holding pond for wet weather storage and a repump station.

A schematic of the system is shown in Figure 2.

The majority of the Hi Hat Ranch consists of improved pasture that was at one time irrigated with a ridge and furrow system. The system basically consists of water being discharged to the highest elevation of a field and being distributed throughout the field via a series of seepage irrigation ditches. The water is maintained in each field by control structures in the main ditches.

The reuse system for this project included the installation of a distribution piping system to transmit the reclaimed water to the previous irrigation well locations, the refurbishing of the existing and construction of new ridge and furrow ditches, the implementation of control and terminal structures, and the constructing of a storage and pumping facility.

The ridge and furrow ditching consisted of the construction of approximately 400 miles of ditches and the installation of 500 control structures. The system was designed and constructed with the aid of existing Soil Conservation Service (SCS) plans for the site. It should be noted, however, that much of the land did not have existing ditches or plans and had to be designed to meet the SCS standards.

The pipeline/distribution system was designed such that all of the existing well sites (the high elevation points of the ranch) could be served via an energy dissipating delivery structure to deliver the reuse into the main transmission ditches of the reuse system. A pipe gallery was also included that allowed the City the option of serving any part of all of the ranch at one time including the citrus grove and, if needed, the storage facility.

The system also included the constructing of a 185 mg storage facility with a pump station, which could either receive or deliver reuse from or to the distribution system.

Overview of System Operation

Reclaimed water is conveyed by a force main which is 36" in diameter and 12 miles in length, from the City's WWTP to the Hi Hat's distribution system. Reclaimed water is served to the site at a minimum of 30 psi. This residual pressure allows the reclaimed water to be used at the far reaches of the site without having to be repumped, with the exception of the on-site citrus groves. The distribution system consists of approximately 61,000 feet of 12-30 inch ductile iron pipe which transmits the water to the irrigation and storage systems. The system is designed such that water can be directed to the ridge and furrow system, the citrus grove and/or to the storage facility. The reuse system consists of two types of irrigation systems: ridge and furrow type irrigation for the pasture and micro-jets for the citrus. The storage facility consists of a 110 acre (185 mg) storage pond with an associated repump facility. The pump station has a dual function of both serving to repump and boost the reclaimed water directly from the WWTP to approximately 60 psi at the pumps as required to serve the groves and also for removing water from the storage pond to serve either the pasture irrigation or the citrus groves, when needed. This system is designed to allow the

ranch to operate under a Best Management Practice, thus providing the ranch with reclaimed water as needed.

DESCRIPTION OF FACILITIES

Distribution System

The distribution system consists of the following:

- Force main and valving
- Turn out structures
- Pipe gallery

The purpose of the system is to transmit, direct and distribute the reclaimed water being received from the wastewater treatment plant to the irrigation and/or storage system. The system is designed such that water may be directed to any or all of the irrigation turn outs simultaneously with water being directed into or out of the storage pond. The reclaimed water is distributed uniformly throughout the ranch such that the City is assured that the system will not discharge any of the reclaimed water off the Hi Hat Ranch.

Force Main

The layout of the force main is designed such that each of the abandoned wells previously used in the past for ridge and furrow irrigation can be supplied with reclaimed water. In addition, the system is designed to supplement the irrigation demands of the citrus grove as well as to provide freeze protection for the grove. The force main is also designed with a route to and from the storage pond such that water can be directed into or out of the pond at any time. It was decided that the most feasible design was to route a main pipe down the existing farm road and to route turnouts, branching off the main, to each of the demand locations (well sites). This design simplified the construction of the force main, as well as allowing for easy access to all of the isolation valves. All of the system's isolation valves are either of the slow-closing/slow-opening butterfly or gate type to alleviate any concerns with water hammer. The force main is designed to deliver 2.5 mgd of water to each turn out, via flow control valves, with the exception of the pipe to the orange grove which requires 6,500 gpm (9.4 mgd) during freeze protection. It should be noted that due to the fact that the orange grove requires a minimum of 30 psi at the grove as opposed to the 0 psi residual pressure required for the ridge and furrow system, the two irrigation systems are operated independently. The maximum flow conditions of the force main is 30 mgd which is the result of all pasture irrigation turnouts being operational simultaneously. The force main is designed to handle this flow with 40% of the flow (12.5 mgd) being directed to the northern portion of the ranch and the remaining 60% (17.5 mgd) being directed to the south.

Turn Out Structures

A structure is located at the end of each turn out, with the exception of the citrus grove. The structure consists of an isolation valve, a flow control valve, a flowmeter, and a flow splitter box.

The isolation valve is designed to remove a turn out from operation. This is required when the hydraulic demand of the pasture land being served by a turn out has been met or during repair and maintenance periods.

The flow control valve regulates the maximum flow to 2.5 mgd. This is achieved with a modulating valve that is being controlled with an upstream orifice plate. When the pressure drop across the orifice plate exceeds a pre-set level reflecting a flow greater than 2.5 mgd, the modulating valve will close such that flow is restricted back to 2.5 mgd as determined by the orifice plate. The maximum limit of 2.5 mgd is based on the Consumptive Use Permits (CUP's) of the previously used irrigation wells which served the ridge and furrow system in the past. This limit can be raised or lowered if an area requires more or less water than anticipated.

The flowmeter is a requirement of DER and its purpose is to monitor and record all of the flow that the turn out is receiving. The flowmeter is of the mechanical type, with a dial-type read out for instantaneous and totalized flow monitoring.

The flow splitter box functions as an energy dissipater and a directional device. The flow splitter box is designed such that water from the distribution system is dropped into the box, thus dissipating any residual static or velocity pressure prior to it reaching the ridge and furrow system. The velocity is reduced to gravity flow to minimize erosion of the furrows. The splitter box is also capable of directing the flow through any or all three of its discharge parts, as well as splitting the flow volume as required.

Pipe Gallery System

The purpose of the pipe gallery system is to interconnect all flow routes of the distribution system, as well as acting as an interface between the treatment plant and the ranch. The pipe gallery consists of a valving layout that interconnects two sources of water with three demands. The two sources being the wastewater treatment plant flow and the water being pumped from the storage pond. The three demands are the northern and southern areas of the ranch, as well as the storage pond. The valving allows the operator the flexibility of directing flow in any combination possible, including delivering water to the pond simultaneously as water is being repumped from the pond back into the system.

Irrigation System

The Hi Hat Ranch has two different types of irrigation systems, each for a different crop. These two types of systems are "ridge and furrow" for pasture land and "micro-jet" irrigation for the citrus grove.

5

Ridge and Furrow Irrigation System

Approximately 4,792 acres of improved pasture land, pengola and bermuda grasses, are irrigated with a ridge and furrow irrigation system. The system was designed around the Soil and Conservation Service standards and was designed to use reclaimed water from the City of Sarasota's Wastewater Treatment Plant as its irrigation source which included meeting all of DER permit conditions for a reuse site.

The ridge and furrow system (Figure 3) consists of a series of paralleled furrows typically spaced approximately 100 feet apart, which are connected to a main transmission channel. The furrows are 18 inches deep and the mains are two feet deep with both having a 3:1 side slope. The system operates in the following manner. The reclaimed water is delivered to the high elevation points of the ranch, strategically located such that all of the improved pasture lands can be served by transmission ditches, via gravity flow. Reclaimed water is served to the main transmission channels at zero pressure via the force main turn outs. Flow control structures at the low end of the main channel cause the water level to rise and flood the laterals (furrows). The furrows then transmit the water into the soil via infiltration which in turn causes the groundwater level in the field to rise. Irrigation is ended when the field reaches the desired soil moisture content. Ridge and furrow irrigation efficiency is approximately 60%. Using the modified Blaney-Criddle method, it is estimated that the expected evapo-transpiration demand of pasture land in this area of Florida, is approximately 52 inches/year or approximately 1 inch/week, however, the site is conservatively irrigated at .5 in/wk to ensure zero runoff.

The ridge and furrow system also consists of terminal control structures. The terminal control structures are essentially a fixed control structure at the end of each main transmission route. These structures are a requirement of DER, and their purpose is to ensure that all of the reclaimed water is retained within the ranch boundaries.

Micro-Jet Irrigation System

The grove is divided into three areas, each requiring approximately 2,000 gpm. There are two turnouts into the grove from the distribution system, with one turn out serving the two northern sections and the other turn out serving the southern section. The system has the ability of being served with either on-site irrigation wells or from the reuse distribution system, or both.

The maximum flow of the grove with all micro-jet emitters on is 6,500 gpm, which is to be expected during freeze protection conditions. The micro-jet irrigation system requires a 30 psi residual pressure at the grove header for all flows. To achieve this, all reclaimed water being received by the grove must be repumped at the storage pond pump station to overcome pipe friction and filtering losses. This includes water from the storage pond for high demand conditions, as well as water from the wastewater treatment plant during low demand conditions. Due to the small orifice diameter of the microjet emitters, an in-line filter assembly was designed and installed to remove

any entrained sand or algae from the flow to the grove. This filter assembly consists of centrifuge separators as well as barrier filters for the removal of sand and algae.

Storage System

The storage system consists of a 110-acre storage pond with a 185 mg capacity, a pump station, and the required piping and appurtenances from the pond to the pump station, as well as parallel pipes interconnecting the pump station with the pipe gallery. The storage facility is designed to meet the wet weather storage requirements of the reuse system and is designed with the ability to supplement any irrigation demand requirements exceeding the effluent flow being received from the wastewater treatment plant, i.e., droughts, freeze protection, etc.

The storage pond is constructed with an earthen berm which is 8 feet above the surrounding ground elevation, which includes 3 feet of freeboard as required by DER. The maximum usable storage depth of the pond is 5 feet. The pond is designed for 14 days of storage at the design flow of 13 mgd or 26 days at the current flow of 7 mgd. Please note that the construction of this facility required the mitigation of approximately 72 acres of wetlands. An emergency spillway, constructed at the southern end of the pond, was designed to discharge water from the pond when the maximum storage depth has been exceeded. The pond also consists of both an influent and effluent structure to transfer water to and from the storage pond.

The pump station is located at the southern end of the storage pond and is comprised of four (4) two-speed 125 Hp vertical turbine pumps. The pump station serves the following two main functions:

- Remove water from the storage pond and repump it to pressure prior to it re-entering the distribution system.
- Pump all water from either the storage pond or the wastewater treatment plant prior to its use by the citrus grove. In this case, the pump station functions as a booster pump, supplying the grove with required minimum pressure of 30 psi.

Permitting

The City of Sarasota agricultural reuse system, at the Hi Hat Ranch, currently operates under several permits. These permits include: Florida Department of Environmental Regulation (FDER) permits for the ridge and furrow irrigation system, distribution system, and storage facility as well as NPDES permits for the irrigation and storage facility. In addition to agency permits for the project, the system is required to meet the conditions included in the reuse agreement between the City and the ranch which includes water quality parameters, minimum and maximum flow rates, and general conditions which allow the ranch to operate under Best Management Practices (BMP).

The specific FDER permit conditions of interest for this project, in which this reuse system must conform are as follows:

- The City shall establish and maintain a log system that will identify which areas have received reclaimed water and when the control structures were adjusted.
- The City shall follow the approved Hi Hat Ranch Soil Conservation Service Plan where applicable, except where it conflicts with the terms and conditions of this permit or it becomes necessary to construct additional control structures in order to prevent a direct discharge of reclaimed water from any ridge and furrow field or citrus grove to surface waters of the state. The construction of any such additional control structures is authorized and required under this permit.
- The City shall not apply reclaimed to any ridge and furrow field until the riser boards have been installed in the appropriate control structure.
- The City shall not remove the riser boards from the terminal control structures of any agricultural reuse field until the water level in the ridge and furrow field controlled by such terminal structures has dropped below the ground surface.
- A piezometer for measuring groundwater elevations in each basin must be monitored by the City. The City must record groundwater levels in basins to be irrigated immediately prior to application, immediately following irrigation and within 24 hours after irrigation.
- Reclaimed water shall not be applied to any basin unless the depth to groundwater as measured at the basin piezometer is greater than six (6) inches prior to application.
- Reclaimed water shall not be applied to any basin until the appropriate water levels have been recorded, the riser boards have been installed and a visual inspection of the basin has been completed.
- The City shall monitor the level of reclaimed water in the storage area on a weekly basis until the water level reaches 36 inches from the top of the emergency overflow weir. When the water level rises above this 36 inch limit, the City will begin monitoring the level of reclaimed water in the storage area on a daily basis, until it falls below this limit.
- The City shall stop adding reclaimed water to the storage area once the level of reclaimed water rises above 36 inches from the top of emergency overflow weir and if the net increase in water level is 10 inches or more over the succeeding 30 day, 15 inches or more over the succeeding 60 days or 20 inches or more over the succeeding 90 days. When the reclaimed water level in the storage area drops below this 36 inch limit, the City may resume applying reclaimed water to the storage area.

The NPDES permits for the project allow discharge from the storage facility only during a 100-year storm event, and from the ridge and furrow irrigation system only during a 10-year storm event.

Conclusion

The Hi Hat Ranch reuse project has been in operation for over two years, and is performing as designed. Records depict that the site is using on the average of .5 inches/week as designed and is meeting all of FDER's permit conditions.

Hi Hat Reuse System Pros and Cons

Pros

- Environmentally Compatible
- Low Energy Requirements
- Low Maintenance
- Low Capital Investment

Cons

- Land Intensive
- High Operational Labor
- Requires Extremely Level Terrain

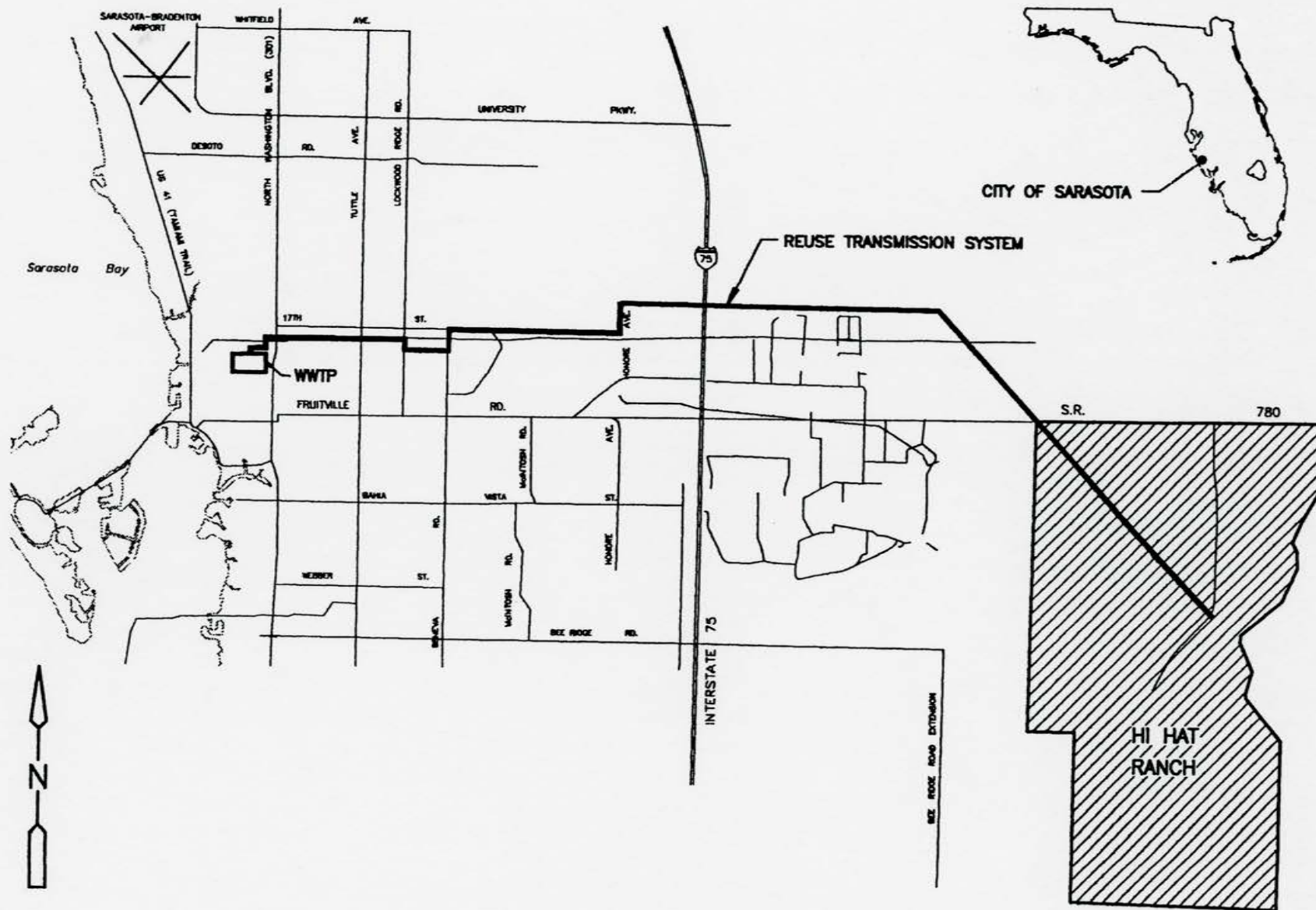


FIGURE 1. CITY OF SARASOTA REUSE TRANSMISSION SYSTEM - HI HAT RANCH

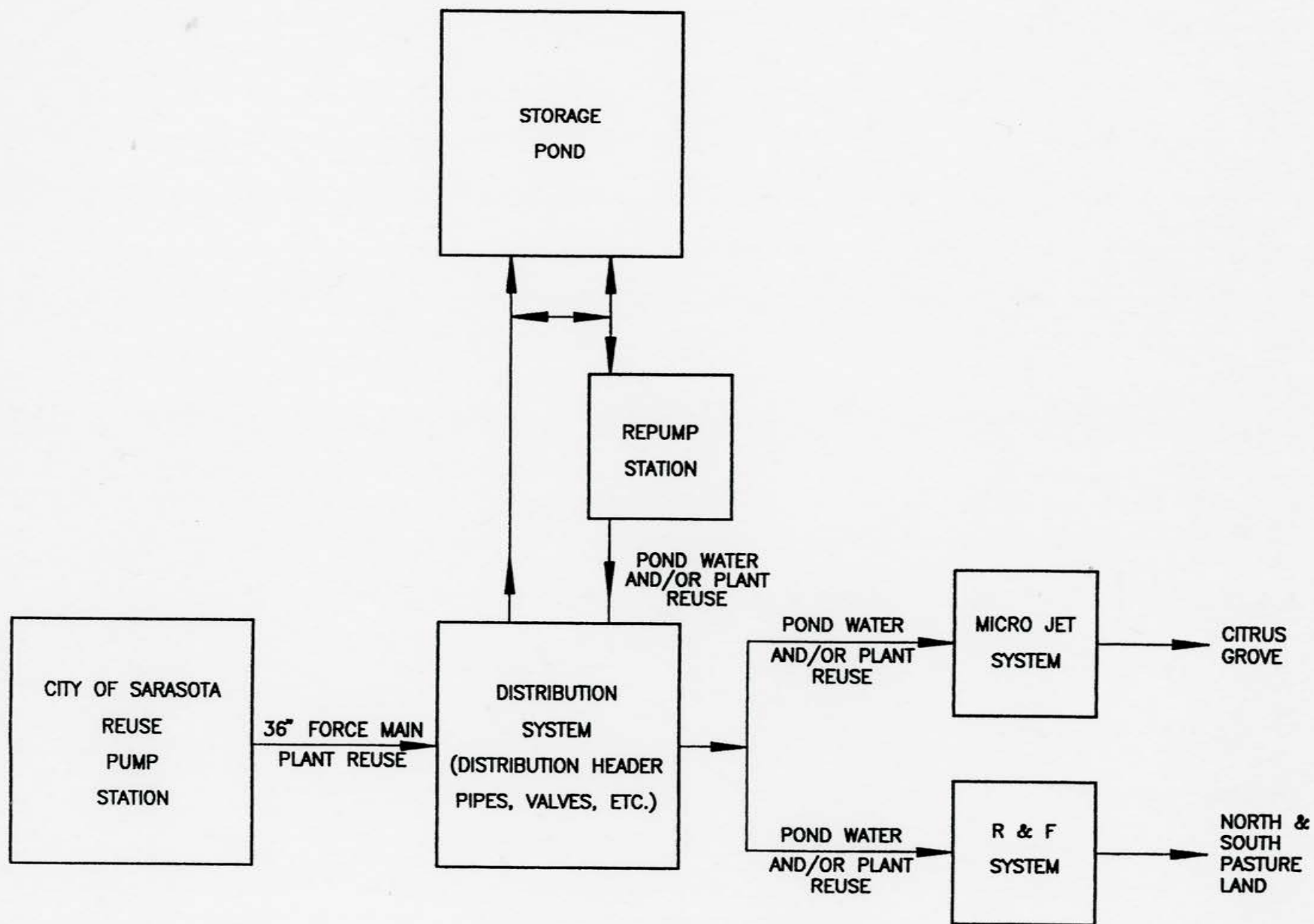


FIGURE 2. REUSE SYSTEM

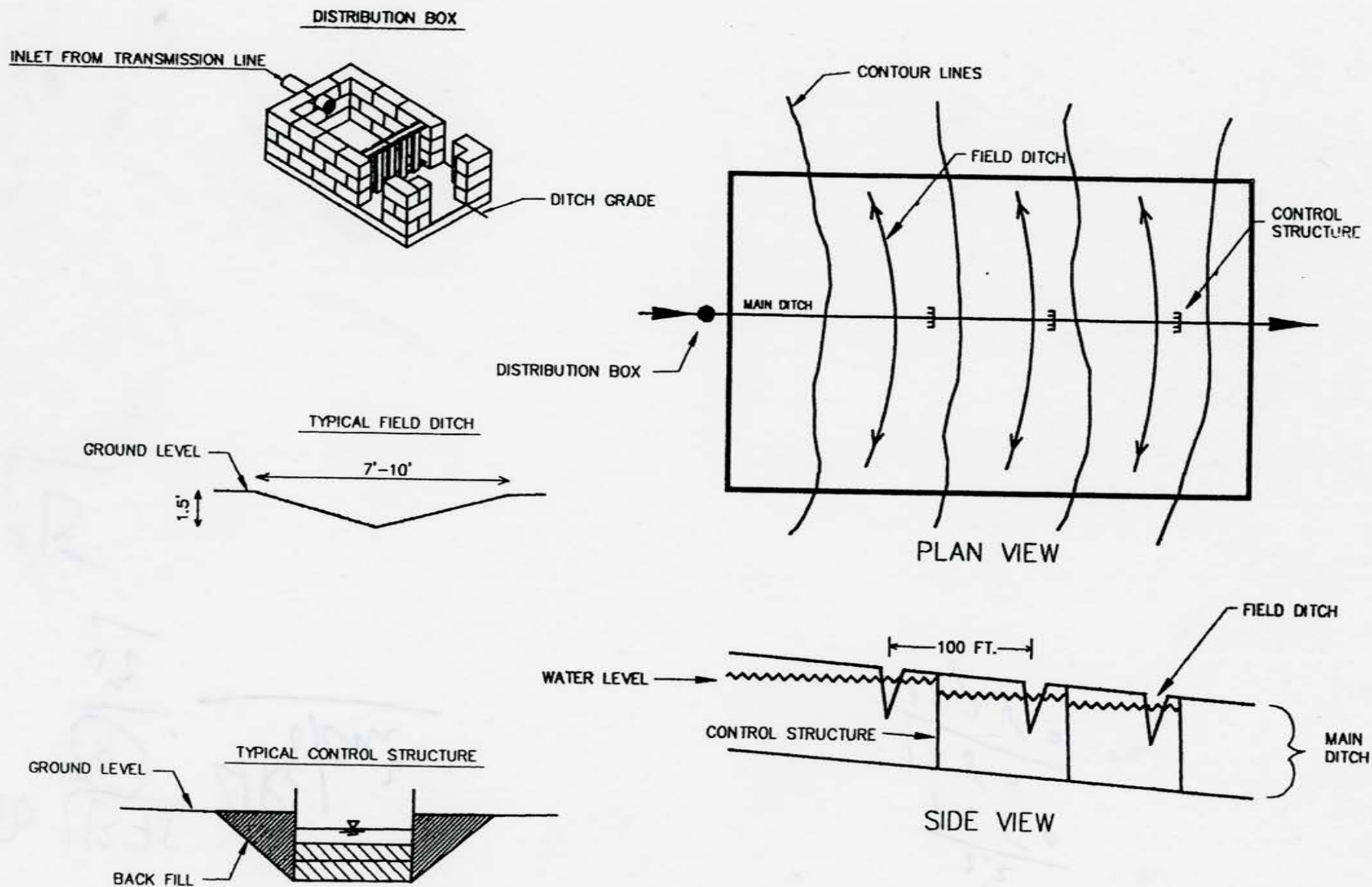


FIGURE 3. RIDGE AND FURROW