ST. GEORGE WATER POLLUTION CONTROL PLANT OPTIMIZATION STUDY

TECHNICAL MEMORANDUM

SCREENING-LEVEL ASSESSMENT OF PRELIMINARY TREATMENT ALTERNATIVES

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1.0 INTRODUCTION

Gamsby and Mannerow Ltd. (G&M) together with process specialists from Conestoga-Rovers and Associates (CRA), University of Western Ontario (UWO) and Huber Environmental Consulting (HEC) were retained by the St. George Landowners' Group to complete an Optimization Study of the St. George Water Pollution Control Plant (WPCP). This Technical Memorandum identifies and assesses proven municipal wastewater preliminary treatment technologies that are considered applicable to the St. George WPCP. This Memo is intended to serve as a desk-top screening-level evaluation only and will form part of the final Optimization Study document. Further Technical Memoranda will be prepared by the project team to cover other aspects of the overall Optimization Study.

The St. George WPCP is located at 43 Victor Boulevard in the Village of St. George and serves the community of St. George by means of a gravity collection system. The plant serves an estimated population of 2,300 people. The community is primarily residential with some commercial and institutional land uses. There are no large industrial customers currently connected to the system. Consequently, the waste stream from the community is considered to be typical municipal domestic wastewater. The plant is owned by The County of Brant and operated under contract by the Ontario Clean Water Agency (OCWA).

The St. George WPCP is an extended aeration activated sludge plant with a rated hydraulic capacity of 1,300 m^3/d and a design peak flow rate of 3,412 m^3/d [Ministry of Environment Certificate of Approval (CofA) No. 9415-6CQKH5 dated June 24, 2005].

2.0 DESCRIPTION OF EXISTING HEADWORKS

Raw wastewater flows to the plant via a 450mm diameter gravity sewer to the headworks, which generally consist of two parallel grit channels followed by a low-speed channel grinder with a hydraulic capacity of 90 L/s (7,800 m^3/day) and a bypass manually cleaned coarse bar screen with 40mm clear openings (Figure 1). Each grit channel is 5.0m long x 0.5m wide with a sloping floor for a depth of 150 to 440 mm. There are sluice gates at each end of both grit channels to allow isolation for grit dewatering and removal. In addtion, there are proportional weirs at the end of each grit channel. There are also sluice gates to control flow either through the grinder and/or the manual bar screen. Under normal operating conditions, all flow is directed through the channel grinder which operates continuously.

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Coarse materials that do not settle out in the channel should either be pulverized by the grinder or captured by the screen. Based on discussions with operations’ staff, the grit channels are cleaned out once every year and accumulated solids are approximately 0.25m deep (average). The solids removed are placed onto an adjacent grit draining pad and left for two or three weeks to dry. Water is captured in a catchbasin located below the pad and discharges back to the headworks just downstream from the grit channel. Dewatered solids are taken to the Paris WPCP for processing.

It was noted in the Process Capacity Assessment Report (G&M, 2009) that due to limited preliminary treatment at the inlet works, as a consequence of lack of screening and inadequate grit removal, accumulations of rags, plastics and filamentous material have been observed in the aeration tank. The presence of non-biodegradable solids such as rags, plastics and grit in the treatment process has led to mechanical failures of pumps and diffusers due to clogging and excessive wear. Operators have indicated that when the air supply to the aerobic digester is turned off for decanting purposes, the coarse bubble diffusers have a tendency to plug when the solids settle. As a result, operators are reluctant to decant the digester in order to reduce maintenance operations with the diffusers. Without adequate plant screening, ongoing operation and maintenance issues such as clogged diffusers and plugged pumps adds to operational challenges requiring extended hours of maintenance for frequent mechanical failures.

The 2009 Process Capacity Assessment concluded that headworks upgrades including automatically cleaned screens and improved grit removal should be considered in order to limit the amount of non-biodegradable solids in the system and reduce overall operational and maintenance problems. Consequently, one of the primary objectives of the overall Optimization Study is to evaluate alternatives to address the identified deficiencies. The evaluation will also consider preliminary treatment requirements necessary to accommodate ultimate planned development of the community within the existing property boundaries of the plant.

3.0 SITE CONDITIONS

The existing plant property measures approximately 168 metres (550 feet) east to west and 137 metres (450 feet) north to south. The developed portion of the property within the fenced area for the actual plant occupies a footprint of approximately 100 metres (328 feet) east to west by 95 metres (312 feet) north to south in the northeast portion of the property. The existing plant site occupies approximately 40% of the total property.

Ground elevations at the plant are in the range of 211 to 212 metres above sea level. Boreholes drilled at the site in 1979 for construction of the original plant indicate that groundwater elevations at that time were measured in the range of 209.0 to 210.5 masl. Surface soils are generally clays and silts overlain by a layer of topsoil. At the location of the proposed headworks, a borehole identified as MH-105 at the time of original design of the plant in 1979 indicated a ground elevation of 212.60m and a groundwater elevation of 211.74m or 0.86m below ground surface. Soils include approximately 300mm of topsoil, 700mm of firm clayey silt, followed by dense silt with occasional clay layers. Consequently, dewatering of excavations during construction of an upgraded headworks facility must be taken into consideration during detailed design.

4.0 HISTORICAL INFLUENT DATA

Historical influent data for calendar years 2004 through 2009 were obtained from OCWA and are summarized in Table 1.

Table 1. Summary of Historical Influent Data (Annual Averages)

Year	Flow [m^3/day]		Total Suspended Solids (TSS) [mg/L]	
	Average	Standard Deviation	Average	Standard Deviation
2004	813	107	186	54
2005	822	87	451	388
2006	843	98	298	189
2007	812	82	251	92
2008	864	116	217	59
2009	860	101	180	63

Over the past six years in operation, flows have gradually increased from ~ 810 m^3/day to 860 m^3/day. The plant is currently running at 66% of the rated capacity; therefore, there is limited remaining capacity to meet future servicing requirements for the St. George catchment area (estimated to be ~ 4,000 m^3/day).

Historical TSS concentrations in the influent are generally typical for municipal wastewater [i.e. between 120 mg/L (low strength) and 370 mg/L (high strength)]. We note, however, that larger floating particles such as rags, plastics, and filamentous material (i.e. solids responsible for the operational issues noted above) are too large to be sampled and analyzed using practical and conventional sampling and analysis methods. TSS concentrations in Table 1 (and in general) are therefore not indicative of particle size and quantities of coarse material.

5.0 SCREENING-LEVEL ASSESSMENT

5.1 EVALUATION FRAMEWORK

Preliminary treatment alternatives to be evaluated for plant optimization are:

1. Grinders
2. Manually-Cleaned Bar Screens
3. Mechanically-Cleaned Bar Screens
4. Grit Removal

A general description of each device is presented below. Evaluation of the alternatives will identify which device is considered most appropriate to limit the amount of non-biodegradable solids in the system and reduce overall operational and maintenance problems. Consideration will also be given to accommodating ultimate planned development of the community within the existing property boundaries of the plant.

5.2 DESCRIPTION OF PROCESS ALTERNATIVES

Grinders

Grinders are typically installed in headworks channels of wastewater treatment plants to intercept coarse solids, and grind or shred them for return to the flow stream. Ground or shredded solids are smaller and more uniform in size, which theoretically makes them easier to remove in subsequent downstream treatment operations and processes. Because grinding mechanisms are subject to high wear and tear and require frequent sharpening or replacement, grinders should be preceded by a grit channel.

Grinding mechanisms may consist of either an oscillating arm that contains cutting teeth to mesh with a stationary screen (comminutor), two sets of counter-rotating assemblies with blades or teeth (macerator), or a high-speed rotating assembly with knife blades that force screenings through a stationary grid or louver (hammermill). In all cases, however, ground solids are not removed from the flow stream. These solids often present downstream problems, as is currently being observed at the St. George WPCP, particularly with rags or bags that tend to form rope-like strands that clog pump impellers, pipelines, air diffusers, and clarifier mechanisms. Recent practice in municipal WWTP design often involves grinders that are replaced or used in conjunction with bar screens, which intercept and remove coarse particles and other debris from the waste stream.

Manually-Cleaned Bar Screens

In general, coarse screens have clear openings ranging from 6mm to 150mm. The screening element consists of parallel bars, rods, or wedge wires positioned at a 30° to 45° angle from the vertical in order to maximize the screening surface area and facilitate cleaning. An approach velocity of at least 0.4 m/s is typically recommended to minimize settling and accumulation of grit in the perpendicular channel (Metcalf and Eddy, 2003). To prevent the pass-through of debris at peak flow rates, the velocity through the bar screen should not exceed 0.9 m/s.

Manually-cleaned bar screens have little to no motorized cleaning equipment and must therefore be periodically cleaned manually by hand using a rake. Consequently, the length of the screening element should not exceed the distance that can be safely and conveniently raked by hand (i.e. approximately 3 m). Spacing/support bars are typically welded to the rear face of the screen bars, out of the way of the tines of the rake.

Manually-cleaned bar screens were historically the most widely used device at the headworks of small to medium sized wastewater treatment plants. However, they are being used less frequently for primary screening not only because of the intense manual labour requirements, but when removal of screenings is infrequent, flooding and overflow can occur due to clogging. The head accumulated between cleanings can also create a massive surge when the screenings are removed. Accordingly, as is the case at the St. George WPCP, they are only used for standby screening in bypass channels for service during high-flow periods, when the primary equipment is being repaired, or in the event of a power failure. The primary device is generally a mechanically-cleaned bar screen.

Mechanically Cleaned Bar Screens

Mechanically-cleaned bar screens have been refined over the past 50 years in order to reduce operations and maintenance issues and improve the screenings removal capabilities. There are four primary types of mechanical bar screens, all of which are currently being constructed of corrosion-resistant materials including stainless steel and plastics. A description of each type of screen is provided below:

1. Chain-operated: a traveling rake moves the screenings upwards and drops them into a collection bin or conveyor. Raking is performed continuously by means of endless chains operating over sprockets.
2. Reciprocating: a rake moves to the base of the screen, engages the bars, and pulls the screenings to the top of the screen where they are removed. Generally, screens utilize a cogwheel drive mechanism for the rake.
3. Catenary: similar to chain-operated screen but with no submerged sprockets. A rake is held against the rack by the weight of the chain. If heavy objects become wedged in the bars, the rakes pass over them instead of jamming.
4. Continuous-belt: a large number of screening elements (i.e. rakes) are attached to drive chains that operate continuously. Hooks protruding from the belt elements are installed to capture large solids (i.e. sticks and rags).

The mechanical device that cleans the bar screen is typically activated by a manual start-stop switch, a timer, an overload switch, an actuator which sense pressure differential between points upstream and downstream of the bar screen, or a float that is activated when head across the bar screen is greater than some predetermined elevation.

For most mechanically-cleaned bar screen installations, two units are installed in parallel so that one can be taken out of service for maintenance. Generally, slide gates or stop logs are installed upstream and downstream of each mechanical screening unit to allow each channel to be isolated, if necessary. If only one unit is installed, a bypass channel with a manually-cleaned bar screen will be provided for emergency use. It is noted, however, that the primary advantages of mechanical bar screens include significantly reduced labour costs and more efficient screening capture. Some mechanical units are also equipped with integrated equipment for washing, dewatering and compacting of the captured solids.

Grit Removal

Grit typically consists of dense inorganic particles in the raw waste stream such as sand, gravel, cinders and other hard solids that have relatively high settling velocities compared to organic solids. Grit removal is a recommended preliminary treatment step to protect rotating mechanical equipment from excessive abrasion and wear, reduce accumulation of heavy solids in pipelines and channels, and reduce the frequency of cleaning of digesters. Grit removal facilities are typical located after screening operations and prior to biological treatment processes.

There are essentially three types of grit separators:

- horizontal flow grit channels
- aerated grit chambers

- vortex grit chambers

Horizontal flow grit channels do not involve use of mechanical or electrical equipment. They typically consist of a channel with specifically designed geometry and slope to maintain a flow velocity that promotes gravity settling of denser grit particles while maintaining lighter and organic particles in suspension. A specific gravity of 2.65 is typically used for design of horizontal grit channels.

Aerated grit chambers consist of a tank with a blower and aeration piping to induce a spiral mixing motion in the tank that enhances grit separation through centrifugal force. Vortex grit separators operate on a similar principle and typically consist of a cylindrical tank installed vertically, and the flow enters tangentially to promote grit separation by centrifugal force.

5.3 Evaluation of Process Alternatives

The primary advantage of using a grinder for preliminary treatment is that it eliminates the messy and unpleasant task of screenings handling and disposal. Unfortunately, the way that this is accomplished is by returning solids to the flow stream after they have been ground up. It is generally accepted in the wastewater industry that once coarse solids are removed from wastewater, they should not be returned regardless of the form. As noted above, this is due to the fact that rags and plastics can have a number of adverse impacts on downstream processes including clogging of pump impellers, pipelines, air diffusers, and clarifier mechanisms. Non-biodegradable material in the biological process unit may also adversely affect the quality of biosolids in the Return Activated Sludge (RAS) and negatively impact beneficial use of digested biosolids.

Bar screens physically intercept and remove large solids from the flow stream that could damage subsequent process equipment and reduce overall treatment process effectiveness. Manually-cleaned bar screens have little to no motorized cleaning equipment; however, operators must be diligent in ensuring that they are frequently cleaned. If they become clogged, there is potential for flooding and overflow. Mechanically-cleaned bar screens significantly reduce labour requirements due to automatic and continuous removal of screenings. As a result of significant technological advances, they also have ability to capture a wide range of particles (i.e. of different shape and size), and some manufactures have included a built-in washing/dewatering/ compacting unit, reducing volumes by up to 80% and subsequently lowering disposal costs.

Based on a desktop review, it is recommended that two new mechanically-cleaned screening units (with integrated equipment for washing, dewatering, and compacting) be installed at the St. George WPCP (one duty, one standby) to reduce overall operational and maintenance problems. The units could be sized for some interim capacity (i.e. 2,600 m^3/day, or double the existing plant capacity), with provisions made for installing additional units as the flows increase.

The screens should be installed in a heated insulated building to control odours and protect the mechanical equipment from freezing. The building could be constructed at the northeast corner of the facility with a temporary by-pass to the existing headworks during construction of the new headworks, which would be used as an emergency backup. Review of available space and property boundaries indicates that a new headworks building can easily be accommodated at this area of the site where the influent sewer is located. We note that all lighting, mechanical and electrical equipment within the building would need to be suitable for Class 1 Division 1 areas (i.e. flammable and explosive under normal operating conditions), due to the emission of combustible gases such as methane (CH_4).

It is recommended that grit removal be provided following screening. With use of a mechanically-cleaned bar screen, a horizontal-flow grit channel is considered suitable for grit removal after screening and ahead of the biological treatment. The service area is primarily a residential community and operating experience indicates that a relatively small quantity of grit is conveyed from the collection system to the plant. This option for grit removal avoids use of additional mechanical and electrical equipment at the headworks which reduces capital and operating costs while providing an appropriate level of treatment and protection of downstream equipment. The existing horizontal grit channel could be incorporated into the upgraded headworks, although capacity of the existing channels will have to be verified. The logistics of construction on the existing headworks would also have to be considered. New grit channels would be preferred from a constructability perspective to maintain the existing headworks operational during construction.

All of which is respectfully submitted.

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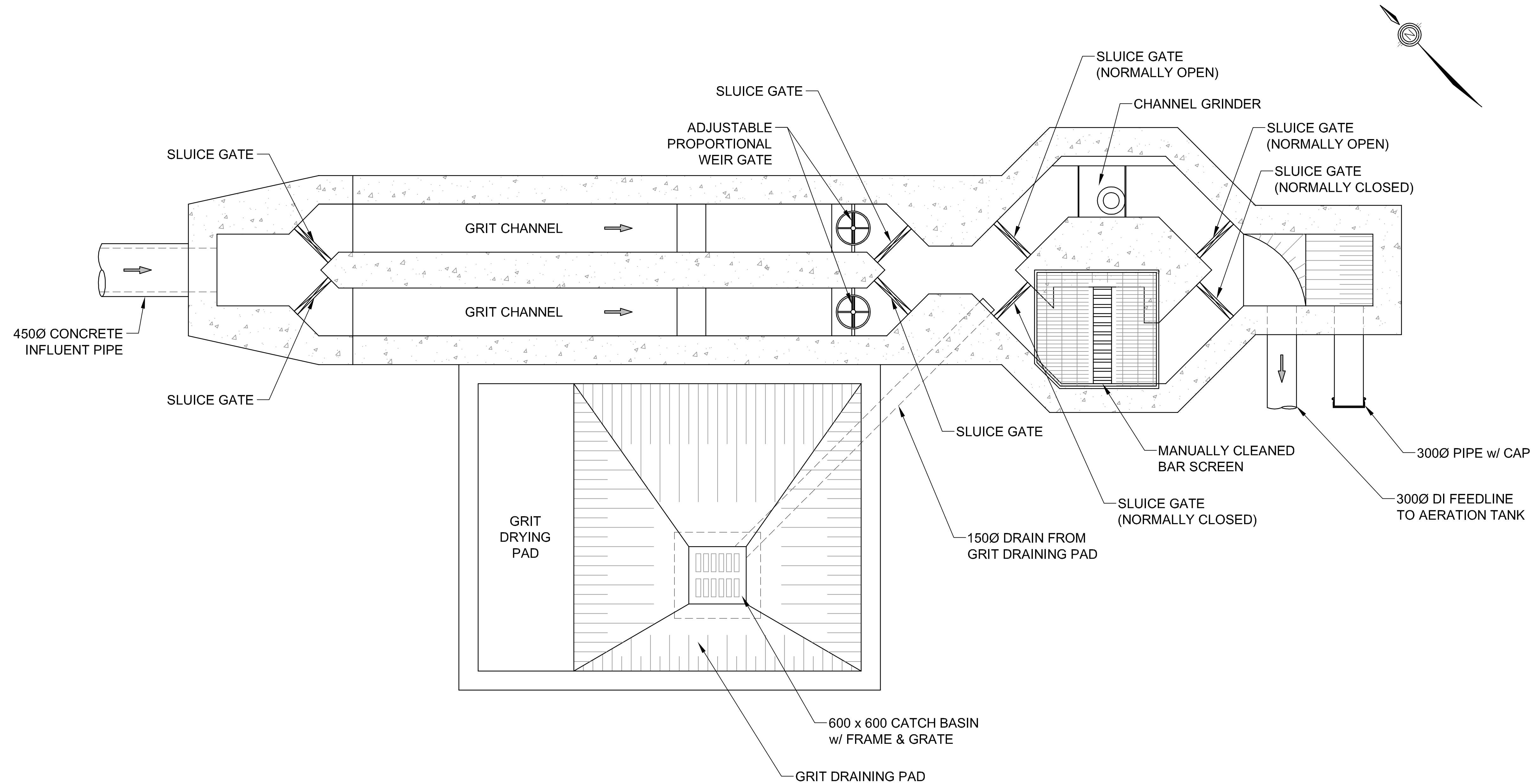

EXISTING HEAD WORKS

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Figure No. 1

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