

# Sanitary Sewage Lift Stations

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The lift station is becoming increasingly common as a component of the sewerage systems of Indiana. Cities and towns that have operated for years without the necessity of a lift station (other than one integral with sewage treatment plant) are finding it necessary to include a lift station in plans for extension of sewers. Those cities and towns which have not yet found it necessary to include a lift station in their system will undoubtedly find one or more indicated as community growth continues. It is therefore incumbent upon city engineers to have a knowledge of types of stations and equipment available as well as the legal and safety measures required in planning for and constructing lift stations.

A lift station is a structure housing equipment necessary to elevate liquid from a low level to a higher level. The station may be designed to handle storm drainage or sanitary sewage but in either case the general design considerations are the same.

The need for lift stations is indicated by either topography or geology. If the area to be sewerred is lower than the existing sewers or the point of discharge it is obvious that a lift station will be required. Property is often developed in an area which can eventually be drained of sanitary wastes by gravity, but which requires too much investment for immediate gravity drainage. The installation of a lift station which may be eventually abandoned or moved can be indicated. Geology may indicate the use of lift stations where rock is present near the surface or ground water conditions will make deep sewer excavations expensive. The use of lift stations because of geological conditions was recently experienced by the author in the planning of work at Logansport and Martinsville.

Logansport, Indiana, is underlain with solid limestone which is close to the surface along the interceptor sewer. In order to reduce the amount of rock excavation, a lift station is being built which will simply lift the sewage and discharge it into a gravity sewer at the station. The cost of the station plus operation is more than offset by the saving in rock excavation.

Martinsville, Indiana, is underlain with a fine water bearing sand within a few feet of the surface. To reduce the cost of trench dewatering, the sewage will be collected at a lift station approximately one mile from the treatment plant and pumped through twin force mains to the treatment plant. The difference in cost between building this lift station a mile from the treatment plant or as an integral part of the plant is much more than made up in reduction in conduit costs. The potential area to be served by the plant is in no way affected. The savings will also offset cost of shallower local sewers along the force main draining to the lift station.

Lift stations are constructed with and without superstructures. The use of a superstructure will add cost to the lift station, but it permits the mounting of motors, controls, electrical power panels, and other items at the ground floor level. This permits locations in well ventilated and lighted areas where hazards are at a minimum. A station without a superstructure requires placing the motors in a location subject to the dangers of flooding or weather; increased attention to lighting and ventilation; and probably the mounting of electrical controls outside the station in weatherproof housing. The use of stairs for access to pumps in deep stations is more easily obtained if the station is designed with a superstructure.

The use of a superstructure on small stations is sometimes difficult due to the size of the station itself. A case in point is a 100 gallon per minute station presently under construction in a neighborhood of nice residences. This station has an area of only 225 square feet. The design of a superstructure of this area which would fit in with the surrounding property improvements appeared impossible. On the other hand, a superstructure of a size and style compatible with the neighborhood was economically prohibitive. Therefore a station without a superstructure is being constructed.

## PUMPING EQUIPMENT

In the past, sewage lift stations were designed quite frequently using submersible pumps. This type of design is not as popular today and is found only infrequently. For a small station of a decidedly temporary nature the submersible pump design can offer a real savings in cost. Submersible pumps can be suspended from a plate in an oversized manhole at the low point upon the sewer. The controls and switches can be mounted above the plate inside this same manhole. At a later date when the sewer is extended to lower areas or it becomes possible to drain the entire area by gravity, the equipment may be removed and the structure continues in existence as an ordinary manhole.

The use of a dry well for the location of pumps is normally preferred because it simplifies maintenance while exposing the minimum amount of equipment and bearings to the damaging characteristics which may be present in the sewage. It is therefore recommended that in any continuously operating, permanent lift station, the dry well type of construction be utilized.

The equipment which forces the liquid from one elevation to a higher elevation is the most important part of the lift station and its choice dictates the most care and attention. This equipment may be centrifugal pumps, torque flow pumps, or pneumatic ejectors. If centrifugal pumps are used they must be of the non-clog design with surfaces well rounded and smooth and passages capable of passing a three-inch diameter sphere. The non-clog type of pump may be obtained from various manufacturers in both horizontal and vertical pedestal mountings (the vertical pedestal is used in the majority of lift stations). The torque flow pump (or recessed impeller pump) was developed originally for the food handling industry and its success there prompted its use in the waste treatment field for the handling of sludges. It is now coming into limited use in lift stations. This pump has the characteristic of an impeller set far back in the casing which, when rotated, induces a current through the casing which lifts liquid and solids very effectively. The claim is made that the solids pass through the pump without touching the impeller. From the observation of plastic models of this pump, this claim appears to be essentially true. It is also claimed that any solid which can enter the pump will pass through it. The torque flow pump is protected by current patents and is, therefore, manufactured by only one company. The pneumatic ejector is basically a pot with inlet and outlet lines properly valved and a means of injecting and exhausting compressed air. When the incoming sewage fills the pot to a predetermined level, the compressed air is injected under the required pressure to eject the sewage from the pot to the higher level desired. When the sewage level in the pot has been lowered to a second predetermined level, the compressed air inlet is closed off; an air exhaust line opens; and the next cycle of operation is started. These pots may be obtained made of cast iron or steel with cast iron normally preferred for permanent installations. Pneumatic ejector equipment is available from at least three manufacturers represented in Indiana.

The sizing of the pumps for a lift station is naturally a prime design factor. In the absence of measured flow data for the area to be served, the provision of 1 gpm (gallon per minute) per house has proved to be satisfactory. This figure is probably an excellent figure to use for subdivisions up to approximately 300 homes. Above 300 homes the 1 gpm

per house is probably overly conservative for it makes no allowances for collection times in the longer sewer systems which are found in the larger developments. A criterion of 250 gpd (gallons per day) per capita has often proved to be a reasonable figure for larger areas. The use of any of these figures is predicted upon the sewer system leading into the lift station being constructed as tight as possible to permit an absolute minimum of infiltration. *Every city and town must require that sewers be constructed of materials and by methods which will produce a minimum entrance of non-contaminated water into the sanitary sewers, lift stations, and treatment units.* Only in this way can the maximum life expectancy of the sewerage system and waste treatment facilities be realized before additions become necessary.

Regardless of the equipment chosen for lifting the sewage, the rate of discharge must be such as to produce scouring velocities in the piping during each cycle of operation. This limits the minimum pump size to 100 gpm and the minimum pneumatic ejector rating to 50 gpm. (The ejectors are rated at an average flow rate with the discharge time equal to the inflow time.) For the small station operating against a low head it may be advantageous to use an ejector because of the shorter time required between cycles of operation.

Any lift station should contain duplicate equipment to provide for failures and maintenance. In stations where no overflow is possible, it is often advisable to provide standby power source to operate the equipment in the event of the failure of the prime power source. With the use of pumps, duplicate units and drives are indicated. The use of pneumatic ejectors may indicate complete duplicate units or, if the risk is considered to be sufficiently minor, the use of duplicate compressors and controls but only one pot.

#### APPURTENANCES

The appurtenances of a lift station may be any or all of the following:

- Pump controls
- Screens
- Heating equipment
- Ventilating equipment
- Dehumidifiers
- Stairway
- Elevator
- Hoist
- Sump Pump
- Water supply
- Electrical convenience outlets

The choice of the use of many of the above listed appurtenances will be dictated by size of the station, depth of the station, or general location. However, there are at least two appurtenances listed without which few stations can properly operate: pump controls and a sump pump.

Pump controls may be float operated, bubbler operated, or probe operated. The float operated control has been in quite widespread use in recent years. It is a simple control wherein the rise and fall of a float actuates switches which control the operation of the pumps. The bubbler control, wherein the air pressure on the control switches is varied with the rise and fall of the liquid, has been frequently used in the last few years. Twenty-five or 30 years ago the use of probes was in common use wherein the rise and fall of the liquid opened and closed the control circuits. These probes frequently became coated with grease or clogged with floating materials in such a manner that the operation was improper. The use of probes, therefore, became unpopular. In an effort to overcome the objectionable characteristics of the probes, Los Angeles placed probes inside a float well and isolated them from the sewage by the use of a beach ball. This system has proven to be quite successful and is now available in a commercial model from a manufacturer of waste treatment and pumping equipment. This system overcomes the disadvantages of the float control which are that the float may develop a leak and sink, the tape may come off the pulley, or the tape may be kinked and not track properly. The beach ball system also is not subject to the clogging or compressor failure which may occur with the bubbler system.

The sump pump chosen for a lift station should be a heavy duty sump pump designed to pass liquids containing considerable solids. The use of a diving bell housing over the motor to insure operation in case of flooding is frequently advisable.

The screening of the sewage to prevent gross solids from entering the pumps is desirable although not always practicable. Screens used for this service include bar screens, comminutors, and the "FlushKleen" screening arrangement.

Ventilation is important to the safe operation and maintenance of lift stations. The Indiana State Board of Health requires forced ventilation both on supply and exhaust for all areas frequently entered. The regulations specify that the rate of turnover shall be six times an hour where continuous operation is provided or a turnover in two minutes where operation is not continuous. If ON-OFF operation is

provided the ventilators should be wired to operate whenever the area being ventilated is to be entered. This may often be done by utilizing the same switch to energize the lights and the fans. With the above volumes of air being circulated it is frequently necessary to provide heating equipment to protect the piping and equipment from freezing conditions. Unless the station is to be continuously manned the temperature need not be held far above 32 Deg. F. For similar reasons the use of dehumidifiers is often desirable.

Access to the lowest levels should be as convenient as it is economically feasible to provide. The use of stairways should be considered. Many times ships ladders or circular stairs may be used without adding excessive cost to the construction. In deep stations (in excess of approximately 25 feet) the use of a man lift or elevator is desirable. If none of the above are deemed economical and a vertical ladder is chosen, the use of a cage should be considered.

The provision of a hoist, trolley, lifting lug, or some other device for removing equipment is an item deserving attention in all but the smallest units. In these small units it may be possible to construct them in a manner which will permit the removal of the entire cover or roof. This will permit the use of portable lifting equipment for maintenance and repair.

The provision of a water supply is always desirable. Interior and exterior hose bibbs are conducive to obtaining good housekeeping. Provision of water often makes the use of water sealed pumps practicable, and it is generally agreed that this is the preferable method of sealing sewage pumps.

It is believed by the writer that every lift station should have not less than one electrical convenience outlet for use with trouble lights and power tools. An outlet can be provided at a reasonable cost, and it will pay for itself in increased efficiency and safety of maintenance and repair operations.

Whether the use of a custom designed and constructed station is preferable to the so-called package lift station will depend upon the circumstances peculiar to the individual station under consideration. The package lift stations observed by this writer are extremely compact and appear to have been designed with considerable less room than is desirable for maintenance and repair crews to perform their duties. On the other hand, if the station is obviously one whose need is temporary, the package lift station does have a high recovery value. Cost wise, the package lift station would appear to offer the opportunity of significant savings in initial cost. Limited experience by the writer's firm in

open competitive bidding between custom type and package lift stations has not borne out this belief, to date.

Sanitary facilities should be provided in any lift station which will be continually manned. Although not common in other stations, some opinion supports the inclusion of these facilities in all stations moderately large and larger.

## RECOMMENDATIONS FOR PLANNING AND CONSTRUCTING LIFT STATIONS

Many of the sanitary lift stations being constructed are by developers for eventual ownership, operation, and maintenance by the municipality or sanitary district. The writer offers the following ideas which were recommended to a client as measures of control upon the planning and construction of these lift stations:

- (1) As soon as a private developer ascertains that he desires to erect a sanitary sewage pumping station which will discharge directly or indirectly into the sewage system of the city of \_\_\_\_\_ he shall so notify the board of works in writing applying for permission to make such a connection. Failure to so notify the board should be made suitable grounds for the refusal upon the part of the board to accept the discharge or the pumping station at later date.
- (2) The developer must agree to deeding sufficient land and macadamized access roads to the city to provide proper operation and maintenance of the pumping station and piping without excessive expense by the city.
- (3) The developer shall present criteria and preliminary plans of the proposed pumping station and piping to the board for review before final plans are prepared.
- (4) Final plans and specifications shall be presented to the board for review before construction commences.
- (5) Final plans and specifications shall be presented to the Indiana State Board of Health, and these said plans and specifications must receive said board's approval before construction commences.
- (6) Plans and specifications must be prepared by an engineer licensed to practice civil engineering in Indiana.
- (7) The board shall have the right of access to the job during construction together with the right of inspection and rejection of work found in nonconformance with the plans and specifications.

- 8) Equipment and materials used shall be of the best grade obtainable. In general, the applicable portions of the specifications used in building the sewage treatment plant shall be used in preparing specifications for the subject pumping stations. (The said S.T.P. specifications might be made a part of the contract document by reference at this point.) Reference to the Manual of Practice on Sanitary and Storm Sewers Design and Construction as a guide can be made.
- (9) Plans shall provide for a frost proof water connection for one (1") inch hose within five feet of the structure.
- (10) Plans shall provide for an outside light mounted above ground in a manner suitable to provide illumination for the safe approach of the station during hours of darkness. This light shall be provided with an automatic switch which shall energize the light at evening dusk and de-energize it again at morning light. Light shall be protected from vandalism.
- (11) Plans shall provide for an alarm horn which shall sound in the event of power failure, breakdown of operation, failure of controls, or any other circumstance requiring prompt attention. This alarm horn shall be so set that it will be audible to not less than two nearby developed properties.
- (12) Cast iron manhole steps shall be provided for access to the wet well through a manhole outside of any superstructure, if a superstructure is provided.
- (13) Access to dry wells more than eight feet deep shall be by metal ships ladder or ships ladders, by circular stairs, or by a caged vertical ladder. The caged vertical ladder is considered to be the least desired. Uncaged vertical metal ladders will be accepted as satisfactory access to dry wells or not more than eight feet depth.
- (14) Plans and specifications shall provide for all piping to be properly supported. Specifically pump nozzles shall not be required to support piping unless these nozzles are designed for pipe loads.
- (15) Plans shall provide a U-bolt, ring, or other satisfactory device above all pumps, motors, or other equipment which might require the use of a hoist, chain falls, or block and tackle in its maintenance.
- (16) Plans shall provide a satisfactory method of preventing unauthorized entrance to the pumping station machinery and controls.



- (17) Developer shall furnish the board not less than two copies of all drawings, installation instructions, operating instructions, maintenance and lubrication instructions, piping diagrams, wiring diagrams, or other such information furnished by the engineer, suppliers, and/or contractors for the satisfactory construction operation, and maintenance of the sewage pumping station.
- (18) The developer shall furnish the board a sworn affidavit attesting that all bills for materials, labor, licenses, taxes, and services incurred in the construction of the pumping station and contiguous piping are paid, and that neither the pumping station, contiguous piping, nor land on which they lie are encumbered by any mortgage, loan, or other financial obligation, before final acceptance by the board.
- (19) Before final acceptance by the board the developer shall file with the board a written guarantee to make any and all repairs necessitated by faulty or defective materials or workmanship or to pay all the costs incurred in making said repairs. This guarantee shall cover any and all such deficiencies which become apparent within the first year after acceptance of the subject pumping station by the board. This guarantee shall be secured by a bond payable to the Board for \$2,500 or 5 per cent of the cost of construction of the pumping station whichever amount is the larger. The board reserves the right to waive this requirement to post bond in event that the developer is a local resident with a long record of sound real estate development. In addition the plans, specifications, and construction shall conform with any and all applicable building, plumbing, and electrical codes, national, state and local.