PREPARED FOR: Western Wake Partners

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SUBJECT: Western Wake Regional Wastewater Management Facilities
Western Wake Water Reclamation Facility
PER Technical Memorandum No. 14 – Effluent Filters

INTRODUCTION

This Technical Memorandum (TM) is one in a series of TMs being prepared for the Preliminary Engineering Report for the Western Wake Regional Wastewater Management Facilities project. The purpose of this TM is to present the preliminary engineering information and data for the effluent filters. Effluent filtration is proposed to provide tertiary treatment to plant flows in order to consistently meet the anticipated NPDES limits and to condition plant flows for effective UV disinfection.

PROCESS REQUIREMENTS

The proposed design capacity of the effluent filters is 18.0 mgd with an anticipated future expansion to 30.0 mgd. The North Carolina Department of Environment and Natural Resources (NCDENR) has provided speculative NPDES permit limits for total suspended solids (TSS), BOD_5, and ammonia. Interim limits have also been set for seasonal (April-October) loadings based on a total nitrogen concentration of 6 mg/L and a total phosphorus concentration of 2 mg/L. A Total Maximum Daily Load (TMDL) allocation may be conducted by NCDENR for the Cape Fear River in the future that would require more stringent limits. The effluent filter facilities will be designed to allow expansion to meet future limits. The following limits are assumed for the purpose of preliminary design.

TABLE 14-1
ANTICIPATED NPDES PERMIT LIMITS

Total Suspended Solids, mg/L	30
BOD_5, mg/L	5/10
Ammonia Nitrogen, mg/L	1/2
Total Nitrogen, mg/L	6
Total Phosphorus, mg/L	2

Summer/winter limits are shown where applicable.

Effluent filters are required to reliably meet nutrient limits in the range anticipated at the Western Wake Water Reclamation Facility (WWWRF). Effluent filters will also improve the effectiveness of the proposed ultraviolet (UV) disinfection equipment by removing TSS that would otherwise impair UV transmission. See TM 15, UV Disinfection Facilities and Post Aeration Facilities, for discussion of the UV disinfection facilities. Due to the anticipated future low total nitrogen requirements, the effluent filters should be designed to allow convenient conversion, in the future, to operation in a denitrification mode.

ALTERNATIVES EVALUATION

Alternative types of filtration equipment have been previously discussed with the Western Wake Partners and with the NCDENR. Deep bed effluent filters have been selected based on their ability to provide a relatively large amount of solids storage (extending filter runtimes) and their suitability for future use as denitrification filters.

PROPOSED FACILITIES

The proposed deep bed filters consist of individual filter cells, a pipe gallery, clearwells, mudwells and an electrical building. The filter cells are equipped with a filter underdrain system and a 72-inch deep bed of coarse sand media supported by a bed of graded gravel. Filtered effluent is stored in the clearwells for use as backwash water. When a filter cell has collected enough solids to require backwashing, the cell is taken out of service and the backwash pumps pump effluent from the clearwell up through the media to remove the collected solids. The dirty backwash water flows by gravity to the mudwells where it is stored and then pumped to the head of the plant. The backwash cycle will also include concurrent air scour to maximize cleaning of the media. Air scour blowers will be provided to supply air during the backwash cycle.

Effluent filters are usually provided with a pipe gallery for accessing filter piping and valves. Filter layouts incorporate one of two approaches for arranging filters around the gallery. A common approach primarily used in water plant filters is to locate filters on both sides of a filter gallery. This approach often results in a more compact, more economical structure but also creates operator access problems since the common filter effluent, backwash supply, backwash reclaim, and air scour piping must span the full width of the gallery, obstructing walking paths. A second approach that simplifies piping and access has filters located on one side of the filter gallery. Another advantage of arranging the filters on one side of the gallery is better truck/crane access for media replacement and maintenance within the gallery. The layout with filters on one side of the pipe gallery, as shown in Figures 14-1 and 14-2, is recommended. However, a layout with filters on both sides of the pipe gallery could be investigated during detailed design, if desired.

The effluent filter facility may be covered by a canopy to minimize algae growth and provide the additional benefit of protecting operators from foul weather. Fabric screens could also be considered for minimizing algae growth.

An automatic filter bypass is proposed in order to prevent overflows in the Effluent Filter Facility as filters become blinded by solids during peak hydraulic flows. The bypass will be sized for 78.8 mgd to pass the full future peak flow in the event that all filters become blinded.

FILTER DESIGN CRITERIA

The effluent filter design for the initial plant design flow of 18.0 mgd is summarized in Table 14-2.:

TABLE 14-2
FILTER DESIGN CRITERIA

Number of Filter Units	6 (5 duty, 1 backwashing)
Filter Unit Dimensions	10 ft. x 70 ft.
Total Filter Surface Area	4,200 sf (3,500 sf active)
Bed Depth	72 inches
Surface Loading Rate at Annual Average Flow (15.3 mgd)	3.0 gpm/sf
Surface Loading Rate at Maximum Month Flow (18.0 mgd)	3.6 gpm/sf
Surface Loading Rate at Peak Flow (47.3 mgd)	9.4 gpm/sf

Based on recommendations from filter equipment manufacturers for optimal filter configuration, the proposed filters have a width of 10 feet and a length of 70 feet for a total surface area of 700 sf each. Because a filter cell must be taken out of service to allow for filter backwashing, it is recommended that a minimum of six cells be provided. With five filter cells in service, the filter loading rate will be 3.6 gallons per minute per square foot of filter surface area (gpm/sf) at the maximum month plant flow rate of 18.0 mgd. When the plant is expanded to 30 mgd, three additional filters will be required to maintain the same loading rates and filtered effluent quality.

The proposed filter loading rates will provide for good TSS removal, as well as removal of BOD_5, phosphorus and nitrogen associated with the TSS, over a wide range of flows. The low TSS concentration will promote effective UV disinfection.

Deep bed monomedia filters can be used effectively to reduce the total nitrogen in the wastewater stream by converting nitrate-nitrogen to nitrogen gas by utilizing an attached growth microbiological process. In order to allow for effective denitrification, a loading rate of 2.0 gpm/sf is recommended. If future limits require a lower effluent total nitrogen concentration, the filters could be converted to denitrification service by adding methanol to the filter influent. Additional filters would be required to decrease the filter loading rate to 2.0 gpm/sf. If the filters are converted to denitrification service, methanol storage and feed facilities will be required to provide methanol to the influent of the filters as a carbon source for biological denitrification.

FILTER BACKWASH SYSTEM

Efficient filter operation is contingent upon the provision of adequate backwash facilities. Filters in service will eventually reach the solids holding capacity of the media and require a backwash cycle to restore the media to a "clean" state by removing the filtered solids. Thorough cleaning of the media is essential to maximizing filter runtimes and minimizing the total volume of effluent used for backwashing.

The most effective method for cleaning filter media is a concurrent water and air backwash cycle. Although a water-only backwash can be effective and is common in wastewater filters, adding a simultaneous air scour to the backwash cycle provides a more thorough cleaning of the filter media. An initial backwash with concurrent water and air is recommended to thoroughly clean the media followed by a final water-only backwash to purge all air from the media, bed before the filter is returned to service.

A flow-through clearwell is proposed in order to ensure that a ready supply of backwash water is available at all times. By providing a flow-through clearwell located in the filter effluent flow path, nuisance problems associated with stagnant water can be avoided, and clearwell size can be reduced as a result of the continuous addition of filter effluent. The clearwell will be divided into two cells. Each clearwell cell will be sized for a storage volume of 1.2 times the required backwash volume. Division of the clearwell into two cells will allow operators to take one cell offline for removal of accumulated solids while maintaining filter backwash capability. As an alternative to a separate post aeration basin, the Western Wake Partners may wish to consider providing aeration equipment in the backwash clearwells to meet effluent dissolved oxygen requirements. Also, the potential for using oversized backwash clearwells for a plant reclaim water source could be investigated.

Filter backwash pumps will be provided to deliver washwater from the clearwell to the filters. Filter air scour blowers will be provided to provide air to the filters during the backwash cycle. Two vertical turbine backwash pumps and two positive displacement blowers are proposed to provide one for duty use and one on standby.

Mudwells will be provided in order to temporarily store solids-laden backwash water leaving the filters. Dual mudwells are proposed in order to allow operators to take one mudwell offline for removal of accumulated solids while maintaining filter backwash capability. Each mudwell will have sufficient volume to contain the washwater from 1.2 complete backwash cycles. After the backwash cycle is complete, washwater will be pumped to the head of the plant by the backwash reclaim pumps. Two submersible non-clog backwash reclaim pumps are proposed to serve as duty and standby pumps.

ELECTRICAL REQUIREMENTS

An electrical building will be provided as part of the Effluent Filter Facility to house the motor control center, power and lighting panels. PLC equipment may also be located in this building. It may be possible for the electrical building to be constructed as a superstructure on top of the filter gallery if access to the filter gallery or equipment is not restricted.

INSTRUMENTATION & CONTROLS

There are many options available for the filter control system ranging from a single control console to individual control panels for each filter. The type of control system will be decided during final design , after consulting with operations staff. However, it is recommended that the control system provide the following:

- Fully automatic operation of filter backwashing based on filter head loss or a timer
- Manual initiation of the automatic backwash sequence
- Full manual operation of all filter pumps and valves

Cost Estimate

Costs for the proposed facilities are included in Table 14-3 below:

TABLE 14-3
PRELIMINARY COST ESTIMATE
EFFLUENT FILTERS

Sitework	$80,000
Structural	$2,271,000
Architectural	$150,000
Mechanical	$3,759,000
Electrical and Instrumentation	$489,000
Subtotal	**$6,749,000**
Construction Contingencies	$1,012,400
Engineering and Construction Services	$776,100
Legal and Financial	$426,900
Total Construction Cost	**$8,964,400**

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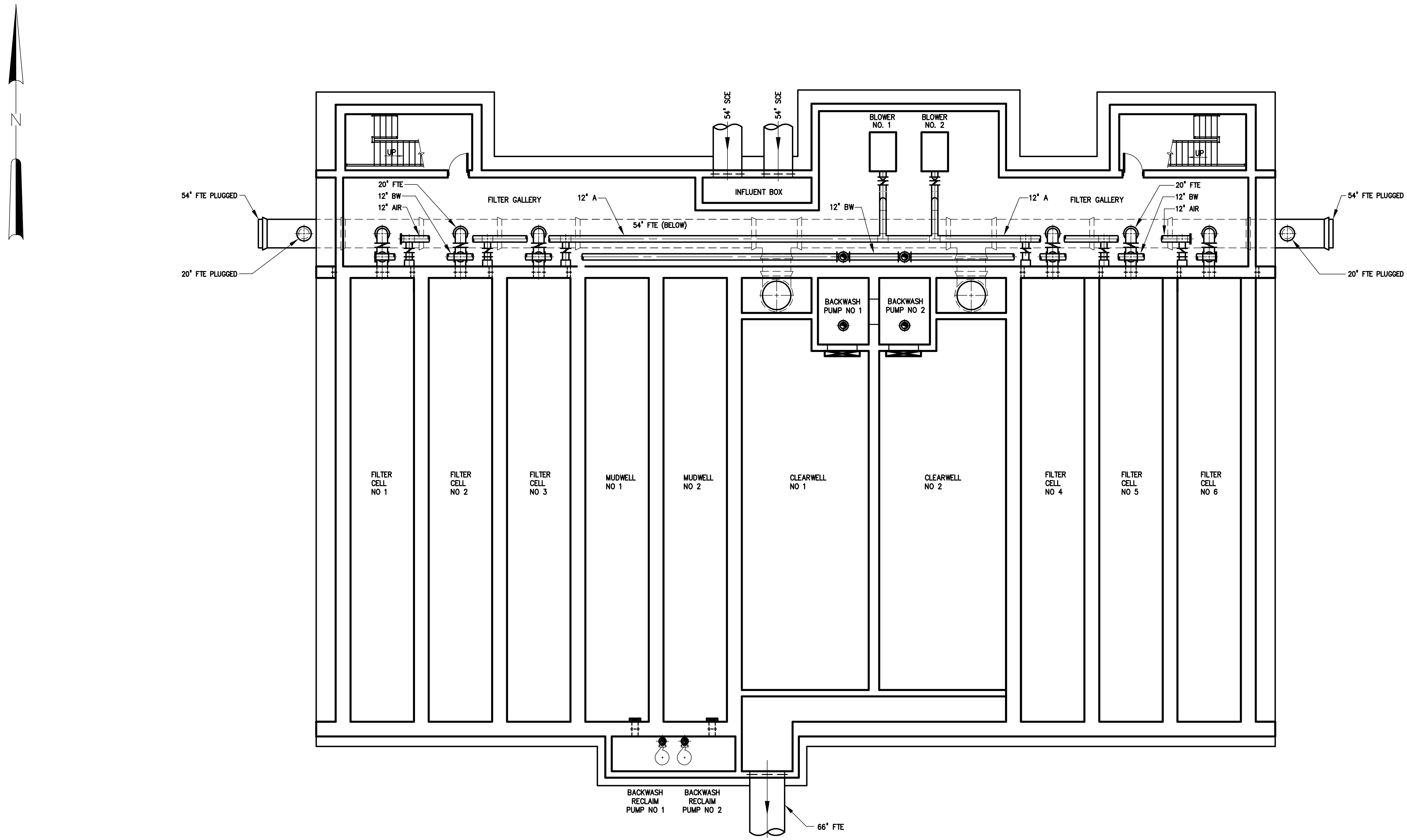
FIGURE 14-1



BOTTOM PLAN

1/16"=1'-0"

FILTER PIPING DESIGNATIONS

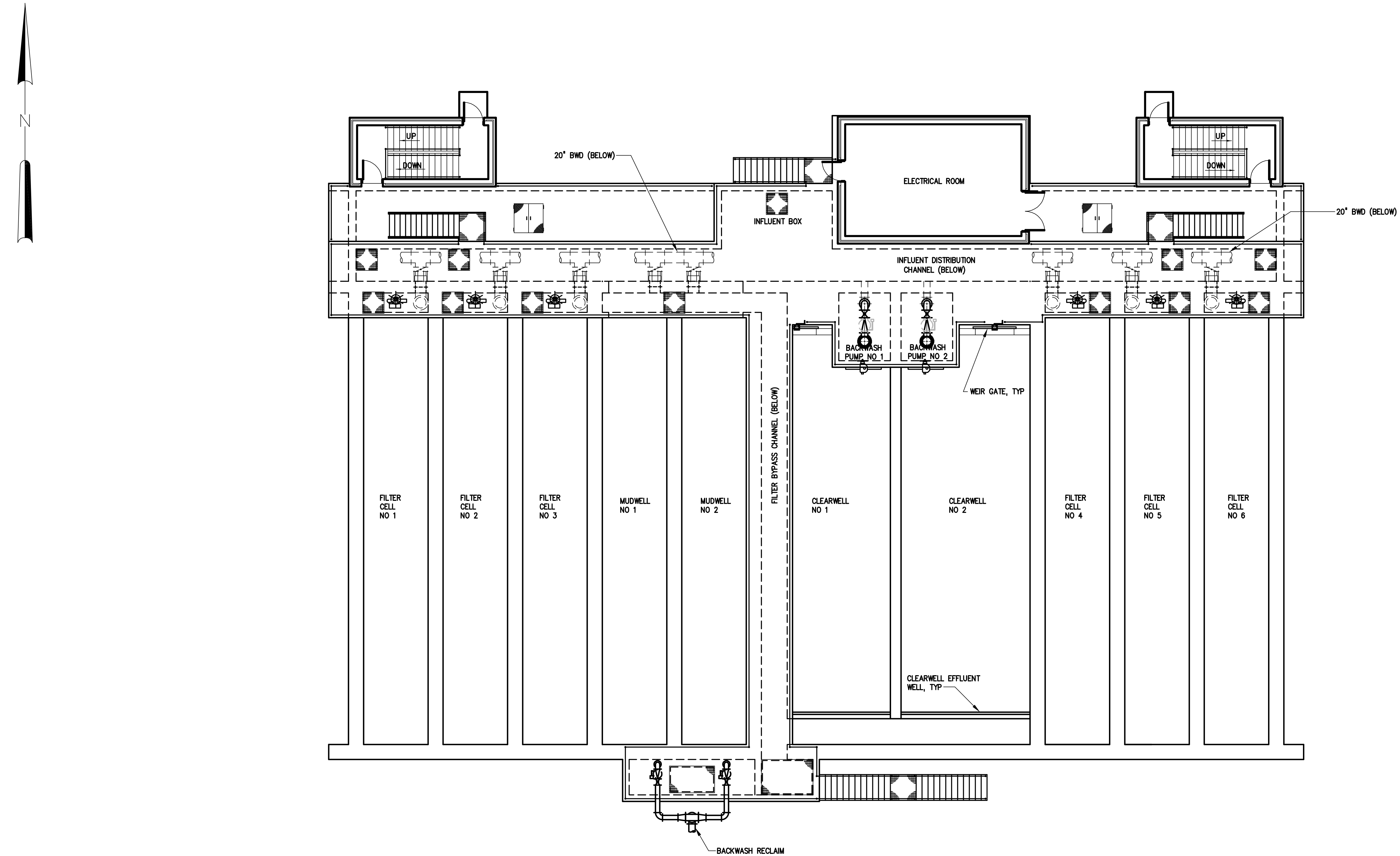
A	AIR
BW	BACKWASH
BWR	BACKWASH RECLAIM
FI	FILTER INFLUENT
FTD	FILTER TO DRAIN
FTE	FILTER EFFLUENT
SCE	SECONDARY CLARIFIER EFFLUENT

CDM / HAZEN AND SAWYER

WESTERN WAKE REGIONAL
WASTEWATER MANAGEMENT FACILITIES

EFFLUENT FILTER FACILITY
BOTTOM PLAN

FIGURE 14-2



TOP PLAN

1/16"=1'-0"

FILTER PIPING DESIGNATIONS

A AIR
BW BACKWASH
BWD BACKWASH DRAIN
BWR BACKWASH RECLAIM
FI FILTER INFLUENT
FTD FILTER TO DRAIN
FTE FILTER EFFLUENT
SCE SECONDARY CLARIFIER EFFLUENT

CDM / HAZEN AND SAWYER

WESTERN WAKE REGIONAL
WASTEWATER MANAGEMENT FACILITIES

EFFLUENT FILTER FACILITY
TOP PLAN