Table III.2.9-1: Alternatives Assessment Qualitative Comparison

Assessment Criteria	Rating by Alternative		
	Step Feed Alternative	IFAS Free Floating Media Alternative	IFAS Fixed Media Alternative
Ability to meet 5 mg/L TN Limit	4	5	3
Operational Flexibility	5	4	2
Operational Complexity	3	5	4
Ability to Retain Autotrophs	3	5	4
Reliability	4	4	2
Constructability	4	5	2
Total	23	28	17

Rating Scale:
5 - Excellent 4 - Very Good 3 - Good 2 - Fair 1 - Poor

A cost comparison was also completed as shown in Table III.2.9-2. The cost for the step feed process is significantly less than the IFAS floating media and fixed media alternatives. The difference in the costs between the step-feed and the IFAS floating media processes is mainly attributable to the cost of media, retaining screens, and aeration system differences. For the fixed media process, significant additional cost is associated with constructing the fifth treatment train and relocating the wet weather clarifiers.

The cost estimate for the IFAS process includes the construction contingency provided by Hydroxyl for a full-scale installation. Cost estimates from the media manufacturers vary and these costs will likely become more competitive based on the size of the FPWWTF.

Table III.2.9-2: Alternatives Assessment Cost Comparison

Assessment Criteria	Rating by Alternative		
	Step Feed Alternative	IFAS Free Floating Media Alternative	IFAS Fixed Media Alternative
Cost	5	4	1

Rating Scale:
5 - Excellent 4 - Very Good 3 - Good 2 - Fair 1 - Poor

III.2.10 Alternative Selection

III.2.10.1 General

Due to the high cost, the fixed media IFAS system was eliminated from further consideration. The remaining two processes, step feed and floating media IFAS were further evaluated as discussed in the following sections.

III.2.10.2 Operational Considerations

III.2.10.2.1 Start up in April

To begin producing an effluent that meets the 5 mg/L total nitrogen limit in May, the nitrification process must be started up in April. The advantages of the floating media system would manifest themselves during the start-up process. During the cold months, the nitrifiers (autotrophs) would remain on the media, although they would be either nearly dormant or growing very slowly. As the wastewater warms with the weather, the nitrifiers would become more active and would begin converting ammonia to nitrate.

Generally, in the step feed process, start-up of the nitrification process would be difficult because there may not be a significant population of nitrifiers in the aeration tanks if not maintained through the winter months. Since the nitrifiers normally grow slowly, developing an adequate nitrifier population could require several weeks.

III.2.10.2.2 Wastewater Variations

Because the NBC's wastewater collection system handles combined wastewater (wastewater plus stormwater) the characteristics of the wastewater entering the FPWWTF can vary considerably from day to day depending on the weather. The nitrifier growth rate is sensitive to these variations in wastewater characteristics.

The impact of CSO flows on nitrogen removal will create challenging conditions for nitrification in early spring. During dry weather, the wastewater at FPWWTF is typical of dilute sewage. The higher flows (77 mgd for sustained periods) will further dilute the wastewater strength, lower the temperature in the aeration tank and reduce the alkalinity. The higher flowrates may also wash-out the nitrifying bacteria (autotrophs) from the tank. This is a concern because the autotrophs are slow growing organisms and are difficult to replace once they are depleted. The lower wastewater temperatures are problematic because the nitrification rate is lower. The lower rate requires a larger volume in the aeration tank to convert the ammonia to nitrate. The reduced strength of the wastewater provides fewer microorganisms (food) and reduces the efficiency of the denitrification process.

In the floating media system, because the nitrifiers would be attached to the media, they would remain in the aeration tank even though their growth rate could be slowed by the lower temperature. Recovery of the nitrification process following an upset condition or storm would be easier. In contrast, a large portion of nitrifiers in the step feed process could be washed out of the aeration tank resulting in the necessity to encourage new growth and losing the nitrification process for an extended period.

III.2.10.3 Advantages and Disadvantages of Step Feed and IFAS-Floating

Table III.2.10.4-1 presents a summary of the advantages and disadvantages of the step feed process and Table III.2.10.4-2 presents the same for the floating media IFAS process.

Table III.2.10.4-1: Step Feed Process Advantages/Disadvantages

Advantages	Disadvantages
1. Well established and understood process - reliable operation	1. The existing aeration tank volume is borderline for providing adequate nitrification from May through October. All tanks would be required at all times.
2. Can be implemented within the existing aeration tanks.	2. Operation is more complex than the IFAS process because of flow split of primary effluent to several areas of the aeration tank and because of several anoxic zones and a mixed liquor solids gradient between the inlet and outlet of the tank.
3. Offers flexibility to meet varying influent conditions by providing flexibility in flow distribution to the anoxic zones.	3. An external carbon source (ethanol) is required during most of the May-October period to produce a reliable 5 mg/L N effluent.
4. Fine screening upstream of aeration tanks and associated handling of screenings is not required (fine screening required for the IFAS systems)	4. Solids loading to the final clarifiers would be higher with step feed than with IFAS. This could result in solids loss during high flow conditions.
5. Removal of foam and scum from the aeration tanks might be simpler because there are no media screens as are required with the floating media IFAS systems.	5. Construction would be more complex than the IFAS system because of work that would be required in the aeration tank influent and effluent channel.
6. Access to the air diffusers for maintenance is not impeded by media	6. The step feed process is prone to wash out of autotrophs under low temperature and/or low wastewater concentrations because of the autotrophs slow grow rate.

Table III.2.10.4-2: Floating Media IFAS Process Advantages/Disadvantages	
Advantages	**Disadvantages**
1. Can be implemented within the existing aeration tanks.	1. Higher risk of operational problems than step feed because of limited experience in the United States. Only a few installations and no installations as large as the FPWWTF.
2. Lower solids loading to final clarifiers than step feed process. This is advantageous during high flow periods to minimize solids loss during	2. Existing aeration tank volume is borderline for meeting the permit limit of 5 mg/L N from May through October. All tanks must be in operation at all times.
3. The BNR modeling results indicated that IFAS can outperform step feed in terms of meeting the 5 mg/L N effluent limit under various temperature conditions.	3. An external carbon source (ethanol) is required during most of the May-October period to produce a reliable 5 mg/L N effluent.
4. IFAS is simpler to operate than the step feed process because there is no solids gradient between the influent and the effluent ends of the aeration tanks.	4. Access to air diffusers in the bottom of a tank requires that the media be transferred out of the tank into another tank.
5. Aeration tank retrofitting would be less disruptive to plant operations because no work is required in the aeration tank influent or effluent channels.	5. Media screens are required in the aeration tanks to keep the media in the tanks. These screens are a cost item, require an air scouring system to keep them clean, and can be subject to fouling.
6. Autotrophs (nitrifiers) growing on media would more likely be maintained through winter increasing likelihood of nitrification in spring.	6. Fine screens are required upstream of the aeration tanks to remove stringy material and other solids that could foul the media screens. An associated screenings handling and disposal arrangement is also required.
7. Floating media IFAS systems are typically procured through vendors who specialize in these systems. The procurement process can include performance guarantees with penalties for insurance that the process will meet the 5mg/L N permit requirement.	

III.2.10.4 Alternative Selection

After careful review of the information collected for the step feed and the IFAS processes, the floating media IFAS process was selected as the recommended alternative. Although its present worth cost is approximately 19% higher than the step feed process, which is the lowest cost alternative, the floating media IFAS process' ability to retain nitrifiers under low temperature and other adverse conditions greatly outweighed its higher cost and other disadvantages. The step feed process was felt to be too susceptible to nitrifier washout and associated inadequate nitrogen removal. Modeling results also suggest that effluent nitrogen concentrations would be 0.5-1 mg/L less for the IFAS floating media than the step feed alternative.

IV IMPLEMENTATION OF RECOMMENDED ALTERNATIVE

IV.1 Design Data

Table IV.2-1 presents the data upon which the recommended BNR alternative would be designed. The monthly average and maximum BNR influent data were developed in Section III from historical primary effluent loadings.

The final effluent data are the RIPDES permit requirements for the final effluent discharged from the FPWWTF.

Table IV.1-1: BNR Design Data

Parameter	Monthly Average	Maximum	Peak Hourly
BNR Influent Flow (mgd)	50	77	91
BNR Influent BOD (lb/day)	40,500	53,000	–
BNR Influent TSS (lb/day)	24,900	40,000	–
BNR Influent NH3-N (lb/day) BNR Influent TKN (lb/day)	4,800 8,000	6,000 10,000	–
Final Effluent BOD*, mg/L lb/d	30 16,263	—	—
Final Effluent TSS*, mg/L lb/d	30 16,263	—	—
Final Effluent TN*, mg/L lb/d	5 2711	—	—

* RIPDES Permit limits

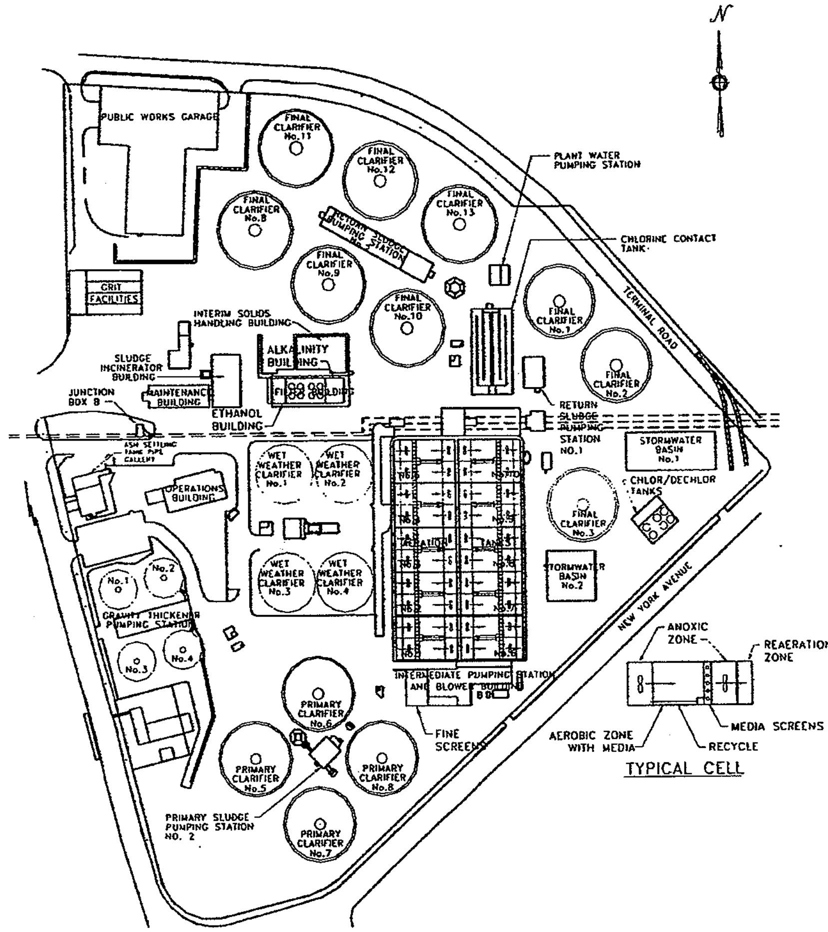

FIGURE IV.2-1: RECOMMENDED ALTERNATIVE -IFAS FLOATING MEDIA FOR 5 MG/L EFFLUENT TN

IV.2 Project Scope

IV.2.1 General

Implementing the floating media IFAS process will require several modifications to the existing aeration tanks and screw lift pumping station. Because there are several types of floating media IFAS systems available, and each one proprietary, the actual modifications to the aeration tanks and pumping station will not be known until a particular system is selected during the procurement phase of the project. However, the available systems will require several similar modifications as described below.

IV.2.2 Aeration Tank Modifications

All the floating media IFAS systems evaluated will require that the aeration tanks be converted to BNR reactors. This would be accomplished by compartmentalizing the tanks with new interior walls to create separate anoxic and aerobic zones. The number of compartments is specific to the particular proprietary system, but at least three compartments are required. Depending on the proprietary system, the compartments would consist of an anoxic zone followed by two aerobic zones, or an anoxic zone followed by one aerobic zone that would be followed by a second anoxic zone. In the latter arrangement, a fourth, small compartment might be required for re-aeration after the second anoxic zone.

The zones would be formed by installing concrete walls across the width of each existing aeration tank. The walls between the anoxic and aerobic zones would be combination weir and orifice walls. Flow would pass over the top of the walls as well as through a submerged opening. The walls at the downstream end of the aerobic zone would have media retention screens that would allow the liquid to pass but not the media. The vendor of the selected IFAS process would determine the volume and dimensions of each compartment and would configure the media screen walls.

The existing aeration tank inlet sluice gates would be replaced with a flow metering and control valve arrangement such that the primary effluent flow split to the BNR reactors could be positively controlled. The existing effluent weirs would be maintained as-is.

Other aeration tank modifications include installation of the following major items:

- Anoxic Zone Mixers
- Nitrate Recirculation Pumps to deliver nitrate rich mixed liquor from the downstream end of the aerobic zone to the upstream anoxic zone
- New aeration diffuser grids

Because the flow through the BNR reactors would pass through flow control valves and over weirs and through screens, more headloss would be induced through the reactors than currently occurs through the existing aeration tanks. At 77 mgd, with one BNR reactor out of service, this additional head loss would cause the water level at the existing screw pumps to be approximately 0.26 ft. higher than the elevation of the existing screw pump discharge lip. This condition, as discussed in the next section, requires that the screw pumps be replaced with higher lift pumps.

IV.2.3 Support System Modifications

IV.2.3.1 General

Existing systems that support the existing aeration process that will also be retained to support the new IFAS process are:

- aeration tank air supply system
- intermediate pumping system
- plant computer system
- return activated sludge system
- waste activated sludge system
- aeration tank dewatering system

Three new systems will be required to support the IFAS process. These include the following:

- new fine screening system
- BNR reactor influent flow control system
- chemical feed system (Ethanol and Alkalinity)

IV.2.3.2 Aeration Tank Air Supply System

Five existing centrifugal air blowers supply air to the existing aeration tanks. The blowers are rated as follows:

- Two units rated at 6050 scfm
- Two units rated at 4525 scfm
- One unit rated at 3000 scfm

The total aeration capacity, with all blowers operating is 24,150 scfm. The IFAS system will require a capacity of 40,000 scfm. Therefore, an additional 16,000 scfm will be required. This additional air can be provided by two additional 8,000 scfm centrifugal blowers. One extra 8,000 scfm blower would be provided as a standby, resulting in three additional blowers being provided. Because there is no space available in the existing blower building for additional blowers and associated electrical equipment, an additional area must be provided for housing the new blowers.

IV.2.3.3 Intermediate Pumping System

The existing intermediate pumping system lifts the primary effluent into the aeration tanks using screw lift pumps. There are four pumps: three rated at 37.5 mgd and one rated at 14 mgd. These pumps have a firm capacity of 91 mgd with one of the 37.5 mgd pumps serving as a standby unit. The highest elevation that the pumps can lift the primary effluent is the elevation of the screw pump lip (elevation 130.33). As discussed in the previous section, the head losses through the BNR reactors causes the water level at the screw pump lip to be approximately 0.26 ft. greater than 130.33, requiring that the screw pumps be replaced with higher head pumps.

Replacement pump alternatives include centrifugal pumps and propeller pumps. The type of pump will be determined during design of the BNR system.

Centrifugal or propeller pumps could be submersible type and be situated in the existing screw pump wet well. New discharge piping would be required to direct the pumped flow into the BNR reactor inlet channel. The pumps would be variable speed driven, and a location would be required to house the variable speed drive units, which would be in the 200-300 hp size range.

IV.2.3.4 New Fine Screening System

As discussed earlier, the IFAS system could require fine screens upstream the BNR reactor to remove stringy material and other solids that could clog the media retention screen in the aerobic zones. These screens would be located just upstream of the intermediate pumps. They would be a self-cleaning, in-channel type with a continuously moving screening belt. The screens can be provided with a screenings washing and dewatering system that reduces the putrescence and volume of the screenings for easier disposal.

IV.2.3.5 BNR Reactor Influent Flow Control System

Influent to each existing aeration tank flows through four 1-ft. square sluice gates. Flow distribution is passively controlled by the hydraulic arrangement of the aeration tank influent channel and the tank influent sluice gates. Under the recommended alternative, influent to the BNR reactors will be positively controlled with flow meters and flow control valves through a computerized flow divide system.