ARLINGTON COUNTY WATER POLLUTION CONTROL PLANT – MASTER PLAN 2001 UPDATE

TECHNICAL MEMORANDUM I – ALTERNATIVE WASTEWATER TREATMENT PROCESS CONFIGURATIONS

1 INTRODUCTION

The workshop on the Master Plan 2001 Update for the Arlington County Water Pollution Control Plant (WPCP) held on the 7th, 8th and 9th April 2001 identified a number of alternative wastewater treatment process configurations. A base case process configuration was developed incorporating:

- *Preliminary and primary treatment*
- *Secondary treatment*
- *Advanced tertiary treatment (AWT)*
- *Wet weather storm flow treatment*

The base case process configuration is referenced as Option 1.

A number of alternative process configurations were also developed for different parts of the wastewater treatment train:

- *Two (2) alternative options were developed for preliminary/primary/secondary treatment.*
- *Two (2) alternative options were developed for advanced tertiary treatment.*
- *Wet weather storm flow treatment options were integrated with the options for preliminary/primary/secondary treatment and with the options for Advanced Tertiary Treatment (AWT).*

It came to the attention of the Master Plan team that the LRTs structural condition has deteriorated to such an extent, that these structures will have to be demolished within 3 – 5 years. The LRTs can therefore not form part of any long-term treatment option, but will remain available in the interim.

This Technical Memorandum No. 1 summarizes the base case and alternative wastewater treatment options. As events developed through further study, additional options not outlined in this original Tech Memo were also examined. The results of these are incorporated into later tech memos. The sludge treatment and biosolids treatment and disposal are dealt with in a separate

Technical Memo. The Technical Memo 1 on the wastewater treatment options, however, recognizes and caters for the anticipated recycle streams from the sludge treatment processes.

An attempt was also made to prepare a preliminary flow balance for Average Dry Weather Flow (ADWF) and for Peak Wet Weather Flow (PWWF). The flow balance was refined as the different wastewater treatment options are developed in more detail.

2 WASTEWATER TREATMENT PROCESS OPTIONS

The wastewater treatment options for preliminary, primary and secondary (PPS) treatment are as follows:

- *PPS Option I – Base case with screening, grit removal, primary sedimentation and BNR activated sludge.*
- *PPS Option II – Screening, grit removal and BNR activated sludge of raw wastewater.*
- *PPS Option III – Screening, grit removal, primary sedimentation, BNR activated sludge and MBR activated sludge.*

The wastewater treatment options for Advanced Tertiary Treatment (AWT) are as follows:

- *AWT Option I – Base case with chemical clarification (LRTs), gravity and retrofitted carbon filters, chlorination and dechlorination.*
- *AWT Option II – Direct filtration on retrofitted mono-media gravity and carbon filters, chlorination and dechlorination.*
- *AWT Option III- Chemical clarification (LRTs), gravity and retrofitted carbon filters of the BNR secondary effluent, with combined BNR and MBR secondary effluent chlorination/de-chlorination.*

The wet weather stormwater base case treatment options incorporate:

- *Storm flow screening and grit removal*
- *Flow equalization*
- *High rate chemical treatment*
- *Filtration*
- *Chlorination/dechlorination*

3 PRELIMINARY/PRIMARY/SECONDARY TREATMENT OPTIONS

3.1 PPS Option I – Base Case

The PPS Option I – Base Case is shown in **Figure 3.1**.

The influent wastewater enters the plant via the Four Mile Run and Potomac Interceptors. The influent wastewater flow combines with several recycle streams including the DAF thickener Underflow, Gravity Thickener Overflow and Centrate/filtrate. The different process recycle streams could be routed to a number of different entry points in the process train. Future facility planning and design work must provide adequate flexibility in this regard. For the purposes of the Master Plan 2001 Update, it was assumed that process recycle streams would return to the Preliminary Treatment process.

The preliminary treatment includes screening, grit/detritus removal and flow splitting to the primary clarifiers.

Primary treatment involves sedimentation with the facility for ferric chloride addition to enhance the primary treatment efficiency. The primary sludge is pumped to

Gravity Thickeners. The primary scum is pumped from the primary clarifiers to the preliminary treatment building for scum concentration and disposal.

The secondary treatment is based on a further expansion of the existing BNR activated sludge process. The existing four (4) step-feed Aeration Tanks (with anoxic/anaerobic compartments) will be expanded by the construction of one or two further Aeration Tanks. The existing six (6) secondary clarifiers will be expanded by the construction of two (2) or three (3) larger secondary clarifiers. The secondary effluent is pumped via the ASE pump station to AWT. The waste activated sludge is pumped to the DAF Thickeners (base case for sludge treatment). The existing Aeration Tanks and secondary clarifiers will require a new mixed liquor collection channel and proper flow distribution to the secondary clarifiers.

The flow balance for the PPS Option I is determined by the following considerations:

- *The ADWF to the preliminary, primary and secondary treatment process is based on 40 mgd plus recycle flows.*
- *The PWWF to the preliminary and primary treatment process is restricted to 88 mgd plus recycle streams.*
- *Wet weather storm flows in excess of 88 mgd are restricted and diverted around the preliminary and primary treatment processes.*
- *The PWWF to secondary treatment is restricted to 75 mgd due to the ammonia breakthrough and solids separation constraints of the secondary clarifiers.*

- *A further 13 mgd of primary effluent is, therefore, diverted during peak wet weather flow conditions around secondary treatment.*

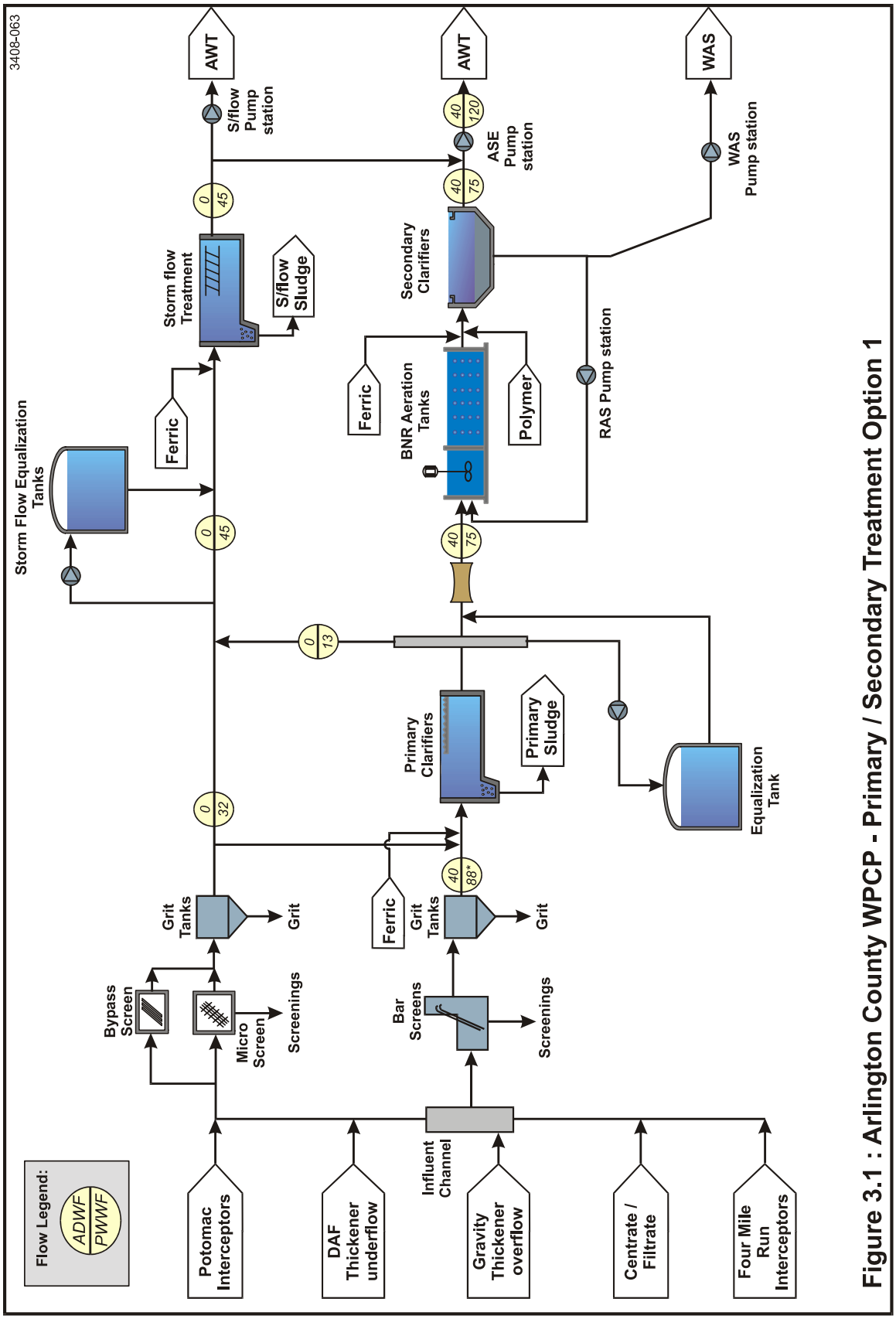

Figure 3.1 : Arlington County WPCP - Primary / Secondary Treatment Option 1

3.2 PPS Option II – BNR Activated Sludge of Raw Wastewater

The PPS Option II incorporates BNR Activated Sludge Treatment of Raw Wastewater as reflected in **Figure 3.2**.

The influent wastewater enters the plant via the Four Mile Run and the Potomac Interceptors. The influent flow combines with several recycle streams including DAF Thickener Underflow and Centrate/Filtrate.

The preliminary treatment includes screening, grit/detritus removal and flow splitting to the primary clarifiers.

No primary treatment processes such as sedimentation are included in the PPS Option II. The raw wastewater is directly treated in the secondary treatment process.

The secondary treatment process is split into a North-side new BNR Activated Sludge process and a South-side expanded BNR Activated Sludge process. The North-side BNR Activated Sludge process will require retrofitting of the existing primary clarifiers into new BNR-type Aeration Tanks. New secondary clarifiers will have to be constructed on the North-side. The South-side BNR Activated Sludge process will be expanded by the construction of a fifth Aeration Tank and two (2) additional secondary clarifiers. Waste Activated Sludge from the North-side and South-side BNR process are pumped to DAF Thickening. The existing Aeration Tanks and secondary clarifiers will require a new mixed liquor collection channel and proper flow distribution to the secondary clarifiers.

The flow balance for the PPS Option II is determined by the following considerations:

- *The ADWF to the preliminary and secondary is based on 40 mgd plus recycle streams.*
- *The ADWF split between the North-side and the South-side BNR is based on the following approximate ratio:*
    - *North-side BNR Activated Sludge = 18 mgd*
    - *South-side BNR Activated Sludge = 22 mgd*
- *The PWWF to preliminary treatment processes is hydraulically restricted to 88 mgd plus recycle streams.*
- *The wet weather storm flow in excess of 88 mgd is diverted around the preliminary treatment process.*
- *A further 13 mgd of raw wastewater is diverted after preliminary treatment during peak wet weather flow conditions.*

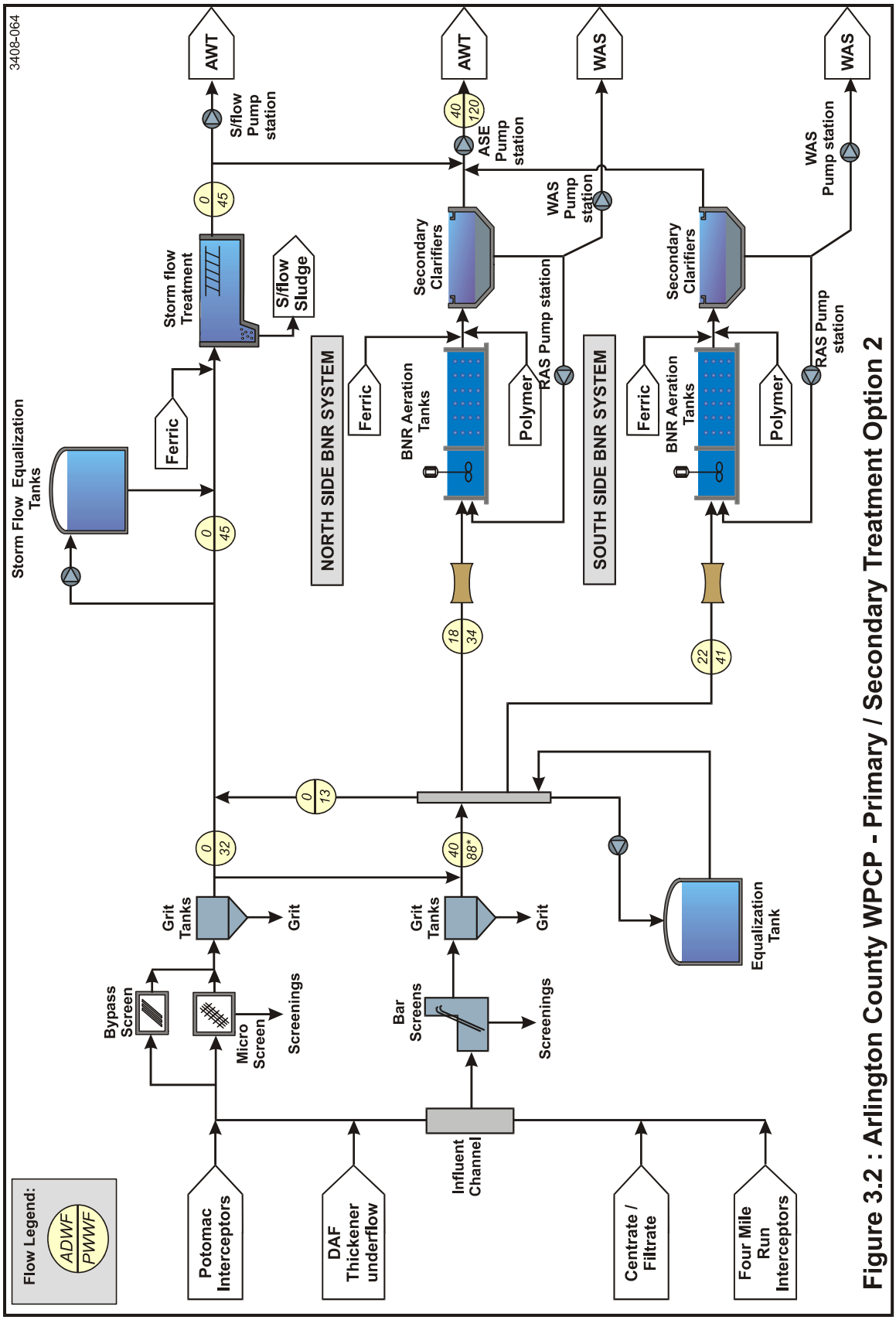

Figure 3.2 : Arlington County WPCP - Primary / Secondary Treatment Option 2

- *The combined PWWF to North-side and South-side secondary treatment is restricted to 75 mgd due to the ammonia breakthrough and solids separation constraints of the secondary clarifiers.*

3.3 PPS Option III – BNR Activated Sludge and MBR Activated Sludge

The PPS Option II incorporates BNR Activated Sludge and MBR Activated Sludge as shown schematically in **Figure 3.3**.

The influent wastewater enters the plant via the Four Mile Run and the Potomac Interceptors. The influent flow combines with several recycle streams including Gravity Thickener Overflow, DAF Thickener Underflow and Centrate/Filtrate.

The preliminary treatment includes screening, grit/detritus removal and flow splitting to the primary clarifiers.

Primary treatment involves sedimentation with the facility for ferric chloride addition to enhance the primary treatment efficiency. The primary sludge is pumped to Gravity Thickeners (base case for sludge handling). The primary scum is pumped from the primary clarifiers to the preliminary treatment building for scum concentration and disposal.

The secondary treatment is based on split treatment of the primary effluent in BNR Activated Sludge and MBR Activated Sludge processes. The BNR Activated Sludge process will be based on the four (4) existing BNR Aeration Tanks and six (6) existing secondary clarifiers. The existing Aeration Tanks and secondary clarifiers will require a new mix liquor collection channel and proper flow distribution to the secondary clarifiers. The new fifth (5) Aeration Tank will be constructed as MBR reactor, which incorporates a hollow fiber UF membrane system.

The secondary effluent from the BNR Activated Sludge process plus some diverted peak storm flow will be transferred via the existing ASE pump station to AWT. The secondary effluent from the new MBR process will require a new pump station to the AWT process.

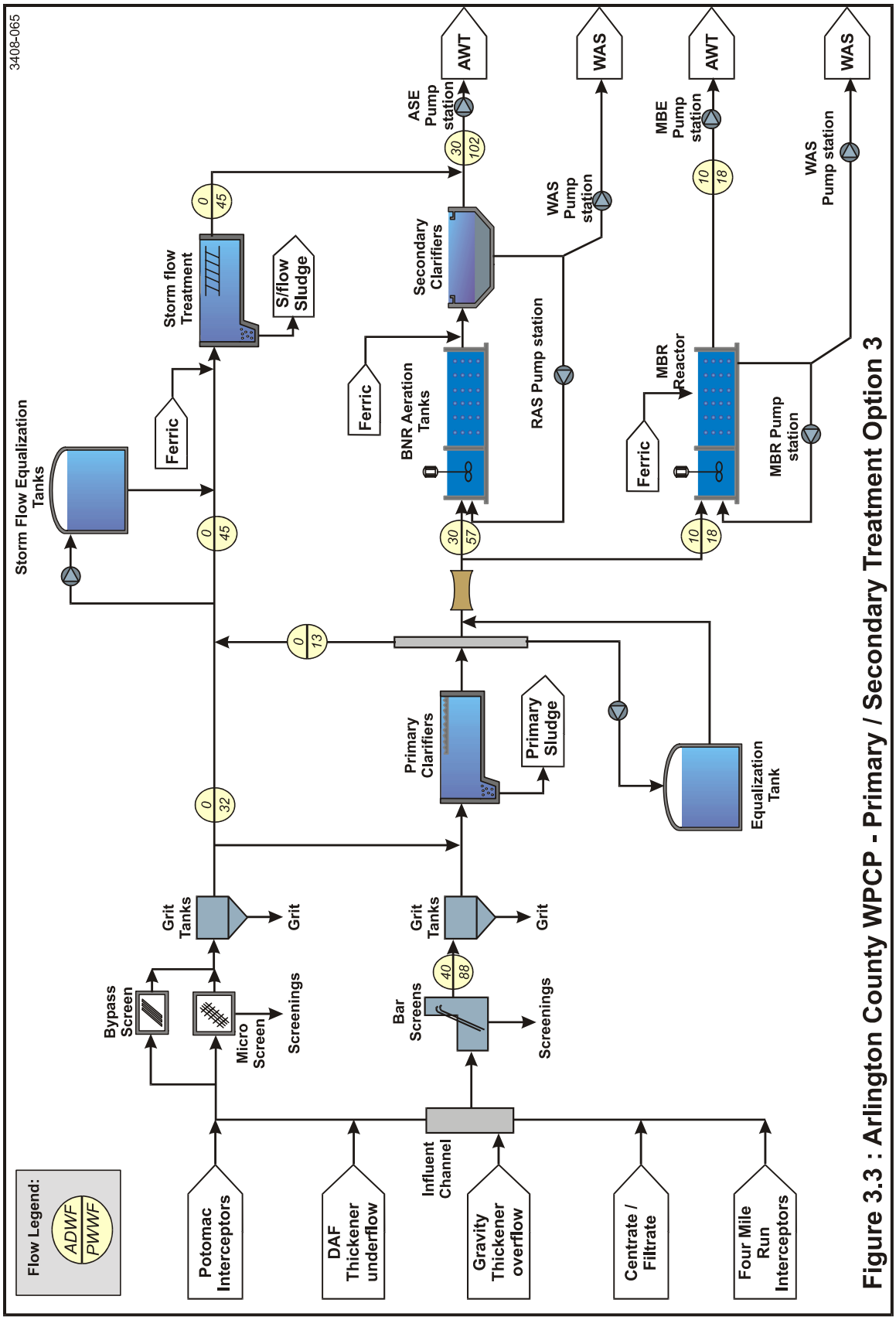

Figure 3.3 : Arlington County WPCP - Primary / Secondary Treatment Option 3

The flow balance for the PPS Option III is determined by the following considerations:

- *The ADWF to the preliminary, primary and secondary treatment process is based on 40 mgd plus recycle flows.*
- *The ADWF of primary effluent is split between the BNR Activated Sludge (30 mgd) and MBR Activated Sludge (10 mgd).*
- *The PWWF to the preliminary and primary treatment process is hydraulically restricted to 88 mgd plus recycle streams.*
- *The wet weather storm flow in excess of 88 mgd restriction is diverted around the preliminary and primary treatment process.*
- *A further 13 mgd of primary effluent is diverted around secondary treatment during peak wet weather flow conditions.*
- *The PWWF to secondary treatment is restricted to 75 mgd due to the consideration of ammonia breakthrough and solids separation constraints of the secondary clarifiers and the MBR process.*

4 ADVANCED TERTIARY TREATMENT OPTIONS

4.1 AWT Option I - Base Case

The process configuration of AWT Option I, reflecting the Base Case is shown in **Figure 4.1**.

The secondary effluent receives ferric addition for phosphate removal and chemical clarification in the LRTs. The first stage LRTs are demolished to make space for the additional aeration tankage. The second stage LRTs are expanded by the construction of a fourth (4) tank. It is noted that due to the poor structural condition of the LRTs that these structures may only be available for the next 3-5 years. The chemical sludge is pumped to the solids handling facility.

The LRT effluent is filtered through the existing gravity filters and the retrofitted carbon filters. The existing gravity filter dual media sand/anthracite and the retrofitted carbon filter media are retained. The gravity and carbon filters operate in parallel. Filter backwash water is withdrawn from the Clear Water Tank, downstream of the gravity filters. The backwater is returned to a dedicated treatment facility or to the Preliminary Treatment Facility.

The gravity-filtered water is pumped to the chlorination/dechlorination facility. The carbon-filtered water gravitates to the chlorination/dechlorination facility.

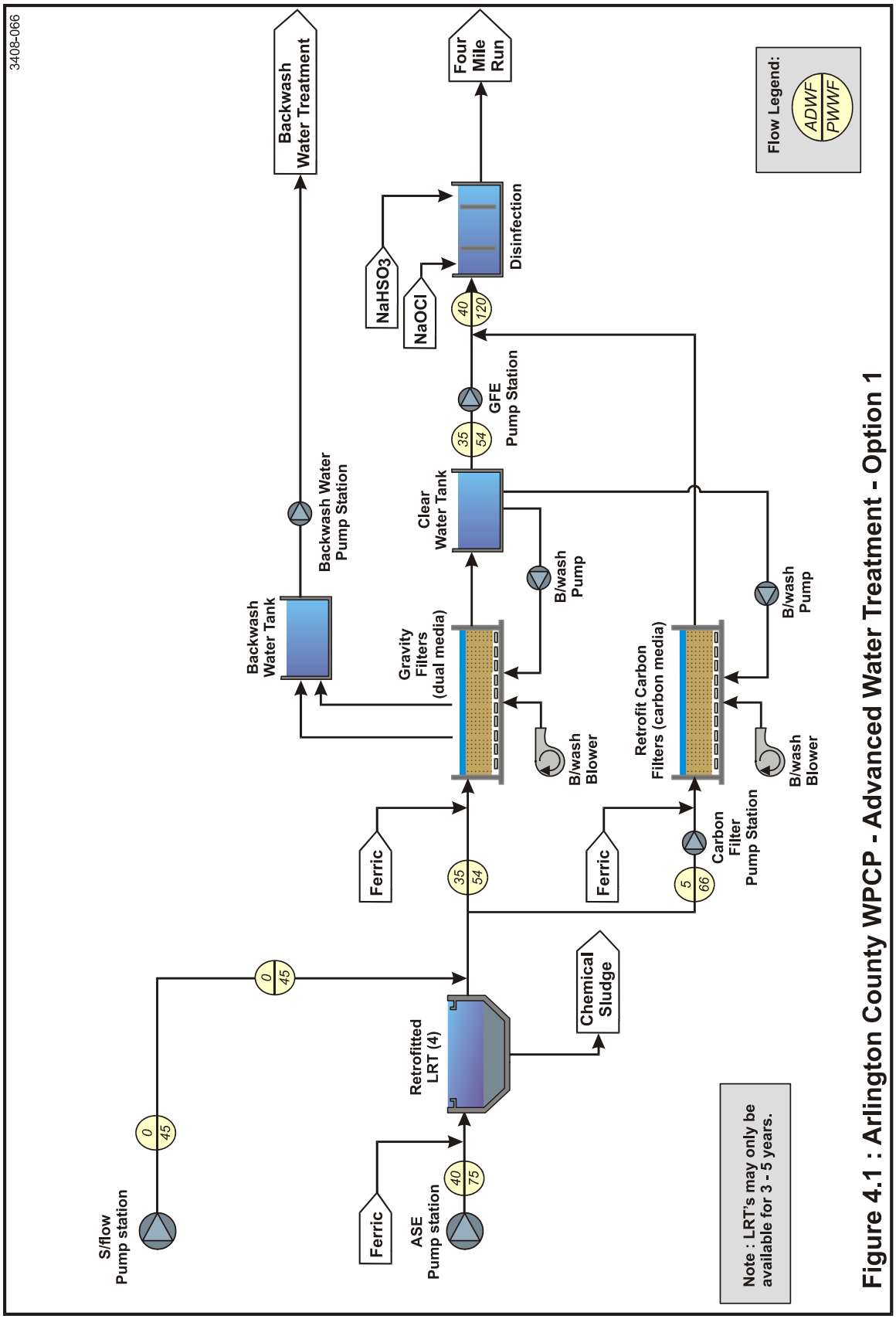

Figure 4.1 : Arlington County WPCP - Advanced Water Treatment - Option 1

The existing chlorination/dechlorination disinfection and treated effluent discharge to the Four Mile Run are expanded to also cater for wet weather storm flows. The existing sodium hypochlorite and the sodium bisulfite storage and dosing facilities are expanding to also cater for wet weather storm flows.

The flow balance for AWT Option I is determined by the following considerations:

- *The ADWF through AWT is based on 40 mgd. The ADWF is split between the gravity filters and the carbon filters. Due to the cost of pumping to the carbon filters, dry weather flow to the carbon filters is minimized.*
- *The pretreated diverted storm flow is also filtered. This places an additional hydraulic load on the carbon filters during wet weather storm flow conditions.*
- *The total peak wet weather flow will require chlorination/dechlorination before discharge to the Four Mile Run.*

4.2 AWT Option II – Direct filtration and sidestream wet weather storm flow treatment in LRTs

The AWT Option II involves direct filtration and sidestream wet weather treatment in LRTs as shown in **Figure 4.2**. It is again noted that the LRTs may only be available for the next 3 – 5 years.

The secondary effluent receives ferric addition for phosphate removal and direct filtration. The existing gravity filter media and retrofitted carbon media are replaced by a mono-media sand filtration media. The ADWF will typically be treated in the mono-media gravity filters to save on pumping costs to the carbon filters.

The ferric storage/dosing facility will require some upgrading and proper mixing upstream of the filtration facility.

The backwash water is abstracted from the Clear Water Tank, downstream of the mono-media gravity filters. The backwash water is returned to the Preliminary/Primary Treatment by pumping to the Four Mile Run Interceptor or to a dedicated treatment facility.

The filtered water will be disinfected by the existing chlorination/dechlorination facility and discharged to the Four Mile Run.

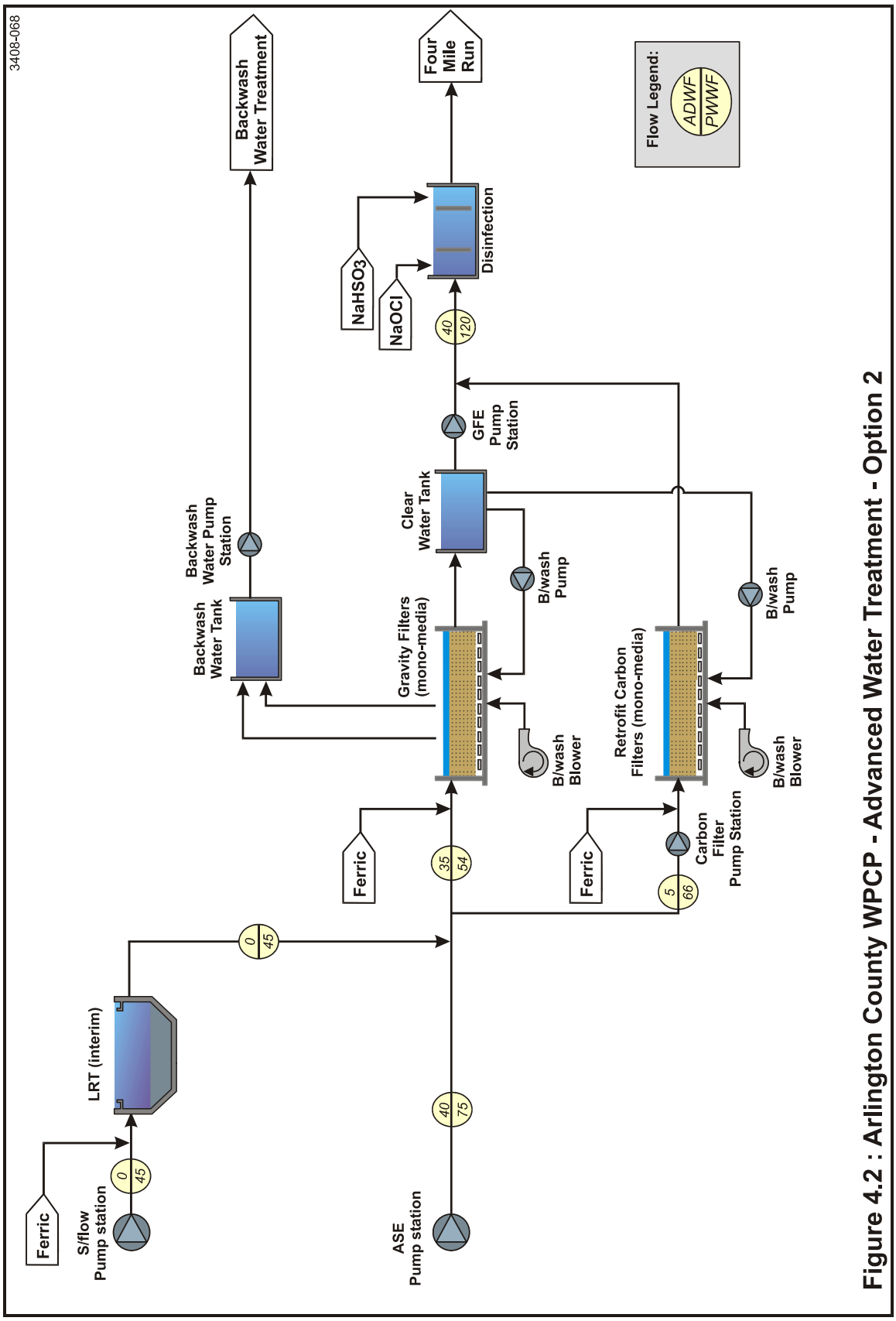

Figure 4.2 : Arlington County WPCP - Advanced Water Treatment - Option 2

The first stage LRTs will be demolished to make space for the additional Aeration Tankage. The wet weather storm flow, which is diverted around the primary and secondary treatment, will receive chemical treatment in the retrofitted second stage LRTs. The existing secondary LRTs will be retrofitted and upgraded. The existing second stage LRTs will be expanded with the addition of a fourth (4) tank. The LRTs may, however, only be available for the next 3 – 5 years due to the poor structural condition.

The ferric storage/dosing and mixing facility will be upgraded and expanded to deal with the additional solids load associated with the diverted storm flow.

The existing chlorination/dechlorination facility will have to be expanded to deal with the additional flow during wet weather conditions.

4.3 AWT Option III – Parallel treatment of ASE and MBR streams

The AWT Option III based on parallel and separate treatment of the ASE and MBR streams is shown schematically in **Figure 4.3**.

The ASE and diverted wet weather storm flow are chemically treated in the retrofitted second stage LRTs. The chemical treatment involves ferric dosing and clarification in the second stage LRTs. The first stage LRTs will be demolished to make space for the additional aeration tankage. The second stage LRTs will have to be expanded by the construction of a fourth tank. The chemical sludge is pumped to the solids handling facility. The LRT tanks, however, have a limited remaining life (3 – 5 years) due to the poor structural condition.

The chemically treated ASE and diverted wet weather storm flow are filtered by the existing gravity filters and the retrofitted carbon filters. The existing gravity sand/anthracite media and the existing carbon filter media will be retained. However, allowance is made for ferric addition, upstream of the filters. The filter backwash water for both the gravity filters and the carbon filters is abstracted from the Clear Water Tank, downstream of the gravity filters. The filter backwash water is returned to Preliminary Treatment via the Four Mile Run Interceptor or to a dedicated treatment facility.

The gravity-filtered water is pumped to the disinfection facility, while the carbon filtered water gravitates to the disinfection facility.

The combined chemically treated and filtered ASE and the MBR are disinfected in the chlorination/dechlorination facility. The existing chlorination/dechlorination facility and the discharge to the Four Mile Run will have to be expanded to deal with the PWWF.

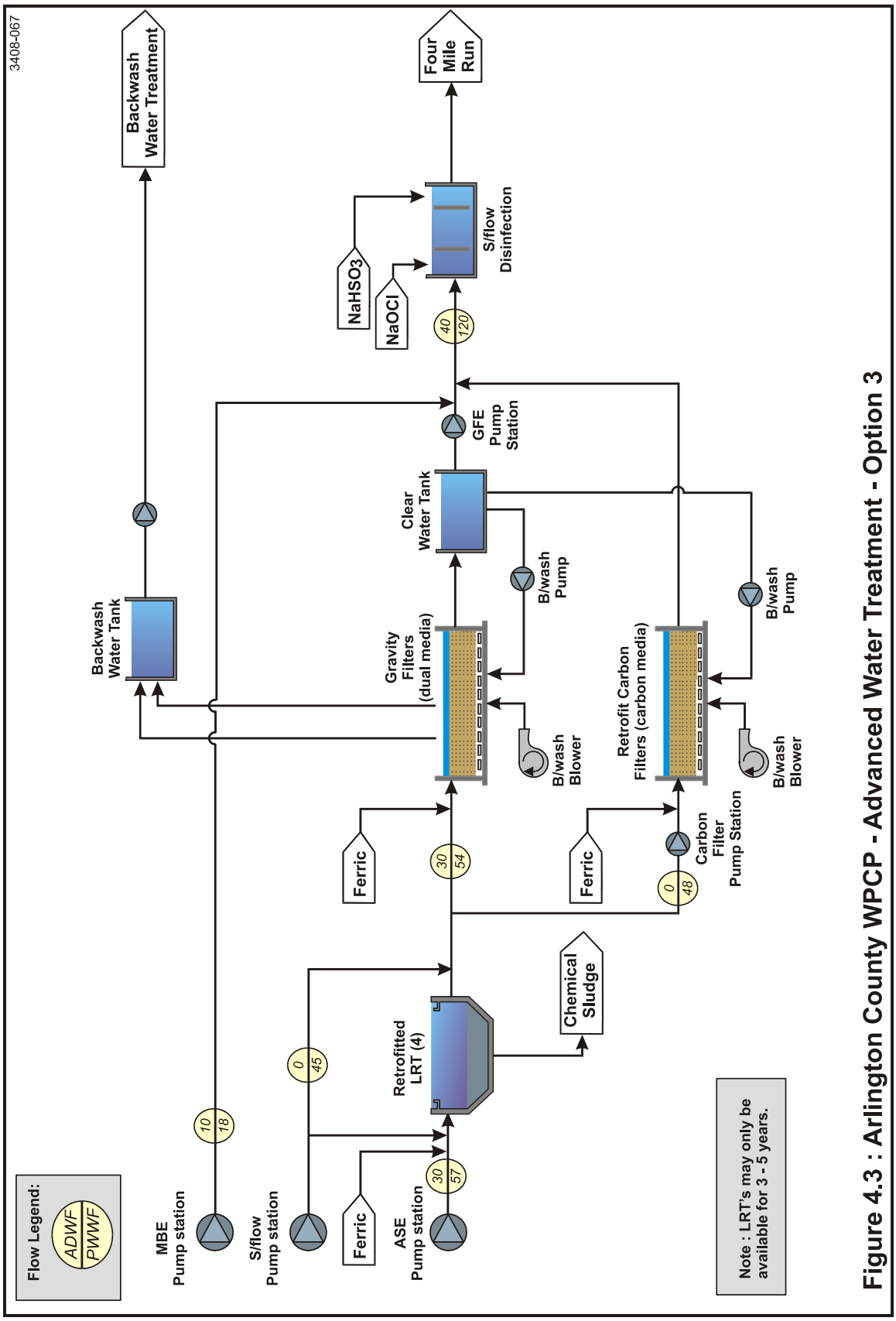

Figure 4.3 : Arlington County WPCP - Advanced Water Treatment - Option 3

5 WET WEATHER STORM FLOW TREATMENT

Some wet weather storm flow may have to be diverted around preliminary, primary and secondary treatment. A base case for treatment and handling of the diverted storm flow was developed.

The raw wastewater diverted around preliminary/primary treatment will require screening and grit removal. The screening must incorporate micro-screening of the diverted storm flow with a further allowance for sidestream bar screening, if all micro screens are not available. Grit/detritus removal is also incorporated into the diverted storm flow.

Peak diverted storm flows will be equalized in a sidestream facility. The objective of the storm flow equalization is risk reduction in not being able to further treat the storm flow in the downstream AWT treatment processes.

The diverted storm flow may be chemically treated to remove BOD, TSS and phosphorus. The treatment may be in a high rate, chemically assisted process. Chemical sludge will be pumped back to the preliminary/primary treatment.

The equalised and potentially pre-treated storm flow will be combined with the secondary effluent. The combined secondary effluent and pre-treated stormwater will receive additional polishing treatment in AWT, before combined discharge to the Four Mile Run.

The practical implementation of the diverted storm flow handling and treatment will also have to be integrated with the preliminary/primary/secondary (PPS) treatment options and the AWT treatment options – refer to the previous section of Technical Memo I. It should be recorded that the regulatory pressure is mounting to eliminate any plant bypasses (which will discharge partially treated wastewater) and to eliminate any internal plant flow diversion, which may result in a discharge not meeting the permit limits.

6 CONCLUDING COMMENTS

The different preliminary, primary, secondary and advanced wastewater treatment processes will be evaluated in term of:

- *Reliable achievement of permit discharge quality*
- *Practical implementation*
- *Ease of operation*
- *Capital investment needs*

- *Operating and maintenance costs*

This will form the basis for selecting the best wastewater treatment option for the Master Plan 2001 Update.

EDITOR'S NOTE: As events developed, additional options beyond those mentioned above were studied. See TM IV, V, VI, and VII. The final liquid treatment options are outlined in TM VIII.