III.2.7.4 Step Feed Alternative - Additional Facilities

In the event that the FPWWTF is unable to meet the 5 mg/L seasonal permit limit on an average monthly basis after implementation and operation of the step feed alternative within the existing tank volume a denitrification filter system may need to be added in order to consistently achieve biological nitrogen removal to the 5 mg/L TN level. An option is the addition of a denitrification filter system which would consist of a set of biological filters arranged in parallel that would biologically and physically remove residual nitrogen. The system would be located in a new filter building and would require an intermediate pumping station to lift the secondary clarifier effluent flow into the filters. The filters require constant ethanol feed for the process and modifications to the ethanol as well as the alkalinity feed systems would be required so that these chemicals could be fed to the post-denitrification filters. A layout of the proposed system is shown in Figure III.2.7.5-1. A summary of the additional facilities required to assure meeting the 5 mg/L limit with the step feed process is presented in Table III.2.7.5-1. These facilities would be in addition to the facilities required for the step feed alternative described in Table III.2.7.4-1.

The operational strategy for the overall treatment scheme would be to optimize nitrogen removal in the step-feed system to reduce the chemical feed requirements of the denitrification filter system. The denitrification filter complex would be constructed on the site of the City of Providence Public Works Garage because there is not sufficient space on NBC owned land at the Field's Point site. The garage and the land where the filter building would be constructed are owned by the City of Providence. In order to acquire this land, the NBC would have to construct a new garage for the City at some other location.

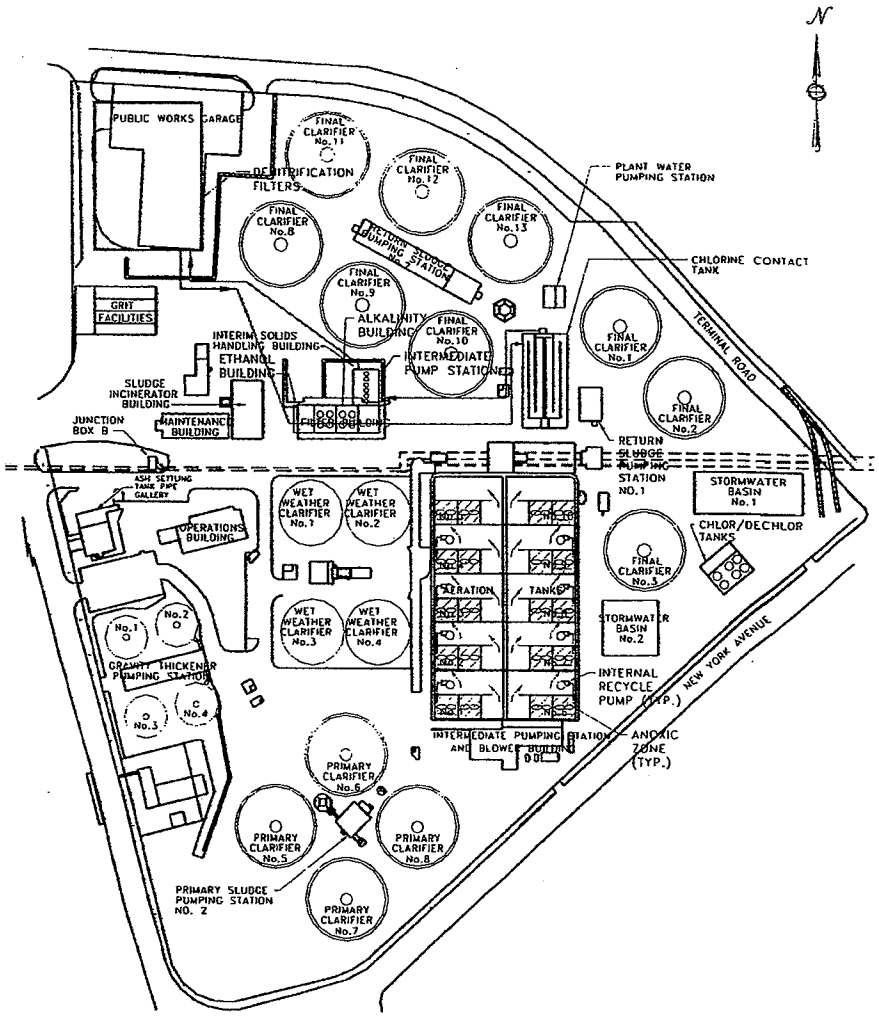

FIGURE III.2.7.5-1: STEP FEED ALTERNATIVE WITH DENITRIFICATION FILTERS

Table III.2.7.5-1: Design Summary Denitrification Filters added to the Step Feed Alternative

Item	Description
Denitrification Filter Complex	
Fluidized Bed Upflow Filters	
Number and Size	12 cells; 1600 sq. ft each
Hydraulic Capacity	77 mgd sustained 91 mgd peak flow
Hydraulic Loading Rate	3 gpm/sq. ft sustained 4 gpm/sq. ft peak
Intermediate Pump Station Capacity	120 mgd with recycle flow

III.2.7.5 IFAS Free-Floating Media Alternative

In this alternative, each of ten complete mix basins is retrofitted into a four-stage system. A layout of the proposed alternative is shown in Figure III.2.7.6-1. The system would be designed based on IFAS manufacturer's recommendations. The modeling results (Table III.2.8.1-1 page 57) predict that the proposed system can comply with the 5 mg/L monthly average TN during the months of May through October with the addition of a carbon source within the existing tank volume.

Modeling indicated that the addition of a supplemental carbon source would be required under certain conditions (flowrates, water temperatures, anoxic zone DO concentrations and nitrate recirculation rates) to maintain the desired level of nitrogen removal. Ethanol is recommended as the supplemental carbon source for the facility. Although methanol is typically less expensive than ethanol, denitrification using methanol requires larger anoxic reactor volumes. The methanol degrading bacteria require a minimum of three days solids retention time in the anoxic zones. This reduces the available aerobic volume, which impacts the reliability of the process to nitrify adequately in colder weather, when wastewater temperatures are less than 15 degrees C.

For this alternative, new facilities required include new fine screens, a new primary effluent pump station, modifications to the existing aeration basins, additional blowers, a new ethanol feed system, an alkalinity feed system and a nitrate recycle pump (NRCY) system. The fine screens would be added upstream

of the proposed primary effluent pumps. The aeration rates were calculated to provide a target DO level in the aeration tank that matched the Hydroxyl pilot study operating DO level.

The existing complete mix aeration basins would be converted to ten independent biological reactors (cells) with the ability to remove any one of the ten cells from service. Each of the cells would be divided into two parallel cells for accessibility. An anoxic zone would be constructed at the head end of each cell followed by an aerobic zone, an anoxic/aerobic swing zone, and would be followed by a re-aeration zone. Walls or screens would be constructed between zones for process control and to retain media. Primary effluent would be routed to the influent end of each cell through a submerged pipe or gate. A new primary effluent pump station would be retrofitted into the existing screw pump station to reduce the possibility of re-aeration of the primary effluent and to overcome head losses induced by zone separation walls, reactor influent flow controls

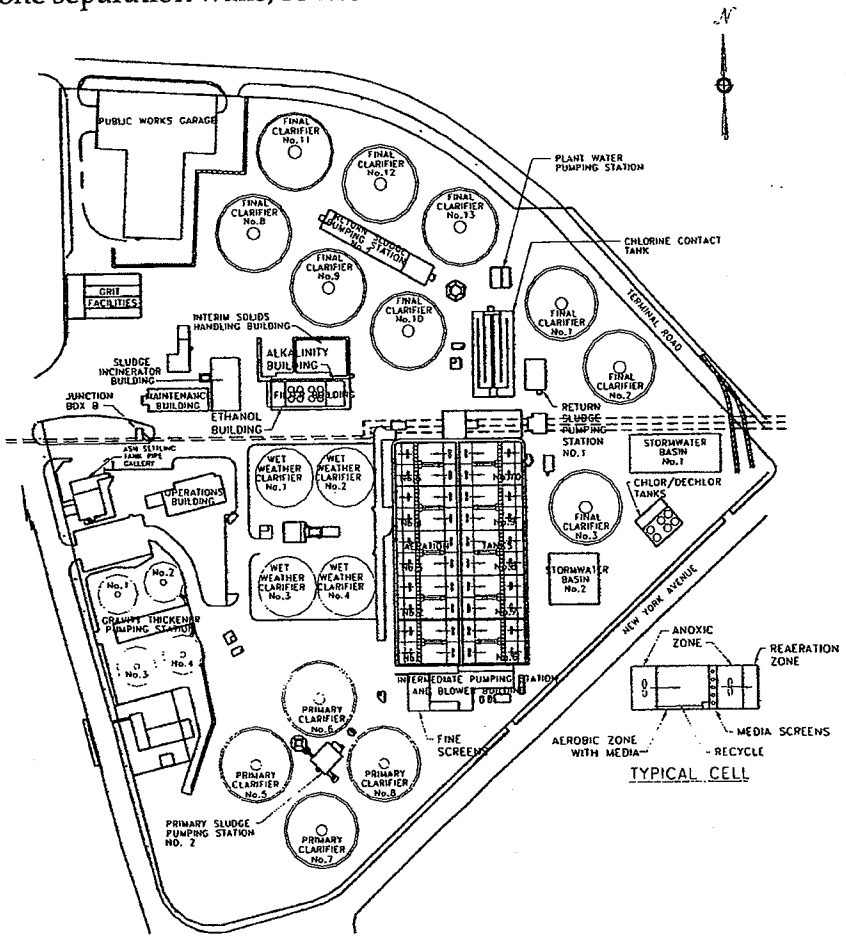

FIGURE III.2.7.6-1: IFAS FLOATING MEDIA PROCESS WITHIN EXISTING TANK VOLUME

and the media screens. Internal through-wall recirculation pumps would be installed within each basin to provide for additional nitrate recycle from the second anoxic zone to the pre-anoxic zone. The design parameters and new facilities required for the IFAS free-floating media alternative are summarized in Table III.2.7.6-1.

III.2.7.6 IFAS Free-Floating Media Alternative - Additional Facilities

In the event that the FPWWTF is unable to meet the 5 mg/L seasonal permit limit on an average monthly basis after implementation and operation of the IFAS Free Floating alternative within the existing tank volume a denitrification filter system may need to be added in order to consistently achieve biological nitrogen removal to the 5 mg/L TN level. An option is the addition of a denitrification filter system which would consist of a set of biological filters arranged in parallel that would biologically and physically remove residual nitrogen. The system would be located in a new filter building and would require an intermediate pumping station to lift the secondary clarifier effluent flow into the filters. The filters require constant ethanol feed for the process and modifications to the ethanol as well as the alkalinity feed systems would be required so that these chemicals could be fed to the post-denitrification process. A summary of the additional facilities required to assure meeting the 5 mg/L limit with the IFAS free-floating media process is presented in Table III.2.7.7-1. These facilities would be in addition to the facilities required for the IFAS free-floating media alternative described in Table III.2.7.6-1.

Table III.2.7.6-1: Design Summary IFAS Free-Floating Media Alternative Within Existing Tank Volume

Item	Description
Total Anoxic/Aerobic Volume	9.8 MG
Number of Basins	10 basins
Four Stage MLE	6 zones
Internal Recirculation Pumps	
Number	20
Size	12 mgd each
Recirculation rate	300 Percent of Raw Feed
Volume per Basin	980,000 gallons
1st Anoxic Zone (11 percent)	107,800 gallons
2nd Anoxic Zone (11 percent)	107,800 gallons
1st Aerobic (Swing) Zone	191,100 gallons
2 nd Aerobic (Swing) Zone	191,100 gallons
3rd Aerobic (Swing) Zone	191,100 gallons
4th Reaeration Zone	191,100 gallons
Total Volume of Air Required	40,000 scfm
Existing Total Blower Capacity	24,150 scfm
Existing Blower Ratings	1 @ 3000 scfm 2 @ 4525 scfm 2 @ 6050 scfm
Additional Facilities Required	
New Anoxic/Aerobic Volume	None
Free Floating Media Volume	388,500 cu. ft.
Fine Bubble Aeration Grids	20 @ 2 grids per tank
Additional Air	16,000 scfm
Blowers, including one standby	3 @ 8000 scfm
Fine screens	5 @ 20 mgd screens 6 mm aperture
PE Pump Station	77 mgd sustained flow 91 mgd peak instantaneous
Ethanol Building	
Storage	40,000 gal
Storage @ Avg. Flow & Dose	16 days
Storage @ Max Flow & Dose	7 days
Chemical Feed Pumps	
Number	3 pumps; chemical metering
Capacity	5- 90 gph
Alkalinity Building	
Storage	20,000 gal
Storage @ Avg. Flow & Dose	20 days
Storage @ Max Flow & Dose	10 days
Chemical Feed Pumps	
Number	3 pumps; chemical metering
Capacity	2- 30 gph

The operational strategy for the overall treatment scheme would be to optimize nitrogen removal in the IFAS process to reduce the chemical feed requirements of the denitrification filter system. The denitrification filter complex would be constructed on the site of the Public Works Garage and a new garage would have to be constructed for the City of Providence. Figure III.2.7.7-1 shows the proposed layout of the recommended facilities.

Table III.2.7.7-1: Design Summary Denitrification Filters With The IFAS Free-Floating Media Alternative

Item	Description
Denitrification Filter Complex	
Fluidized Bed Upflow Filters	
Number and Size	12 cells; 1600 sq. ft each
Hydraulic Capacity	77 mgd sustained 91 mgd peak flow
Hydraulic Loading rate	3 gpm/sq. ft sustained 4 gpm/sq. ft peak
Intermediate Pump Station	
Capacity	120 mgd with recycle flow

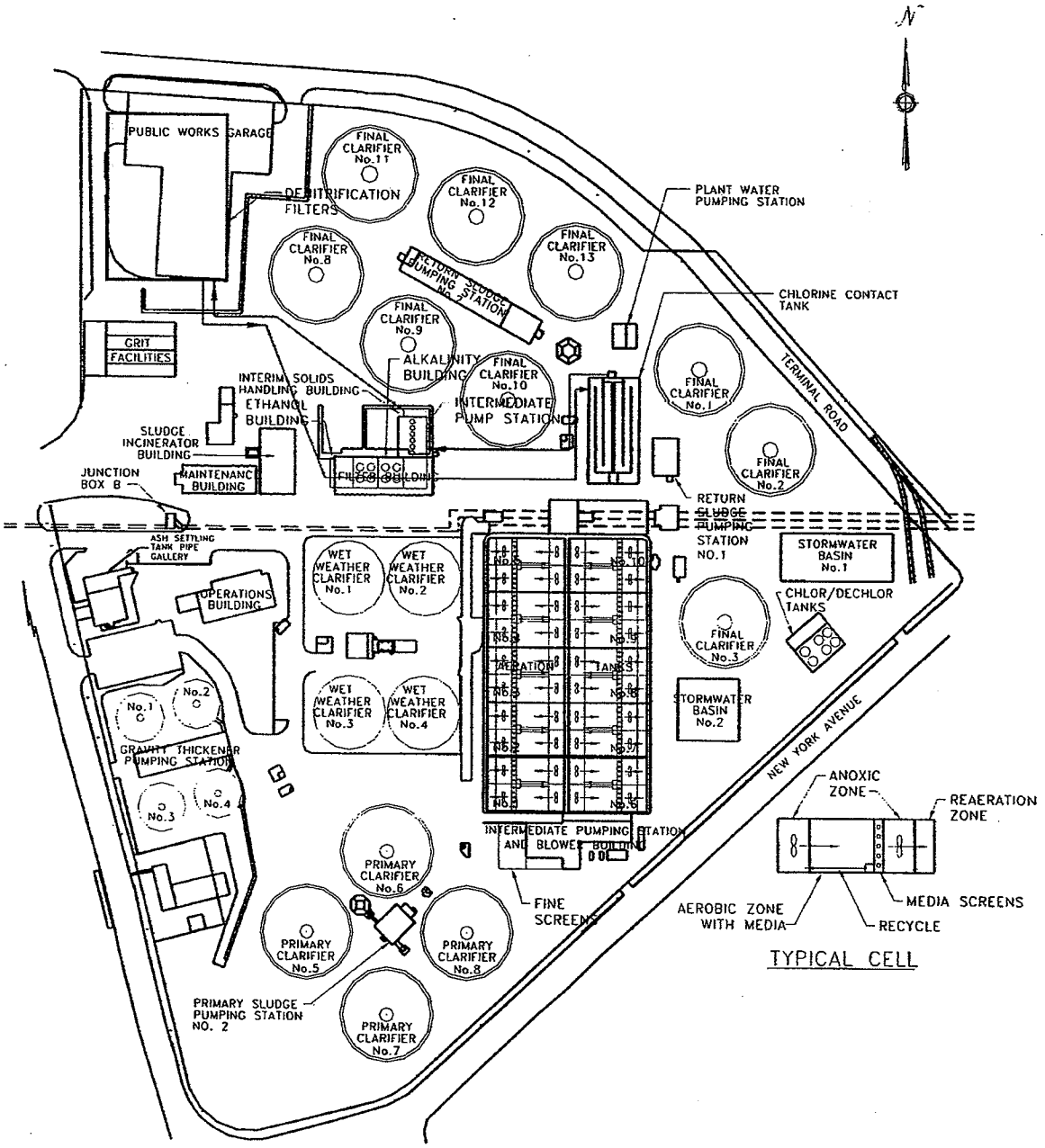

FIGURE III.2.7.7-1: IFAS FLOATING MEDIA PROCESS WITH DENITRIFICATION FILTERS

III.2.7.7 IFAS Fixed Media Alternative

In this alternative, an anoxic/aerobic treatment train is provided with ringlace-type media provided in the first aerobic zone of the treatment system to maximize use of the existing aeration tank volume. The ringlace media is a fixed media attached-growth system installed in the aeration basins to reduce the amount of new tank volume. A second anoxic/aerobic (swing) zone would be constructed following the aerobic zone with the media. A layout of the proposed alternative is shown in Figure III.2.7.8-1.

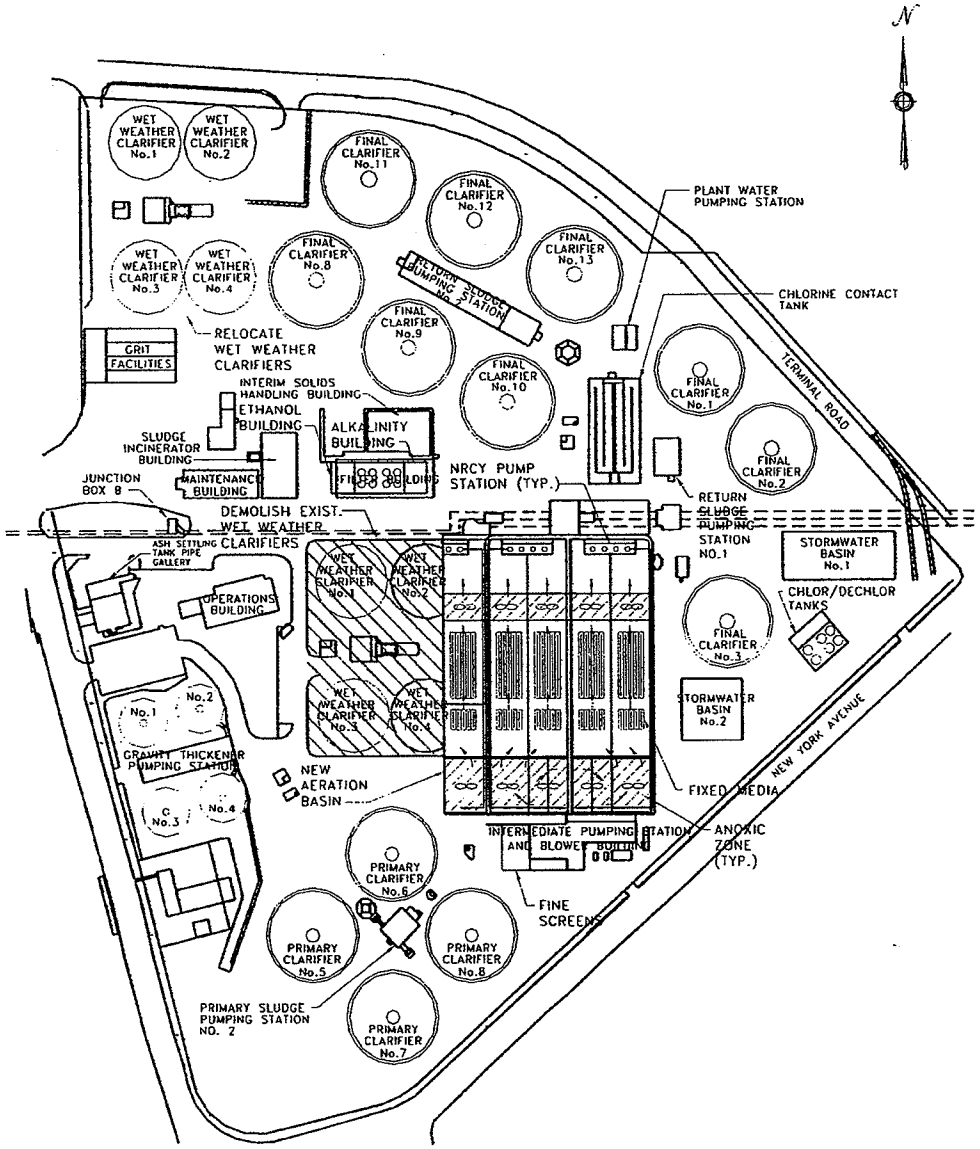

FIGURE III.2.7.8-1 IFAS FIXED MEDIA

New facilities required include 2.2 MG of additional aeration tankage, an alkalinity feed system, additional blowers, new wet weather clarifiers and a nitrate recycle pump system (NRCY). The air requirements are greater for this alternative than for the step feed alternative.

The existing wet weather clarifiers would require relocation in this alternative. It is assumed that the wet weather clarifiers would be constructed on the site of the Department of Public Works Building adjacent to the plant site. The existing complete mix basins would be converted to four parallel plug flow trains with a dual stage anoxic zone at the head end of each train. A fifth parallel plug flow train would be constructed at the location of the wet weather clarifiers. A new primary effluent pump station would be required to allow the proper flow split due to hydraulic losses across baffle walls and to avoid an entrainment in the anoxic zone influent. The design parameters and new facilities required for the IFAS fixed media alternative are summarized in Table III.2.7.8-1.

III.2.7.8 IFAS Fixed Media Alternative - Additional Facilities

In the event that the FPWWTF is unable to meet the 5 mg/L seasonal permit limit on an average monthly basis after implementation and operation of the IFAS fixed media alternative, additional facilities would have to be installed.

The system would be located in a new filter building and would require an intermediate pumping station to lift the secondary clarifier effluent flow into the filters. The filters require constant ethanol feed for the process and modifications to the ethanol storage and feed system would be required to increase system flexibility and reliability. Modifications to the alkalinity feed system would be required so that these chemicals could be fed to the post-denitrification filters. A summary of the additional facilities required to assure meeting the 5 mg/L limit with the IFAS fixed media process is presented in Table III.2.7.9-1. These facilities would be in addition to the facilities required for the IFAS fixed media alternative described in Table III.2.7.8-1.

The operational strategy for the overall treatment scheme would be to optimize nitrogen removal in the IFAS process to reduce the chemical feed requirements of the denitrification filter system. The denitrification filter complex would be constructed next to the aeration basins, at the former site of the wet weather clarifiers. Figure III.2.7.9-1 shows the proposed layout of the recommended facilities.