DESIGN MEMORANDUM

Dalecarlia Water Treatment Plant and Georgetown Reservoir Residuals Collection and Treatment

U.S. Army Corps of Engineers
Baltimore District
Washington Aqueduct Division

DESIGN MEMORANDUM - REPORT

BOOK 1 OF 5

WR&A
Whitman, Requardt and Associates

DESIGN MEMORANDUM

FINAL

NOVEMBER 1996

Dalecarlia Water Treatment Plant and Georgetown Reservoir Residuals Collection and Treatment

ENGINEERING ESTIMATE (35% DESIGN)

BOOK 1 of 5

WR&A
Whitman, Requardt and Associates

DESIGN MEMORANDUM
RESIDUALS COLLECTION and TREATMENT

DALECARLIA WATER TREATMENT PLANT
AND GEORGETOWN RESERVOIR

ACKNOWLEDGMENTS

The completion of this design project involved pooling resources from several area and regional consultants. Whitman, Requardt and Associates teamed with the following consultants during the overall design effort leading up to and including this design memorandum. The following acknowledges each design team member and their primary function:

- **Whitman, Requardt and Associates, Baltimore MD**
  Lead Engineers, Project Management and Overall Design Coordination
- **Malcolm Pirnie Inc., Newport News VA**
  Consulting Engineers (process and pilot testing)
- **Victor Wilburn Architects, Washington DC**
  Architectural Design
- **Paul Spreiregen FAIA, Washington DC**
  Public Affairs and Conceptual Architectural Design

DESIGN MEMORANDUM
RESIDUALS COLLECTION and TREATMENT

DALECARLIA WATER TREATMENT PLANT
AND GEORGETOWN RESERVOIR

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This report is the written text that presents the design and describes the technical evaluations that were completed during the design.

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This volume contains the drawings corresponding to the written Report (Book 1 of 5).

BOOK 3 of 5 - GEOTECHNICAL INVESTIGATION REPORT

This report presents the subsurface investigations conducted at the four sites and related design evaluations.

BOOK 4 of 5 - ENGINEERING ESTIMATE (35% design)

This document presents the cost estimate for the proposed facilities.

BOOK 5 of 5 - DESIGN CALCULATIONS

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DESIGN MEMORANDUM

DALECARLIA WATER TREATMENT PLANT
AND GEORGETOWN RESERVOIR

RESIDUALS COLLECTION and TREATMENT

EXECUTIVE SUMMARY

Purpose and Scope

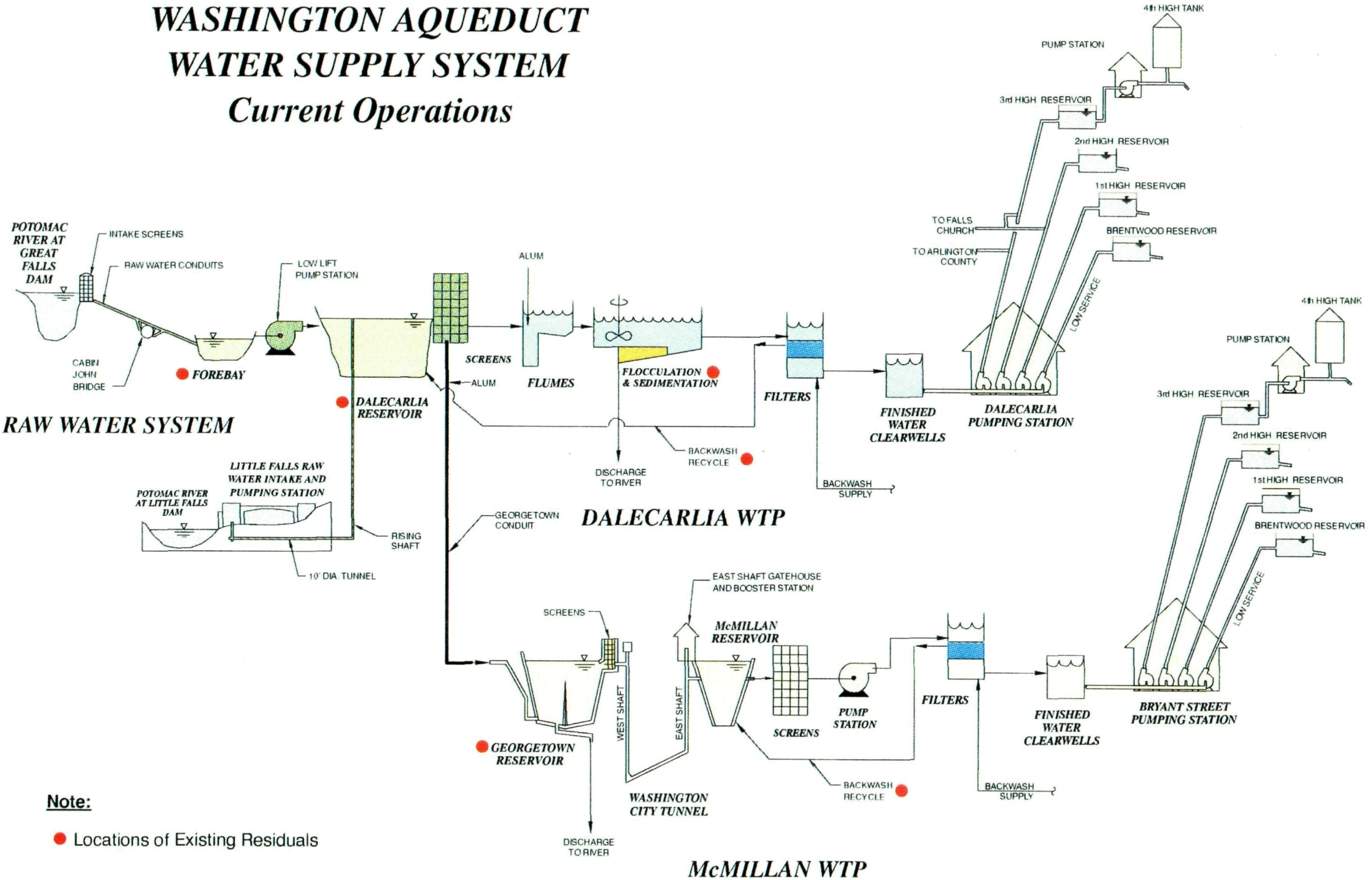
This Design Memorandum was conducted with the objective of presenting the most feasible design to collect, convey and dewater residuals generated as by-products from the water treatment operations of the Dalecarlia Water Treatment Plant, Georgetown Reservoir and the Dalecarlia Forebay. The facilities proposed in this Design Memorandum would enable the Washington Aqueduct Division (WAD) to comply with an anticipated mandate from the United States Environmental Protection Agency (USEPA) which involves the elimination of the current practice of routinely discharging of plant residuals to the Potomac River.

Background

The Washington Aqueduct Division (WAD) of the US Army Corps of Engineers, Baltimore District, owns and operates the drinking water supply system that serves the District of Columbia, Arlington County and the City of Falls Church. The major facilities include the Great Falls Intake, Little Falls Pumping Station, Dalecarlia Reservoir, Dalecarlia Water Treatment Plant, Georgetown Reservoir, McMillan Reservoir and McMillan Water Treatment Plant. A schematic of the existing operations of the Dalecarlia Water Treatment Plant is provided on Figure ES-1. The residuals (or solids) resulting from the water treatment system operation accumulate primarily in the sedimentation basins at the Dalecarlia Water Treatment Plant and the Georgetown Reservoir which serves as the sedimentation basins for the McMillan Water Treatment Plant. These residuals are periodically flushed to the Potomac River during periods of high river flow and turbidity, in accordance with provisions of a National Pollutant Discharge Elimination System (NPDES) permit granted to the

WASHINGTON AQUEDUCT WATER SUPPLY SYSTEM

Current Operations



Note:

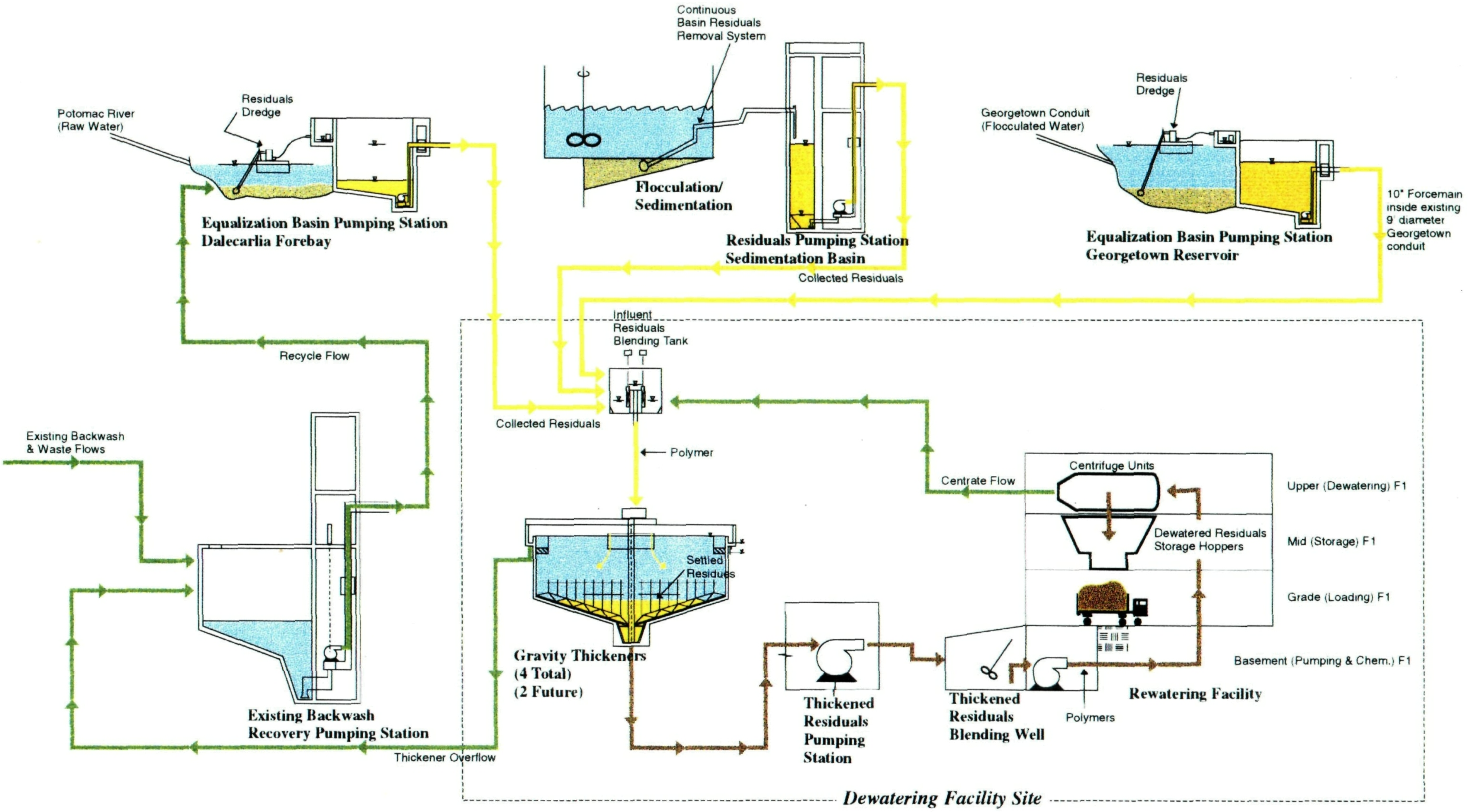
● Locations of Existing Residuals

Figure ES.1

WAD. USEPA, however, has advised WAD that a forthcoming NPDES permit renewal would prohibit further river discharging of residuals from the treatment facilities. A similar situation, relative to the revoking of discharge permit provisions, occurred during the late 1970's, prompting WAD to prepare plans and specifications for residuals collection and treatment facilities. Those plans were not implemented subsequent to WAD obtaining USEPA permission via a NPDES permit to continue the practice of discharging the plant residuals to the river under certain conditions of river flow and turbidity. WAD did, however, construct facilities which eliminated river discharging of filter backwash waste by recycling that flow to the Dalecarlia Reservoir.

Recent Developments

The Safe Drinking Water Act Amendments of 1996 (PL104-182), signed on August 6, 1996, grants consent for the District of Columbia, Arlington County, Virginia and the City of Falls Church, Virginia to establish a non-Federal public or private entity to operate, maintain and manage the Washington Aqueduct. The secretary of the Army is to submit, not later than one year from the above date of enactment, a plan for the transfer of ownership to this new entity. The actual transfer of all right, title and interest of the United States in the Washington Aqueduct to the new entity is to occur within three years from the above date. This act also includes provisions for reissuance of the previously referenced NPDES permit. Prior to reissuing a NPDES permit for the Washington Aqueduct, the Administrator of USEPA is to consult with the customers and the Secretary of the Army to consider concerns regarding the proposed residuals collection and treatment facilities. This may include a public hearing. In addition, this act provides authorization for the Army Corps of Engineers to borrow from the Treasury of the United States such amounts for fiscal years 1997, 1998 and 1999 as required in carrying out capital improvements during those fiscal years for the Washington Aqueduct to ensure continued operation until such time as a transfer of title has taken place. The amounts to be borrowed are not to exceed $29,000,000 for fiscal year 1997, $24,000,000 for fiscal year 1998, and $22,000,000 for fiscal year 1999. The Washington Aqueduct Division has advised that funds for the design and construction of the proposed residuals collection and treatment facilities have not been budgeted within the above noted capital borrowing capability through fiscal



Dalecarlia WTP and Georgetown Reservoir Residuals Collection and Treatment

Proposed Process Schematic

Figure ES.2

year 1999. Therefore, unless the above amounts are revised or upon other agreement, the design and construction of the proposed facilities will not commence until after fiscal year 1999. At that time, an entity other than the Army Corps of Engineers will be operating, maintaining and managing the facilities now under control of the Washington Aqueduct Division.

The intent of this study was to evaluate the engineering and economic aspects of a range of feasible solutions and some which, while technically feasible, may require political and legislative actions beyond the capability of Washington Aqueduct to influence. The alternative chosen for study gives the best analysis of an option that processes solids at the Dalecarlia site and removes them over land with trucks. While this alternative will meet the NPDES permit limitations, no final decision on a construction alternative can be made until an Environmental Assessment under the provisions of the National Environmental Protection Act has been performed.

Proposed Facilities

Alternatives for collection and treatment of the plant residuals were evaluated and presented in a series of technical memoranda throughout the course of this project. The evaluation included pilot studies, bench-scale studies, field testing, design research and analysis, as well as field visits to similar facilities.

The proposed facilities presented in this Design Memorandum were determined to be the most feasible of the alternatives evaluated. The proposed process schematic for residuals collection and treatment operations is presented on Figure ES-2. The following listing summarizes the proposed residuals collection and treatment facilities, existing facility upgrades and operations to accomplish the project objectives:

- Continuous collection of settled alum residuals from the four sedimentation basins at the Dalecarlia Water Treatment Plant utilizing a suction header residuals collection system. A residuals pumping station would be provided at the sedimentation basin site to convey the residuals collected from the basins to the dewatering facility site.

- Dredging of settled accumulation of alum residuals from Georgetown Reservoir No. 1 and No. 2 over a 4-½ month period each year. The dredged residuals would be conveyed to an on-site equalization basin during each daily dredging period (7 hrs/day). Submersible pumps within the residuals equalization basin would then convey the residuals to the dewatering facility site over a period of approximately 20 hrs/day.

- Dredging settled Potomac River solids from the Dalecarlia Reservoir Forebay over a 4½ month period each year, not concurrent with dredging at Georgetown. The dredged residuals would be conveyed to an on-site equalization basin during each daily dredging period (7 hrs/day). Submersible pumps within the residuals equalization basin would then convey the residuals to the dewatering facility site over a period of approximately 20 hrs/day.

- Four gravity thickeners at the dewatering facility site (north-west region of the Dalecarlia Reservation) to prepare the collected residuals for the dewatering operation.

- A dewatering facility utilizing six centrifuges and associated feed pumps, polymer feed systems and storage hoppers to dewater the residuals to a solids content of at least 30% as suitable for trucking and disposal. Building arrangement would provide for direct loading of trucks from the storage hoppers above.

- Relocation of the discharge point of the Backwash Recovery Pumping Station (which pumps filter backwash waste, clearwell leakage, sedimentation basin leakage and other miscellaneous flows) from the current Dalecarlia Reservoir discharge location to the Dalecarlia Forebay.

- Upgrading the existing Backwash Recovery Pumping Station to capacities required to handle side stream flows from the dewatering process.

- Site planning spacial allocations which provide expansion opportunity and to meet future Enhanced Surface Water Treatment Rule regulations through application of either an inclined plate settling facility or micro filtration unit operation.

- Modifications to existing Dalecarlia Waste Drainage Systems and Facilities to minimize potential adverse effects from the various waste streams.

Plant drain and the existing recycle operations would include the following improvements:

- Revisions to Chemical Building waste piping currently discharging to the 84"plant drain.

- Revisions to finished water pumping station waste piping currently discharging to the main plant drain.

- Submersible pumping station in existing 30 MG clearwell drain structure for use in decanting operations.

- An 84" plant drain pumping station to transfer normal flows to the Backwash Recovery Pumping Station for recycling.

Implementation Schedule

During the design development culminating with this Design Memorandum, the anticipated 36 month construction period for the Residuals Collection and Treatment Facilities has been revised from 10/98 through 9/01 (mid-point of 4/00) to a revised period of 10/01 through 9/04 (mid-point of 4/03). As described above under "Recent Developments", funding provisions for this project have not been included by WAD within the "Borrowing Authority" established for capital improvement projects pursuant to the SDWA Amendments (PL104-182). Therefore, it is expected that the final design for the proposed residuals collection and treatment facilities would commence not earlier than fiscal year 2000 (September 1999), and would be initiated under the authority of a new entity that is to assume title to the facilities now operated by the Washington Aqueduct. As indicated below, the projected date that construction would commence is October, 2001.

Construction has been estimated to take 36 months and potentially longer if the work commences in the late fall/early winter season. The milestones from execution of optional design services through construction is projected as follows:

Milestone Activity	Period	Duration	Fiscal Year Funded
Execution of Optional Design Services (Final Plans and Specs).	10/99 to 1/00	4 Months	N/A
Design and Review Phase (Final Plans & Specs)	2/00 to 4/01	15 Months	2000
Advertise, Bid and Award	5/01 to 9/01	5 Months	N/A
Construction Period (Mid-Point of Construction: April 2003)	10/01 to 9/04	36 Months	2002, 2003 and 2004

Estimated Project Costs

The total estimated costs for the facilities presented herein are $63,387,000, based upon April 2003 dollars, the projected mid-point of the estimated construction schedule. This total includes all material, labor, equipment, General Contractor and estimated Subcontractor mark ups, bonding and tax, as required to perform the construction. This total also includes mark ups for a 25% Design Contingency, 7.5% Funding Contingency, and 6% Site Inspection/Overhead for Construction Management Services.

The anticipated 36 month construction period for the proposed Residuals Collection and Treatment Facilities has been revised from 10/98 through 9/01 (mid-point of 4/00) to a revised period of 10/01 through 9/04 (mid-point of 4/03). The cost implications of this three year delay to the construction period has been accounted for within this estimate by escalating the current 1996 dollars to the new projected construction mid-point (April 2003). The escalation factor, at three percent per year, for the original period (10/98 through 9/01) was 12.55%, whereas the escalation factor due to the revised construction period (10/01 through 9/04) is now 22.99%. Both escalation factors are calculated from an April 1996 estimate cost basis to the respective construction mid-points noted above. The summary breakdown of these costs is as follows:

Estimate ID (Level One)	Description (Work Area)	Original Period Total Cost (4/00 Mid-Pt)	Revised Period Total Cost (4/03 Mid-Pt)
1.	Dalecarlia Sedimentation Basin Pumping Station and Renovations	$11,360,000	$12,413,000
2.	Georgetown Reservoir Pumping Station and Renovations	6,584,000	7,195,000
3.	Dalecarlia Forebay Pumping Station and Renovations	2,295,000	2,508,000
4.	Waste Streams Handling Facilities	2,441,000	2,667,000
5.	Dewatering Site Area Facilities and Utilities	32,115,000	35,094,000
6.	Supporting Facilities (Utilities Between (Areas and Landscaping)	3,212,000	3,510,000
	Totals	$58,007,000	$63,387,000

DESIGN MEMORANDUM

DALECARLIA WATER TREATMENT PLANT AND GEORGETOWN RESERVOIR

RESIDUALS COLLECTION and TREATMENT

1.0 INTRODUCTION

The Washington Aqueduct Division, United States Army Corps of Engineers, Baltimore District, under Congressional mandate since 1853, has owned and operated the drinking water supply system which has grown to serve the District of Columbia, Defense Mapping Agency, National Airport, the Pentagon, Arlington Cemetery, the City of Falls Church, and Arlington County. The facilities owned and operated by the Washington Aqueduct Division, U.S. Army Corps of Engineers include: the Great Falls Dam Intake and Little Falls Raw Water Intake/Pumping Station on the Potomac River, the Dalecarlia Raw Water Reservoir, two 10-mile long raw water conduits from the Potomac intakes to the Dalecarlia Reservoir, two water treatment plants (Dalecarlia and McMillan), treated water transmission mains (including the historic, 2-mile Georgetown Conduit), multiple finished treated water reservoirs (including Georgetown and McMillan Reservoirs) and finished water pumping stations. The Washington Aqueduct Division (WAD), as any major water utility, is continually undergoing upgrades and improvement initiatives in effort to keep pace with new technologies, to meet more stringent water quality regulations and to replace facilities that have exceeded their useful life. This report is the conclusion of a series of design studies initiated by WAD in its effort to meet current regulatory requirements and/or objectives regarding the handling of waste streams resulting from the water treatment process.

The Clean Water Act (1987 amendments) includes provisions which govern discharge of water treatment plant residuals to surface receiving waters. Discharges are prohibited without a National Pollutant Discharge Elimination Systems (NPDES) permit. Employing practices which predate present environmental measures, WAD has for decades discharged its alum residuals generated at the Dalecarlia Water Treatment Plant and Georgetown Reservoir sites directly into the Potomac River. Currently, WAD only river discharges its water treatment generated residuals during periods of high river flow and turbidity in order to lessen the impact of the added solids to the river in accordance with the facility's NPDES permit. While river discharging had been a common practice throughout the region, the WAD current NPDES discharge permit expired in May, 1994.

The United States Environmental Protection Agency (USEPA) is the responsible regulatory agency controlling permitted discharges of water treatment residuals to surface waters within the District of Columbia. USEPA had advised the WAD that the practice of discharging water treatment residuals to the Potomac River would no longer be permitted. The WAD to date has not received its new NPDES permit. In anticipation of receiving a permit mandating zero river discharge, WAD has pursued a technical resolution for residuals handling. WAD's intent is to institute systems and operations which would eliminate Potomac River residuals discharging from its current standard practices. The construction of the design proposed herein would enable the WAD to accomplish that objective.

The Safe Drinking Water Act Amendments of 1996 (PL104-182), signed on August 6, 1996, include provisions (Refer to Appendix A) that affect the status of the Army Corps of Engineers as Owner and operators of facilities known as the Washington Aqueduct, the status of the anticipated NPDES permit and the schedule for implementing the improvements and facilities that are proposed by this design memorandum for residuals collection and treatment. A detailed synopsis of these provisions has been presented in the Executive Summary, under "Recent Developments".

1.1 Authorization

Authorization of the design and associated studies performed to generate the documents leading up to and including this Design Memorandum were approved under U. S. Army Corps of Engineers Contract DACW 31-94-C-0141.

Funding authorization to generate the construction documents and to construct the facilities presented within this design memorandum have not currently been allocated or approved. The Washington Aqueduct Division, until recently, operated on a "pay-as-you-go" basis and was not empowered to finance capital projects. This is due to a series of complicated laws and acts which have evolved over time since the Aqueduct's inception. Funds for capital improvements required to meet regulatory obligations, as presented in this DM, were first to be secured via payment from wholesale customers. However, as described in the Executive Summary under "Recent Developments", the Safe Drinking Water Act Amendments of 1996 has dramatically impacted the future of this project. Although this act provides borrowing authority to the Washington Aqueduct for capital projects through fiscal year 1999, the budgeted amounts do not include final design or construction funding for this project. Further, a new non-Federal public or private entity is to assume ownership and responsibility for operating, maintaining and managing the facilities of the Washington Aqueduct not later than August 1999. Authorization to proceed with final design and subsequent construction of the project is, therefore, anticipated to be the responsibility of the new entity. Scheduling impacts of this development have also been incorporated into the proposed construction schedule.

1.2 Scope of Design Memorandum

This Design Memorandum (DM) would serve as the basis for preparation of final construction plans and specifications for the proposed residuals collection, conveyance, and dewatering facilities at the Dalecarlia Water Treatment Plant and Georgetown Reservoir. Once constructed, these proposed facilities would eliminate the future discharge of water treatment generated residuals to the Potomac River by WAD or its successor entity. Proposed facilities would also meet the anticipated NPDES permit requirements, which had been promised to mandate a zero discharge of plant residuals, (current permit update pending awaiting USEPA re-issuance - since 1994).

The work efforts related to the preparation of this document were conducted to comply with requirements stipulated in:

(I) U.S. Army Corps of Engineers, Baltimore District, Contract No. DACW-31-94-C-0141, dated 9-23-94, amended 10-28-94 (Modification No. 1) and 8-25-95 (Modification No. 2), and

(ii) "SECTION 2 - USCOE GENERAL SCOPE OF WORK", Item B.1(a) which states: "Preparation of Design Memorandum for Facilities for collection and treatment of Water Treatment Plant Residues ..." and Item B.3(a) which states, "... DM shall summarize all reviews, investigations, studies, evaluations, testing, etc. Regarding the collection and treatment of residuals at the Dalecarlia Water Treatment Plant and

Georgetown Reservoir ... and should include all design criteria, design calculations, and preliminary construction plans and construction cost estimate."

(iii) Amendment/Modification No. P00002, dated 8-25-95, which states that the design memorandum shall "Include the solids from the Dalecarlia Reservoir in the dewatering process. Evaluate current waste streams that discharge to the main plant drain; Determine what steams can be recycled, determine if treatment is required, and design facility to separate/treat the streams. Modify backwash recovery pumping station to allow discharge to north end of Forebay from present location. Perform preliminary planning and conceptual design (10% complete) for future recycle treatment facility. Perform subsurface geotechnical investigations."

This document presents the summary conclusions of all technical memoranda, studies, field testing, design research and design analyses which supports the proposed design. Section 1.3 lists all the documents and reports that this design team, headed by Whitman, Requardt, and Associates, conducted as part of the overall design process. It is upon these investigations and analyses that this DM is based. This DM does not reiterate all of the previously concluded design alternatives and possibilities. Rather, this DM states and refers to the appropriate document that contains the additional information which substantiates the proposed design.

1.3 Pertinent Prior and Concurrent Reports

Numerous technical memoranda, studies, field testing, and design research has been conducted by this design team as a part of the overall design scope noted above. Denoted here for reference purposes is a listing of separately bound volumes of this Design Memorandum; pertinent prior reports upon which this DM is based and which were completed as part of this overall design scope; as well as a listing of reference reports completed by others and employed as background knowledge.

1.3.1 Separately Bound Volumes of this Design Memorandum

The following list denotes the other supportive volumes included as part of the comprehensive submission of this Design Memorandum. These supportive volumes are:

Book 2 of 5 - Design Memorandum - Drawings
Book 3 of 5 - Geotechnical Evaluation
Book 4 of 5 - Engineering Estimate
Book 5 of 5 - Design Calculations

1.3.2 Pertinent Prior and Concurrent Reports - by Design Team

Whitman, Requardt and Associates, and other design team members prepared the documents denoted below as part of the overall design services authorized (see Section 1.2). These documents have been completed prior to, and/or concurrent with, the work covered by this design memorandum. These documents include:

Technology Review of Dewatering Equipment - Technical Memo No. 1,
Whitman, Requardt and Associates, Baltimore, MD; in Association with Malcolm Pirnie, Inc., Newport News, VA, November 1994

Review of Residuals Collection and Treatment Concepts - Technical Memo No. 2,
Whitman, Requardt and Associates, Baltimore, MD; in Association with Malcolm Pirnie, Inc., Newport News, VA, November 1994

Clean Water Act and Safe Drinking Water Act Impact Assessment -Technical Memo No.3,
Whitman, Requardt and Associates, Baltimore, MD; in Association with Malcolm Pirnie, Inc., Newport News, VA, November 1994

Projections of Residuals Production - Technical Memo No. 5 (Final),
Whitman, Requardt and Associates, Baltimore, MD; in Association with Malcolm Pirnie, Inc., Newport News, VA, June 1995

Enhanced Coagulation Process Studies - Technical Memo No. 6,
Whitman, Requardt and Associates, Baltimore, MD; in Association with Malcolm Pirnie, Inc., Newport News, VA, August 1995

Residuals Thickening and Dewatering Pilot Study-Technical Memo No. 7,
Whitman, Requardt and Associates, Baltimore, MD; in Association with Malcolm Pirnie, Inc., Newport News, VA, March 1995

Alternative Operating Concepts for Residuals Handling Facilities and Presentation of Proposed Design Concept - Technical Memo No. 8,
Whitman, Requardt and Associates, Baltimore, MD; in Association with Malcolm Pirnie, Inc., Newport News, VA, June 1995

Site Planning and Architectural Design Concepts - Technical Memo No. 9, Text - Part 1 of 2,
Whitman, Requardt and Associates, Baltimore, MD; in Association with Paul D. Spreiregen, FAIA, Washington, D.C. and Victor Wilburn Architects, Washington, D.C., November 1995

Site Planning and Architectural Design Concepts Technical Memo No. 9, Illustrations - Part 2 of 2,
Whitman, Requardt and Associates, Baltimore, MD; in Association with Paul D. Spreiregen, FAIA, Washington, D.C. and Victor Wilburn Architects, Washington, D.C., November 1995

Waste Streams Handling and Treatment Alternatives - Technical Memo No. 10,
Whitman, Requardt and Associates, Baltimore, Maryland, April 1996

Residuals Disposal Study and Report
Whitman, Requardt and Associates, Baltimore, MD; in Association with Malcolm Pirnie, Inc., Newport News, VA, November 1995

Preliminary Impacts Investigation for Dalecarlia and Georgetown Reservoirs Residuals Disposal Facilities Project,
Whitman, Requardt and Associates, Baltimore, MD, November 1995

1.3.3 Referenced Reports - by Others

The following list of reports was completed by groups other than the Design Team which prepared this Design Memorandum. The reports were reviewed and utilized as background information upon which some reference was drawn.

Conceptual Modernization Plan for Washington Aqueduct, Washington, D.C. Final Report,
U.S. Army Corps of Engineers, Baltimore District, Washington Aqueduct Division, April 1994

Washington Aqueduct Dalecarlia and McMillan Water Treatment Plants Conceptual Plan for Modernization Final Report,
U.S. Army Corps of Engineers, Baltimore District, March 1994

Conceptual Project Cost Estimates and Feasibility Report on Alternative Methods for Dewatering Alum Sludge,
Montgomery Watson, Herndon, VA, February 1994

Design Memorandum-Solids Recovery Facilities Dalecarlia Water Treatment Plant and Georgetown Reservoir,
Camp Dresser & McKee, Inc., Suitland, MD, 1979

Site Disposal Study for Water Treatment Plant Waste Residues Dalecarlia Water Treatment Plant and Georgetown Reservoir,
Camp Dresser & McKee, Inc., December 1979

2.0 DESCRIPTION OF EXISTING FACILITIES

A general schematic of the Washington Aqueduct's Water Supply System is provided on FIGURE 2.1. The following discussion highlights each of the existing facilities from which settled, accumulated water treatment residuals will be removed and dewatered. These existing Dalecarlia residuals generating facilities, identified on FIGURE 2.1 via red-dot reference, include the following:

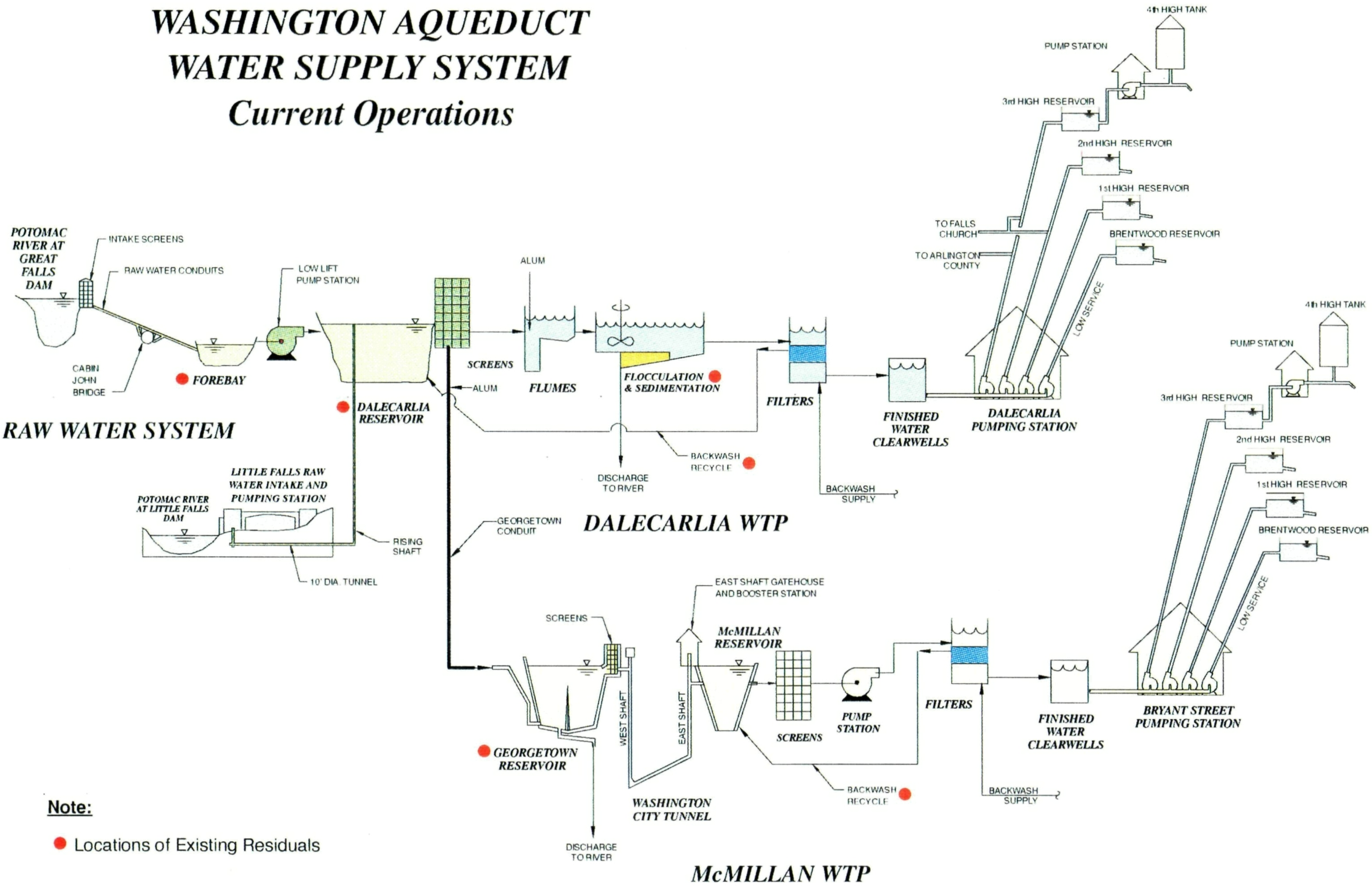
- Dalecarlia Sedimentation Basins
- Georgetown Reservoir
- Dalecarlia Forebay and Reservoir
- Dalecarlia Backwash Recovery Pumping Station (Backwash Recycle)

Alum residuals, the by-product of mixing aluminum sulfate (alum) with suspended material present in the raw water, settle in the Dalecarlia Sedimentation Basins and the Georgetown Reservoirs. Heavier Potomac River particulate, silt, and sand settles in the Dalecarlia Forebay prior to the addition of settling enhancing chemicals such as alum and coagulant polymers. Dalecarlia filter backwash wastewater is recycled into the Dalecarlia Reservoir. All of these existing facilities are presented in the discussion that follows and are shown on the drawings of this Design Memorandum (see BOOK 2 of 5).

2.1 Dalecarlia Sedimentation Basins

The Dalecarlia Water Treatment Plant provides alum coagulation, flocculation, sedimentation, filtration, and disinfection. The rated capacity of the Dalecarlia WTP is 164 MGD with a plant overload capacity of 240 MGD and an average water demand of 120 MGD. Sedimentation of alum coagulated residuals occurs in four sedimentation basins. Basins 1 and 2 are conventional rectangular basins and Basins 3 and 4 are double-deck (under and over flow path configuration) rectangular basins. The sedimentation basin residuals accumulate and remain within a respective basin until the flow and turbidity levels of the Potomac River are such to facilitate a discharge as allowed by the expired NPDES permit. During high river flow and turbidity conditions, the basins are cleaned, as required, and accumulated residuals are flushed to the river by a combination of draining and hosing. The annual cleaning frequency for each basin varies. While typically averaging at least two

WASHINGTON AQUEDUCT
WATER SUPPLY SYSTEM
Current Operations



Note:

● Locations of Existing Residuals

Figure 2.1

flush/clean cycle per year, Basins 3 and 4 were reported to include three cleanings per year during 1991 and 1992, while reconstruction of Basins 1 and 2 progressed. A summary description of the existing sedimentation basin facilities is provided below, and reflected on Sheets M-13 through M-19.

Dalecarlia Basins 1 & 2:

- Conventional rectangular basin configuration, each with settling area of approximately 55,000 sq ft (135 ft x 407 ft). Water depth is approximately 16 ft.

- Maximum capacity is 75 MGD per basin. Average capacity is 21.5 MGD per basin assuming all basins in service and a total plant flow of 120 MGD.

- Structural condition is very good since these basins were recently constructed (1992).

- Presence of cross-collector troughs and basin configuration anticipated possible future chain and flight type residuals collectors.

- Existing decant provisions permit directing all but bottom 4 feet (elevation 132 down to elevation 128) of basin volume to plant drain and subsequent recycling to Dalecarlia Reservoir whenever basin is to be manually cleaned.

Dalecarlia Basins 3 & 4:

- Rectangular double-deck basin configuration (upper deck elevation 131, lower slab elevation 112) with residuals deposition primarily in lower level. Settling area of lower level is approximately 41,800 sq ft (138 ft x 316 ft) when allowing for area of the 90 support columns in each basin. Lower level and upper level depths are approximately 16 and 14 feet, respectively.

- Rated (maximum) capacity for each basin is 90 MGD. Average capacity is 38.5 MGD per basin assuming all basins in service and a total plant flow of 120 MGD.

- Structural condition of the basins may not be satisfactory and some reconstruction or repairs should be expected. Basin 3 was constructed in 1964 while Basin 4 was constructed in 1947.

- Major modification to basin floor and excavations should be minimized due to access difficulty and since the existing basin floor rests on rock.

- No provisions currently exist for decant/recycling of settled basin volume prior to a flush and cleaning.

2.2 Georgetown Reservoir

The Georgetown Reservoir is located approximately 2 miles south of the Dalecarlia WTP site and is comprised of three settling areas separated by paved earth berms and control gates. Raw water from the Dalecarlia Reservoir is chemically treated and conveyed to the Georgetown Reservoir via the 2-mile long, 9-foot diameter Georgetown Conduit. Flocculation occurs in the Georgetown Conduit with settling of the alum coagulated residuals occurring in the Georgetown Reservoir basins. Settled water flows from the Georgetown Reservoir through the 4-mile long Washington City Tunnel to the McMillan Reservoir and then to the McMillan Water Treatment Plant for filtration and disinfection. The rated capacity of the McMillan WTP is 120 MGD with a plant overload capacity of 180 MGD and an average water demand of 100 MGD.

When the treated water reaches the Georgetown Reservoir, control gates separate the flow into two streams. A portion is directed to Basin 1 and the remainder to Basin 2, although there is no means for determining an actual flow split. Refer to Sheet C-7 through C-8. Flow ratios into the basins, for the purpose of residuals collection and removal, has been approximated to be 33 percent to Basin 1 and 67 percent to Basin 2. A plan of the Georgetown Reservoir Basins 1, 2 and 3 is shown on drawing C-9.

Deposition of alum residuals within Georgetown Reservoir typically is limited to Basin 1 and the first half of Basin 2, prior to the weir-wall. The flow from Basins 1 and 2 into Basin 3, having already undergone considerable settling time, contains minimal settleable solids. Basin 3, therefore, rarely requires cleaning, while Basins 1 and 2 are routinely dewatered and cleaned at least twice each year. Bypass piping allows the basins to be temporarily taken out of service.

Residuals are manually cleaned from the Georgetown Reservoir and periodically discharged to the Potomac River similar to the Dalecarlia WTP sedimentation basins. Large floor drain openings along the bottom of Basins 1 and 2 direct the basin volume to the Potomac River during basin dewatering and cleaning operations. Existing access ramps allow large equipment to plow the settled residuals into the floor drains for flushing to the Potomac River. The second half of Basin 2 and all of Basin 3 serve essentially as settled water storage volume. The surface area of Basin 1 is 220,000 sf and Basin 2 is 820,000 sf. The approximate average water depths are 16 and 20 feet, respectively for the two basins.

2.3 Dalecarlia Forebay and Reservoir

The Dalecarlia Reservoir is located on the east side of MacArthur Blvd, and east of the Dalecarlia Water Treatment Plant. The Reservoir is comprised of the main Dalecarlia Reservoir (approximately 1,825,000 sf surface area) and the Forebay area (approximately 150,000 sf surface area). The Aqueduct System delivers raw water by gravity from the Potomac River intake at Great Falls directly into the Forebay which has a depth of approximately 13 feet. The raw water is then pumped from the Forebay into the main Dalecarlia Reservoir (a vertical lift of approximately 7 feet, elevation 141' up to 148'). A second Potomac River intake is located at Little Falls where the Little Falls Pumping Station directs the raw water directly to the main Dalecarlia Reservoir. Most of the raw water originates at Great Falls and thus enters the Forebay. The Little Falls Pumping Station is typically used only during high water demand periods and occasionally for exercising the pumping units. Residuals accumulation in the Forebay has been periodically dredged to a nearby spoil area which now lacks capacity for additional solids. The main Reservoir has not been dredged for at least 40 years and recent surveys indicate major solids accumulation there. The Corps of Engineers is now preparing bid documents to dredge the Dalecarlia Reservoir to its original 13 foot average depth.

2.4 Dalecarlia Backwash Recovery Pumping Station

The existing Dalecarlia Backwash Recovery Pumping Station was constructed in 1980 to eliminate the routine discharge of filter backwash waste to the Potomac River as the first step in achieving total elimination of waste discharge from the plant to the river. The facility consists of a large wetwell that intercepts the backwash waste from the plant drain system, a deep drywell pumping station rated at approximately 8,000 gpm (1 pump operating, 1 pump standby) and includes a 24-inch force main which recycles the flow to the Dalecarlia Reservoir near the location of the plant intake (approximately 300' north of the intake). The facility has been represented schematically on FIGURE 2.1 as "backwash recycle". The primary constituent of the flow that is “recycled” to the Dalecarlia

Reservoir is the filter backwash waste. Other Dalecarlia plant drain waste sources include various storm drains and drain lines connected to the main plant drain within the filter and chemical buildings.

2.5 Dalecarlia WTP Waste Streams - Sources and Conditions

The investigations of existing conditions are presented on Sheet M-9 and were included in the presentation of *Waste and Recycle Streams Handling Report, Technical Memorandum No. 10*, dated April 1996. Highlights from that report are summarized herein.

Approximately 35% of the total number of waste stream sources are flows generated by rain runoff from pervious and impervious ground surfaces and roofs. About half of the impervious runoff from property owned by the Army Corps is conducted to the Potomac River, the other half is "recycled" by being sent back to the Reservoir via the Backwash Recovery Pumping Station, a form of storm water management water quality treatment. The volume of runoff is obviously storm dependent and unpredictable.

A second major source of the total waste stream is the filter backwash from filter buildings. These flows are also recycled back to the Reservoir via the Backwash Recovery Pumping Station. The total backwash flow is approximately 3.75 MGD.

A third source of waste flow comes from miscellaneous plant leakage. Foundation drains under the sedimentation basins discharge an estimated 2000 gpm (or more) flow into the C&O Canal. This flow, however, is in the process of being redirected to the Potomac River by the WAD staff via the existing tailrace and will thence be a permitted discharge. Foundation drains from the 30 MG clear water basin, Filter Building, Chemical Building and Finished Water Pumping Station contribute an additional 200± gpm which is currently being recycled. Seepage from raw water, settled water and filtered water conduits also contribute to these waste flows. Infiltration from the Dalecarlia Reservoir into the 9-foot by-pass conduit and groundwater infiltration into the 94-inch and 102-inch spillway channel conduit underdrains contribute a small but steady flow that currently passes to the river.

A fourth source of the waste stream is the water discarded after being utilized for the cooling system in the Finished Water Pumping Station and operate valves in the Chemical, Filter and Pumping Station Buildings. This flow has been estimated at approximately 1 MGD and is currently recycled to the Reservoir.

A fifth major contributor to the waste streams is the infrequent and unpredictable overflows from the Dalecarlia Reservoir spillway, the 30 MG clear water basin, the Finished Water Pumping Station suction gallery, the sedimentation basins, the 84-inch/54-inch plant drain junction chamber, the wash water storage tank and the carbon facilities. The WAD NPDES general permit with Maryland allows discharges from the plant drain. The 30 MG clear water overflow and suction gallery overflow can be covered by this permit and should be directed to the plant drain and then to the river. Overflows from the 84-inch/54-inch junction chamber, wash water storage and carbon facilities are currently recycled.

A sixth and final category of waste flows are composed of contaminated water and chemical discharges into sinks and floor drains in the Chemical, Chlorine, Pumping Station and Filter Buildings. The contamination may be significant or insignificant but the flow quantities are normally very slight. The sampling water draining into laboratory sinks and turbidimeters represent the largest contributions to this flow.

3.0 RESIDUALS GENERATION PROJECTIONS

Residuals production projections for the four sources of residuals (Dalecarlia Sedimentation Basins, Georgetown Reservoir, Dalecarlia Forebay and Reservoir, and Dalecarlia Filter Backwash Water), were presented in a prior technical memorandum, *Projections of Residuals Production, Technical Memo No.5.* Residuals production projections were based on a statistical evaluation of plant records for the period of August 1991 to September 1994 and the *Enhanced Coagulation Process Study, Technical Memo No.6* summary highlights indicated in this section. The residuals generation projections for Dalecarlia WTP and Georgetown Reservoir (McMillan WTP) are estimated using "annual average" finished water production rates, 120 MGD and 100 MGD respectively. These plant production rates are less than the Dalecarlia and McMillan plant design capacities of 164 MGD and 120 MGD, respectively. Lower design flow rates are used based on the fact that the actual finished water production rates from the two plants were observed to vary within very narrow ranges over the last 10 years (85 to 110 MGD at Dalecarlia WTP, and 80 to 90 MGD at McMillan WTP). Additionally, limited population growth is expected in the plant service areas during the useful life of the proposed residuals handling facilities.

3.1 Alum Residuals Production at Dalecarlia WTP Sedimentation Basins and Georgetown Reservoir

The following equation was applied to estimate residuals solids production in locations where alum addition occurs as part of the water treatment process. This equation was used to predict residuals production projections in the Dalecarlia WTP Sedimentation Basins and the Georgetown Reservoir Basins 1 and 2. The general equation employed:

$$\mathbf{M = (8.34)\,(Q)\,[1.0\,(TSS)\;+\;0.3\,(AL)]}$$

where:

M = residuals production, dry lbs/day
Q = water flow rate, MGD
TSS = removed total suspended solids, mg/l
1.0 = TSS/turbidity factor, a ratio obtained from plant data
AL = alum dosage, mg/l
0.3 = residuals production factor
8.34 = unit conversion factor.

Typically in water treatment facilities, the influent solids content carried into the process is measured as turbidity. Statistical analysis of plant data indicates an average TSS/turbidity ratio of approximately 0.8. A more conservative TSS/turbidity ratio of 1.0 was applied to develop the residuals production projections to account for seasonal deviations of the actual TSS/turbidity ratio statistically observed from the plant data.

The alum residuals production factor in the above equation indicates what portion of alum added to the raw water converts to suspended solids. Typically, this factor is in a range of 0.2 to 0.3, but could stoichiometrically be as high a 0.4 depending upon levels of bound water in the floc matrix. The 0.3 value was utilized based on previous experience with other projects with raw water quality similar to that of the Potomac River. These alum residuals are accumulated and settled in the Dalecarlia WTP Sedimentation Basins (1 through 4) and the Georgetown Reservoir (Basins 1 and 2).

The use of the term "Maximum Month" and "Maximum Week" solids production are used to denote the peaking productions actually observed in the plant's data during the statistical evaluation. "Maximum Month" productions represent the highest average month production observed when applying the above equation and utilizing the actual operational data of flow, turbidity, and chemical use (alum). A "Maximum Month" value was correspondingly obtained for each of the four years of the operational data set. "Maximum Week" represents the highest seven day average within that corresponding year's "Maximum Month" production. "Maximum Week" rates would be the highest week production for that year's data. The highest "Maximum Month" solids production has been employed to form the basis of design. While not being actual worst case, the Maximum Month values do represent a conservative approach since the various sources of residuals accumulation all contain considerable solids storage capacity.

The alum residuals production projections were developed for Dalecarlia Sedimentation Basins and Georgetown Reservoir based on two conditions: conventional coagulation and enhanced coagulation. Conventional coagulation is defined as the currently prevalent practice of optimizing the turbidity removal process by adjusting pH and coagulant/coagulant aid dosage. Enhanced coagulation is defined as the practice which would be required as part of the proposed Stage 1 Disinfectant/Disinfection By-Product (D/DBP) regulations. This latter practice is intended to reduce the DBP precursors in order to minimize the formation of DBP's. Enhanced coagulation is satisfactorily practiced when the Total Organic Carbon (TOC) is reduced during treatment by a particular percentage based on source water TOC and alkalinity.

Design alum dosages for conventional coagulation, which is currently practiced at both plants, is estimated based on statistical analysis of plant records. The design turbidity removals and alum dosages used in the calculation of residuals production projection (conventional coagulation) for the Dalecarlia Sedimentation Basins are 19 NTU and 23 mg/l for annual average, 60 NTU and 32 mg/l for the maximum residuals production month, and 85 NTU and 40 mg/l for the maximum residuals production week. The corresponding design values used for the Georgetown Reservoir are 19 NTU and 20 mg/l, 60 NTU and 28 mg/l, and 85 NTU and 35 mg/l, respectively. Applying conventional coagulation design values, the resulting Residuals Production Projections are summarized on TABLE 3-1.

The design alum dosages used in the calculation of residuals production projection (enhanced coagulation) for the Dalecarlia Sedimentation Basins and Georgetown Reservoir are 30 mg/l for annual average and seasonal conditions, and 50 mg/l for maximum monthly as well as maximum weekly residuals production periods. These alum dosages are based on results obtained during the enhanced coagulation process studies which are detailed in *Enhanced Coagulation Process Studies-Technical Memo No. 6*. The design turbidity removals under enhanced coagulation conditions are the same statistical values used under conventional coagulation conditions. Applying conventional coagulation design values, the resulting Residuals Production Projections are summarized on TABLE 3-2.

3.2 Dalecarlia Forebay/Reservoir Solids

Solids accumulated in the Dalecarlia Forebay and Reservoir are settled from the raw water without chemical addition and do not include the alum component indicated in the equation above. Dalecarlia Forebay/ Reservoir residuals accumulation projections are based on statistical analysis of plant records which included total flow, influent turbidity and effluent turbidity. The amount of residuals accumulated in the Forebay/Reservoir were calculated from the difference of the solids entering the Forebay and solids leaving the Reservoir. The design flows used in the calculation of

TABLE 3.1

DALECARLIA WATER TREATMENT PLANT AND GEORGETOWN RESERVOIR

RESIDUALS PRODUCTION PROJECTIONS SUMMARY
(CONVENTIONAL COAGULATION)

Source of Residuals	**Residuals Production (lbs/day)**						
	Annual Average	**Average Spring**	**Average Summer**	**Average Fall**	**Average Winter**	**Maximum Month**	**Maximum Week**
Dalecarlia Sedimentation Basins(1)	25,900	41,700	21,700	16,700	25,200	63,900	93,000
Georgetown Reservoir(2)	20,900	35,300	16,200	12,800	21,100	59,900	91,600
Subtotal (A)	**46,800**	**77,000**	**37,900**	**29,500**	**46,300**	**123,800**	**184,600**
Dalecarlia Reservoir(3)	20,200	36,700	14,600	11,500	20,000	50,000	113,800
Dalecarlia Waste Backwash Water(1)	500	600	500	400	800	1,100	1,200
Subtotal (B)	20,700	37,300	15,100	11,900	20,800	51,100	115,000
TOTAL (A+B)	**67,500**	**114,300**	**53,000**	**41,400**	**67,100**	**174,900**	**299,600**

Notes:

(1) Based on projected average annual flow of 120 mgd.
(2) Based on projected average annual flow of 100 mgd.
(3) Based on projected average annual flow of 220 mgd.

TABLE 3.2

DALECARLIA WATER TREATMENT PLANT AND GEORGETOWN RESERVOIR

RESIDUALS PRODUCTION PROJECTIONS SUMMARY (ENHANCED COAGULATION)

Source of Residuals	**Residuals Production (lbs/day)**						
	Annual Average	**Average Spring**	**Average Summer**	**Average Fall**	**Average Winter**	**Maximum Month**	**Maximum Week**
Dalecarlia Sedimentation Basins⁽¹⁾	28,000	43,100	24,500	19,800	26,600	68,800	95,900
Georgetown Reservoir⁽²⁾	23,400	37,200	19,300	15,800	23,000	65,700	95,900
Subtotal (A)	**51,400**	**80,300**	**43,800**	**35,600**	**49,600**	**134,500**	**191,800**
Dalecarlia Reservoir⁽³⁾	20,200	36,700	14,600	11,500	20,000	50,000	113,800
Dalecarlia Waste Backwash Water⁽¹⁾	500	600	500	400	800	1,100	1,200
Subtotal (B)	20,700	37,300	15,100	11,900	20,800	51,100	115,000
TOTAL (A+B)	**72,100**	**117,600**	**58,900**	**47,500**	**70,400**	**185,600**	**306,800**

Notes:

(1) Based on projected average annual flow of 120 mgd.
(2) Based on projected average annual flow of 100 mgd.
(3) Based on projected average annual flow of 220 mgd.

residuals accumulation projections for the Dalecarlia Forebay/Reservoir are 220 mgd as an annual average, 200 mgd for the maximum residuals accumulation month and 210 mgd for the maximum residuals accumulation week. The design differences between influent and effluent turbidity for those three periods are 11 NTU, 30 NTU and 65 NTU, respectively. The calculated residuals accumulation projections for the Dalecarlia Forebay/Reservoir in dry pounds per day are 20,200 lbs/day for annual average, 50,000 lbs/day for maximum month of 113,800 lbs/day for maximum week.

3.3 Dalecarlia WTP Filter Backwash Waste

Residuals production projections for Dalecarlia WTP filter backwash waste are estimated as the difference between the amount of filter influent and effluent solids. Average annual and maximum month filter backwash residuals production projections are 500 lbs/day and 1,100 lbs/day, respectively.

3.4 Residuals Production Projection Summary

The calculated residuals production projections for the Dalecarlia Sedimentation Basins and Georgetown Reservoir for conventional coagulation along with a summary of residuals production projections for the Dalecarlia Reservoir and Dalecarlia filter backwash wastewater are as indicated on TABLE 3.1. The calculated residuals production projections for enhanced coagulation at the Dalecarlia Sedimentation Basins and Georgetown Reservoir, along with the residuals production projections for the Dalecarlia Reservoir and Dalecarlia filter backwash wastewater, are as indicated in TABLE 3.2.

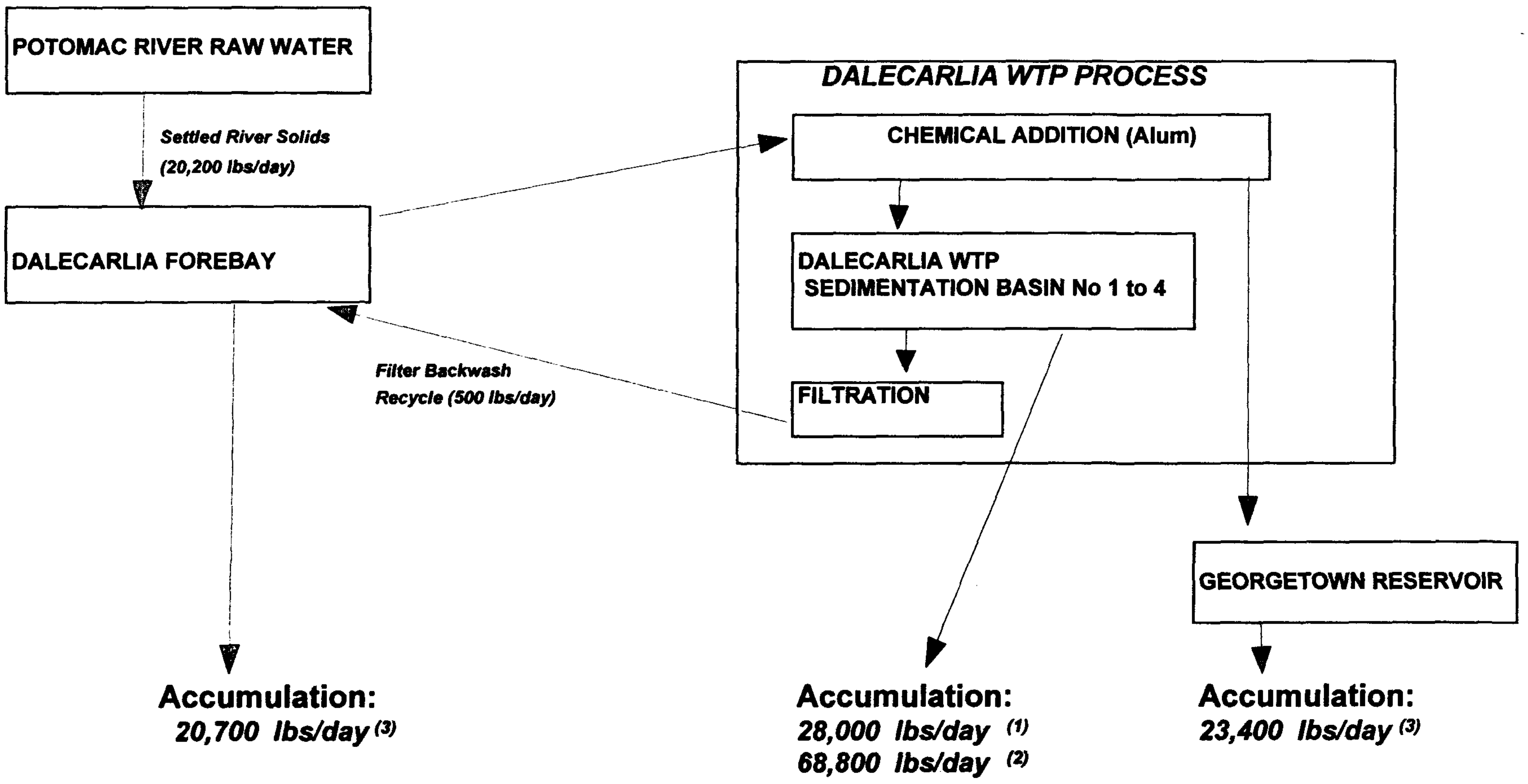
As indicated, the residuals production projections for enhanced coagulation at 72,100 lbs/day on an annual basis exceed the values for conventional coagulation at 67,500 lbs/day by approximately 7 percent. The more conservative enhanced coagulation projections have, therefore, been employed to size all proposed residuals collection and treatment facilities. It should be noted that projections presented in TABLES 3.1 and 3.2 are residuals generation rates. Residuals removal rates from these sources differ from the generation rates dependent upon the actual operating schedule of Dalecarlia residuals collection and treatment facilities. FIGURE 3-1 presents the design basis of the residuals collection and treatment as required to handle the corresponding residuals accumulation rates at each existing location. Section 4 will present a summary of how the accumulation rates reflected in FIGURE 3-1 would be handled.

RESIDUALS PRODUCTION - ACCUMULATION RATES

FIGURE 3.1

DESIGN BASIS of RESIDUALS COLLECTION and TREATMENT

Dalecarlia WTP and GEORGETOWN RESERVOIR



NOTES:

1 28,000 lbs/day Sedimentation Basin Residuals Production Rate per "ANNUAL AVERAGE", Enhanced Coagulation Projection Numbers
2 68,800 lbs/day Sedimentation Basin Residuals Production Rate per "MAXIMUM MONTH", Enhanced Coagulation Projection Numbers
3 Recycle, Georgetown Reservoir and Dalecarlia Forebay Residuals are based upon an "ANNUAL AVERAGE", Enhanced Coagulation Projection
4 All Values are reported in lbs/day, and are from Tech Memo No 5, and are as reflected on TABLES 3.1 & 3.2 of this Design Memo
5 Residuals Production Numbers were obalned per statistical analysis of plant data, 1991 to 1994, and are reported as DRY WEIGHT residuals

4.0 RESIDUALS COLLECTION AND TREATMENT ALTERNATIVES

This section summarizes the conclusions of engineering studies, design analyses, team progress meetings, technical memoranda and review conferences with the Washington Aqueduct Division regarding alternatives for residuals collection and treatment. Each of the major processes upon which the overall design has been based are presented in summary herein. Reference has been made to the pertinent and/or concurrent documents which explore other alternatives considered and subsequently eliminated, should the reviewer require more detailed information. The outcome of these investigations are to collect and treat the accumulated solids presented in FIGURE 3-1, which form the basis of design sizing of all facilities presented in this Design Memorandum.

Throughout this study, the intent has always been to evaluate the engineering and economic aspects of a range of feasible solutions, some of which, while technically feasible, may require political and legislative actions beyond the capability of Washington Aqueduct to influence. The alternative chosen for study gives the best analysis of an option that processes solids at the Dalecarlia site and removes them over land with trucks. While this alternative will meet the NPDES permit limitations, no final decision on a construction alternative can be made until an Environmental Assessment under the provisions of the National Environmental Protection Act has been performed.

4.1 Residuals Collection and Conveyance

Residuals collection and conveyance methods to be employed for residuals accumulated in the Dalecarlia Sedimentation Basins, Georgetown Reservoir and the Dalecarlia Reservoir Forebay were evaluated throughout the project and summarized in *Alternative Operating Concepts for Residuals Handling Facilities and Presentation of Proposed Design Concept - Technical Memo No. 8*. Residuals collection alternatives included manual cleaning, mechanical collection systems and floating dredge systems. Conveyance considerations included equalization-storage, pumping facilities and force main alignments for directing the collected residuals to the dewatering facilities.

4.1.1 Dalecarlia Sedimentation Basins

Residuals Collection -Alternatives considered for residuals collection from the Dalecarlia Sedimentation Basins included:

- Periodic manual cleaning
- Chain and flight mechanical collection system
- Suction header/guide rail cable driven mechanical collection system

The suction header/guide rail collection system is proposed due to cost considerations and its proven operational success at other regional water treatment facilities. This system utilizes a perforated suction header pipe that travels along a guide rail that is attached to the basin floor. The header travels on rails which traverse the width of each basin, with a run length of 135 to 137 feet, depending upon the basin. A flexible hose is connected from the suction header pipe to a fixed discharge pipe which directs the collected residuals to the Sedimentation Basin Residuals Pumping Station wet well, and is subsequently pumped to the thickeners at the dewatering site for processing. Differential fluid levels between the wet well and the sedimentation basins create the suction at the header pipe for withdrawing the settled residuals from the basin floor. Similar systems operate effectively at settled solids concentrations of between 0.25 percent and 2.0 percent. Solids concentrations in excess of 2.0 percent should be avoided due to the potential for the units to become "stuck". Manual controls are proposed to facilitate recovery from a “stuck” condition without the need to drain the basin. A 0.5 percent solids concentration has been used to size the Sedimentation Basin Residuals Pumping Station and associated piping.

System operations would consist of the intermittent cycling of the various suction header units in each basin such that a limited number are operating simultaneously. Unit travel speeds would have two or three settings, adjustable to suit conditions such as basin flow, solids production and settling rates. Operation of the units would be controlled via programmable controller. Additional description of the proposed controls is provided in Section 13.

Four manufacturers of suction header technology were investigated, while two cable driven systems, General Filter (Sludge Sucker) and Leopold (Clari-Trac) were utilized for design layouts.

Existing installations utilizing a cable driven collection units were surveyed and found to have satisfactory system performances. Research of other regional facilities revealed that an accumulation residuals blanket depth of up to four feet could be drawn through the header system without necessitating a basin flushing or operation process shut-down for flushing. Most operators of these existing installations were generally satisfied with their performance and indicated that low maintenance requirements and good solids removals could be anticipated for the cable-driven systems.

Residuals Conveyance - Conveyance of the residuals collected from the Dalecarlia Sedimentation Basins involved the consideration of pumping station configuration and placement alternatives as well as the discharge force main alignment. The need to include basin draining provisions for routine maintenance was considered during the evaluation of various alternatives. The Sedimentation Basin Residuals Pumping Station's proposed depth is set to enable this periodic maintenance draining for either of the four basins.

4.1.2 Georgetown Reservoir

Residuals Collection - Alternatives considered for residuals collection from Basin No.1 and part of Basin No.2 at the Georgetown Reservoir included:

- Mechanical collection systems as considered for the Dalecarlia Sedimentation Basins
- Floating dredge pumping unit operation

A floating dredge pumping unit was determined to be the preferred alternative for collecting residuals at Georgetown Reservoir due to considerably lower estimated capital costs ($250,000 vs. $2,250,000 for mechanical collection equipment); due to reduced sizing requirements for the thickening and dewatering facilities; and due to its flexibility in scheduling the residuals removal operations. Electrically powered floating dredge pumping units are proposed rather than propane dredging units due to reduced noise as well as concern regarding safety of a propane operation. Automatic dredging operations were considered but were eliminated from further consideration based upon the limited operational benefits weighted against a significant cost increase (Presentation Hand Out at Team Meeting No. 11, August 1995).

The proposed dredging operation at the Georgetown Reservoir Basins requires that the existing concrete bottom slabs be leveled. These slabs currently are configured as a series of ridges and valleys shaped to facilitate easy residuals draining and therefore must be leveled to a slope and shape to facilitate ease of dredging. Installation of a twelve foot wide stop gate structure would be required to provide dredge transfer operations between Basin 1 and 2. Aluminum plates are proposed as "stop logs". The structure must meet dam spillway construction criteria, with buried cut-off wall sections to maintain the integrity of the division dam between the basins. Due to the age of the Georgetown Reservoir, the proposed implementation of the dredging facilities would also be accompanied by repairs to valves, gates and concrete slabs, as required.

<u>Residuals Conveyance</u> - Equalization of the dredged residuals volume prior to conveyance to the dewatering site was determined to be advantageous and is proposed to be accomplished by the construction of an equalization basin at the Georgetown Reservoir site. Inclusion of an equalization basin at this site will provide the following benefits:

- Provide on-site storage equivalent to the 7-hour dredging volume of the proposed single shift dredging operation,
- Provide for a steady 20-hour residuals pumping period to the dewatering facilities to be located more than two miles away at the Dalecarlia Water Plant site,
- Reduce required horsepower of dredge pumps since the dredge would pump to the nearby equalization basin rather than to the dewatering site,

- Reduce required capacity of residuals conveyance pumps,
- Permit the utilization of a smaller diameter conveyance pipeline,
- Eliminate the requirement for an equalization basin at the thickeners or for additional thickener storage capacity on the Dewatering Facility site, and,
- Provide for a more consistent residuals flow and concentration feed to the thickeners.

Conveyance of residuals from the equalization basin at Georgetown Reservoir to the dewatering site at the Dalecarlia WTP complex would be accomplished via a proposed 10-inch diameter 13,600 LF force main. The main portion of the force main, 10,000 LF, is proposed to be installed within the existing nine foot diameter, brick/parged, Georgetown Conduit. Another viable alternate alignment considered was an open cut trench installation along the urbanized MacArthur Boulevard. A "cut and fill" construction alternative was subsequently eliminated when found to be too time consuming, disruptive to traffic and cost prohibitive. The proposed force main mounting within the existing brick conduit is positioned to enable continued maintenance access and minimize adverse impacts to this operating, historic, civil engineering landmark.

4.1.3 Dalecarlia Forebay

Residuals Collection - The only alternative that appeared to be feasible for collection of accumulated solids from the Dalecarlia Forebay is by floating dredge operation. The shape of the forebay and its earth bottom, as well as estimated costs, precluded consideration of a mechanical solids removal systems. Successful prior experience of WAD staff in dredging the Dalecarlia Forebay was also recognized. An electric dredge, similar to the one proposed for the Georgetown Reservoir site is therefore proposed to be provided at the Dalecarlia Forebay.

Residuals Conveyance - Equalization of the dredged River Solids Volume will be handled similar to that described above under 4.1.2 for the Georgetown Reservoir.

RESIDUALS PROCESSING SCHEDULE
DESIGN BASIS of RESIDUALS COLLECTION and TREATMENT

LOCATION	*ACCUMULATION RATES*	*PROCESSING SCHEDULE With Corresponding Rates of Collection and Treatment*		
		WINTER PROCESSING (3 Months)	SPRING & PARTIAL SUMMER PROCESSING (4 1/2 Months)	PARTIAL SUMMER & FALL PROCESSING (4 1/2 Months)
		January February March	April May June July August	September October November December
Dalecarlia Sedimentation Basins *Continous removal*	*68,800 lbs/day*	68,800 lbs/day removal	[illegible]	[illegible]
Georgetown Reservoir *Dredge operation removal*	*23,400 lbs/day*		[illegible]	
Dalecarlia Forebay/Reservoir *Dredge operation removal*	*20,700 lbs/day*			[illegible]
TOTALS *Required Residuals Processing Rates*		*68,800 lbs/day Processed*	*163,700 lbs/day Processed*	*152,750 lbs/day Processed*

NOTES:

1 The above Residuals Accumulation Rates are from TABLE 3.2 and FIGURE 3.1 of this Design Memorandum, reported as DRY Lbs/Day
2 68,800 LBS/Day Accumulation in Sedimentation Basin Residuals are "MAX MONTH", Enhanced Coagulation Projections
3 23,400 LBS/Day Georgetown Reservoir Residuals are based upon an "ANNUAL AVERAGE", Enhanced Coagulation Projection Rates
4 94,900 LBS/Day Georgetown Processing rate - based upon 4 1/2 month collection of one full year's accumulation of 23,400 LBS/Day
5 20,700 LBS/Day Dalecarlia Forebay Residuals are based upon an "ANNUAL AVERAGE", Enhanced Coagulation Projection Rates
6 83,950 LBS/Day Forebay Processing rate - based upon 4 1/2 month collection of one full year's accumulation of 20,700 LBS/Day

FIGURE 4.1

4.2 Residuals Thickening

Thickening is proposed to reduce the volume of residuals and the size of the subsequent dewatering facilities. Two key functions of the residuals thickening facility are residuals concentration and residuals storage.

The concentration of residuals to be processed by the thickening facility would widely vary due to fluctuations in concentration and flow from the residuals sources. FIGURE 4.1, *Residuals Processing Schedule,* presents the proposed Residuals Collection and Treatment Rates from each location, for each period of the year. FIGURE 4.1 reflects the proposed processing schedule and rates required to annually remove the residuals accumulated at each existing location. FIGURE 3.1, *Residuals Production - Accumulation Rates,* presented the mass of residuals accumulating in the Sedimentation Basin, Georgetown Reservoir and the Dalecarlia Forebay, respectively. As shown on FIGURE 4.1, *Residuals Processing Schedule*, the Sedimentation Basin Solids Accumulation is proposed to be removed continuously and these proposed removal facilities are sized based upon the highest "maximum month" residuals production rates statistically observed for the four years' worth of operational plant data analyzed. The two proposed reservoir dredge operations (Georgetown and Dalecarlia Forebay) are based upon "annual average" residuals production rates, since the proposed removal would only need to be designed to handle the statistical mean or average annual mass of residuals accumulated at both locations.

Residuals within the Dalecarlia Forebay predominantly consist of river silts and fines, but would consist of up to five percent alum residuals deposited from a relocated recycle stream. Based on field sampling of settled residuals, it is proposed that a dredged solids concentration of 1.5 percent solids be assumed for sizing of the dredge and pumping facilities. Similarly, the proposed Georgetown Reservoir dredging operation would convey a residuals stream of approximately 1.5 percent solids alum residuals. The Dalecarlia WTP sedimentation basin residuals removal system is designed to remove accumulated residuals at an average concentration of approximately 0.5 percent. Although these respective concentrations represent the basis of design, variations in residuals flow concentrations are anticipated.

Total solids concentrations from these three major residuals sources are anticipated to range from 0.25 to 2.0 percent solids (and possibly higher dependent upon operator control). Alum residuals containing chemically bound water are often difficult to settle. The thickening characteristics and the quality of these residuals would vary seasonally, depending on the alum dosage applied. The overall efficiency of the dewatering equipment would be directly dependent upon the ability of the thickening system to handle the flow and solids concentration variabilities received from the three major sources.

Alternatives for the residuals thickening operation that were considered for this project included : gravity thickening, centrifugal thickening and gravity belt thickening. These technologies were evaluated and discussed in *Alternative Operating Concepts for Residuals Handling Facilities and Presentation of Proposed Design Concept-Technical Memo No. 8*.

Gravity thickening typically involves circular tanks with conical shaped bottoms, with scraper mechanisms to direct the gravity-induced settled solids to the central bottom outlet. Gravity thickeners equalize the flow and concentration of residuals fed to the dewatering facilities due to their large holding capacity.

Centrifugal thickening involves the application of a centrifugal force 2,000 to 3,000 times the force of gravity. Separation results from the centrifugal force-driven movement of the suspended solids away from the axis of rotation of the centrifuge. The increased settling velocity imparted by the centrifugal force as well as short settling distance of particles accounts for the comparatively high capacity of centrifugal equipment.

Gravity belt thickening involves the concentration of residuals as their free water drains by gravity through a porous horizontal belt. Free water released from the residuals drains through the belt as the belt travels the horizontal length of the thickener while the solids remain on top of the belt. A ramp at the end of the belt causes the residuals to pool and roll backward, increasing the detention time on the belt. The thickened residuals then travel over the ramp into a hopper for pumping to downstream processes.

Based on detailed analysis of advantages and disadvantages of these technologies, it is concluded that a gravity thickening process is the most viable application of available technology to handle the residuals treatment. The gravity thickening process is proposed due to the following main reasons:

- Lowest overall capital, operation and maintenance costs
- Very reliable performance for wide range of operational conditions
- Adequate residuals equalization and storage capacity
- Simple operation and maintenance

A series of bench-scale gravity thickening tests were performed with the purpose of establishing criteria for sizing of the gravity thickeners. Detailed descriptions of these were presented in a prior technical memorandum, *Residuals Thickening and Dewatering Pilot Study-Technical Memo No. 7*. These tests were also summarized as part of *Technical Memo No. 8,* as referenced above. The average concentration of thickened residuals at 2.5 percent solids did not increase significantly by increased polymer dose or hydraulic retention time. Maximum residuals concentrations were typically achieved between 4 and 6 hours after the beginning of the tests. Analysis of test results, utilizing polymer addition and an allowance for differences between pilot-scale and full-scale thickening conditions, concluded that sizing of the gravity thickeners utilize a maximum design solids loading rate of 7.0 lbs/square foot/day. Design criteria for thickening is based upon a residuals flow peaking factor (maximum month/average annual solids load ratio) of 2, with the maximum solids loading rate of 7.0 lbs/sq ft/day. This corresponds to an average solids loading rate of 3.5 lbs/sq ft/day.

These proposed maximum and average solids loading rate design criteria were validated via a review of thickener design criteria for similar facilities including: Corbalis Water Treatment Plant in Fairfax County, Virginia (which treats Potomac River water); Moores Bridges WTP, Norfolk, Virginia; Stickney and Meyers WTP's in Mobile, Alabama; and City of Houston's WTP, Texas. Maximum design solids loading rates for these plants ranged from 5 to 14 lbs/sq ft/day. The maximum design hydraulic detention time of 18 hours has also been utilized for thickener sizing based on maintaining a factor of three times the retention time of the bench-scale testing. A maximum hydraulic loading rate of 200 gpd/sf has also been considered in sizing the thickeners and associated effluent piping.

Actual sizing of the proposed residuals thickening facilities, utilizing the above criteria, is both solids and hydraulic loading dependent. The sizing dependency is directly affected by anticipated residuals collection operations. Operational alternatives and corresponding impacts to thickener sizing are discussed later in Section 4.4.

As noted above, a primary function of the gravity thickeners is to provide equalization of solids quality and quantity between the residuals sources and the dewatering equipment. The thickeners would be operated continuously with intermittent draw-off of thickened residuals to suit the operation of the dewatering facility. Since the quality of thickened residuals from each thickener is expected to vary slightly at any given time, a blending tank is proposed to blend the various streams of thickened residuals prior to dewatering. The blending tank would provide additional thickened residuals storage and the means to convey a more uniform concentration of thickened residuals to the dewatering equipment, thus benefitting the dewatering efficiency. The blending tank sizing would provide approximately 4 hours of retention at the maximum rate of dewatering operation.

4.3 Residuals Dewatering

A series of evaluations were conducted to determine which dewatering technology would be most appropriate for processing the residuals produced by the various sources previously discussed. These evaluations included: performance surveys, site visits, pilot plant and settling characteristics studies, and engineering cost analyses. Three mechanical dewatering technologies were considered, including: belt filter presses, diaphragm filter presses, and centrifuges. A description and preliminary assessment of the various dewatering technologies is presented under separate memorandum (*Technology Review of Dewatering Equipment-Technical Memo No. 1*).

Belt filter presses involve distribution of conditioned residuals onto a moving porous belt on which gravity drainage takes place as in gravity belt thickening. Following gravity drainage, the partially dewatered residuals enter the compression zone of the belt filter press in which the residuals are compressed between two porous cloth belts which operate at pressures up to 20 psi and travel in a serpentine path over numerous rollers. The preliminary assessment presented in *Technical Memo No. 1* eliminated belt filter press technology as not feasible for dewatering of Dalecarlia residuals. Reasons cited included: low cake concentration compared to other two technologies; performance very sensitive to variations in residuals quality; and excessive number of units required for this project due to relatively small unit capacity sizes currently available.

Diaphragm filter presses consist of a series of filter plates supported and contained in a structural frame. When two adjacent plates come in contact with each other, a compartment is formed between the plates to hold the residuals. A porous cloth medium lines the compartments to retain solids while releasing water from the residuals. Residuals are pumped into the press to fill all compartments and to begin the dewatering process. The diaphragm then squeezes the cake, resulting in high cake concentration. Upon completion of the filter cycle, the plates are separated, the cake is released by gravity to disposal and the filter presses is washed in preparation for the next cycle. Each filter cycle typically takes two to three hours.

Centrifuges are the most commonly used technology for dewatering of alum residuals and operate by subjecting the residuals to a centrifugal force approximately equal to 2,400 to 3,000 times the force of gravity to separate heavier solid particles from lighter liquid phase. The centrifuges are horizontal, solid bowl, continuous countercurrent flow, scroll-type units, which consist of a horizontally mounted solids bowl which rotates at high speed. The dewatering process is continuous feed with residuals constantly applied to the unit and dewatered solids continuously removed. Residuals cake removal is accomplished by a screw conveyor (scroll) located within the centrifuge bowl, which rotates at a slightly higher speed than the bowl itself. The screw action of the scroll conveys the solids to the conical end of the machine and out the open end.

Diaphragm filter presses and centrifuges were subsequently evaluated via a side-by-side dewatering pilot study, visiting existing dewatering facilities, and detailed process and cost comparisons. The pilot study was conducted at the Dalecarlia WTP over a 10-day period beginning the week of November 7, 1994. The primary objective was to determine the performance of the

TABLE 4.1

DALECARLIA WATER TREATMENT PLANT RESIDUALS HANDLING FACILITIES

SUMMARY OF DEWATERING PILOT TESTS

Parameter	**Centrifuge**		**Filter Press**	
	Average	**Range**	**Average**	**Range**
Residuals Source	Dalecarlia Sedimentation Basin No. 1			
Feed Rate	40 gpm	25 - 65 gpm	88 liters	62 - 118 liters
Feed Solids Concentration, %	1	0.8 - 2.3	1	0.8 - 2.3
Cake Solids, %	29.8	26.1 - 31.4	34.4	30.9 - 37.4
Solids Recovery, %	98.1	92.5 - 99.8	99.7	97.6 - 99.9
Polymer Dosage, lbs/dry ton ⁽¹⁾	8.2	2.8 - 1.1	8.3	5.9 - 12.6
Centrate/Filtrate TSS, mg/l	115	51.0 - 214.0	6	3.0 - 11.0
Centrate/Filtrate BOD5, mg/l	14	12.0 - 16.0	6	3.0 - 11.0
Centrate/Filtrate Toxicity		Not toxic		Not toxic

Parameter	**Centrifuge**		**Filter Press**	
	Average	**Range**(2)	**Average**	**Range**(3)
Residuals Source	Dalecarlia Reservoir			
Feed Rate	35 gpm	35 gpm	108.5 liters	108.5 liters
Feed Solids Concentration, %	0.7	0.6 - 0.8	1	1
Cake Solids, %	42.3	42.2 - 42.4	44.9	44.9
Solids Recovery, %	96.9	94.9 - 99.0	99.94	99.94
Polymer Dosage, lbs/dry ton (1)	7.8	4.9 - 10.5	6.4	6.4
Centrate/Filtrate TSS, mg/l	193	86 - 300	10	10
Centrate/Filtrate BOD5, mg/l		Not Measured		Not Measured
Centrate/Filtrate Toxicity		Not Measured		Not Measured

(1) Tests Completed With Cationic Polymer LT22S
(2) Based on Two Runs Only
(3) Based on One Run Only

centrifuge and membrane filter press using Dalecarlia WTP residuals under variety of operational conditions. Pilot testing procedures and results are presented in detail in a separate memorandum (*Residuals Thickening and Dewatering Pilot Study-Technical Memo. No. 7*).

TABLE 4.1 summarizes pilot study results from centrifuge and filter press performance. Analysis of these results indicate that the residuals generated at Dalecarlia sedimentation basins and Dalecarlia Reservoir can be readily dewatered. The concentration of residuals cake dewatered by Sharples high-solids centrifuge ranged from 26 to 31 percent and averaged 30 percent. The Edwards and Jones membrane filter press was capable of achieving cake solids concentration in a range of 30 to 37 percent with an average concentration of 35 percent. Dalecarlia Reservoir solids were easier to dewater than the residuals generated in the Dalecarlia sedimentation basins. Cake solids concentration of 42 percent and higher was achieved by both centrifuge and filter press when dewatering reservoir residuals. Analysis of residuals cake chemical characteristics indicates that the cake has a superior quality as compared to that of residuals from a typical water treatment plant. The Dalecarlia's residuals can be classified as a non-hazardous material. The results of the pilot-scale testing indicated that filter press technology could produce residuals cake averaging approximately 35 percent solids while the centrifuge technology could produce residuals cake averaging approximately 30 percent solids. Since both technologies produced cake solids concentrations acceptable for any disposal alternative, the comparative analysis proceeded on the basis of relative costs (capital, O&M, hauling and disposal), overall performance, operation, maintenance, safety, odors and noise, spacial and structural requirements, as well as future technology development. An assumed operational concept was utilized to estimate solids loading to the dewatering facility. TABLE 4.2 provides a summary of the comparison of centrifuges and filter presses.

The impact of residuals disposal costs on the selection of dewatering technology was evaluated and is presented in FIGURE 4.2. That figure compares the total estimated amortized dewatering and disposal costs for a 2-shift operation as a function of disposal fees. Analysis of this figure indicates that filter presses would be more cost effective than centrifuges only if residuals disposal fees (hauling and tipping fees) become higher than $110/wet ton. FIGURE 4.3 presents the total disposal cost comparison of filter presses and centrifuges for a 3-shift operation. Filter presses would be more cost effective at a disposal cost of approximately $70/wet ton operating at 3-shifts.

TABLE 4.2

DALECARLIA WATER TREATMENT PLANT
RESIDUALS HANDLING FACILITY

COMPARISON OF CENTRIFUGES AND FILTER PRESSES

Item	Centrifuges	Filter Presses
Basic Design Criteria		
- Type	High Speed/Solids Bowl	Membrane
- Operating Schedule	Two 8-hr shifts (5 days /wk)	Two 8-hr shifts (5 days/ wk)
- Number of Units	5 duty + 1 standby	4 duty + 1 standby
- Unit Capacity	200 gpm	2300 cu ft/cycle @ 6 cycles/day
- Residuals Cake (% solids)	30	35
- Polymer Dosage (lbs/ton)	8	8
- Solids Recovery (%)	98	99
- Sidestream TSS (mg/l)	540	270
- Cake Storage (cu ft)	10,200	8,700
- Number of Truckloads (1)	17	19
Costs (1995 Dollars) (2)		
- Capital ($)	$18,200,000	$29,861,000
- O& M ($/year)	$923,000	$976,000
- Amortized ($/year)(3)	$2,510,000	$3,580,000
Overall Performance	- Lower cake concentration - Lower sidestream quality - Cake concentration less sensitive to residuals quality - Continuous control of dewatering process by adjusting centrifuge torque, polymer dose, and feed rate. If initial process parameters are not selected properly they can be easily adjusted during the dewatering process at minimum impact on cake concentration.	- High cake concentration - High sidestream quality - Sidestream quality less sensitive to residuals quality - No continuous control capabilities. Once dewatering of batch of residuals is initiated the dewatering process for this batch can not be controlled. If process parameters for a batch are not selected properly or filter cloth is damaged the entire batch will be of low cake concentration.

Notes: (1) Estimated assuming 20 cu. yd. trucks
(2) Include costs for dewatering and storage facilities. Disposal costs not included (1995 Dollars).
(3) Estimated 6 percent interest rate for 20 years

TABLE 4.2
(Continued)

DALECARLIA WATER TREATMENT PLANT RESIDUALS HANDLING FACILITY

COMPARISON OF CENTRIFUGES AND FILTER PRESSES

Item	Centrifuges	Filter Presses
Operation	- Continuous process - Higher level of automation - Easier to operate - Less operator attention needed - Less staff required - Less operator training needed	- Batch process - More staff required - More skilled operators needed - Operator assistance needed for removing cake from filter plates at the end of each batch

Maintenance	- Less maintenance staff needed
	- Less equipment to maintain:
	  - Feed pumps
	  - Centrifuges
	  - Centrifuge drives
	- Smaller spare parts inventory
		- More maintenance intensive
		- More equipment to maintain:
		  - Feed pumps
		  - Filter presses
		  - Filter press hydraulic drives
		  - Air compressor system
		  - Filter cloth washing system
		  - Filter cloth replacement

Safety	- Safer for operation and maintenance
	- Operators are not in contact with residuals during operation or maintenance
	- All moving parts of equipment are completely enclosed
	- Cleaner working areas
		- Safety concerns:
		  - Operators could be exposed to sprays during filter cloth washing, and during hosing of filter press area after every batch cycle.
		  - Area around filter presses is slippery after hosing
		  - Potential for accidents during manual cake removal from filter plates
		  - High pressure air and hydraulic moving systems could present danger if not operated properly.

TABLE 4.2
(Continued)

DALECARLIA WATER TREATMENT PLANT RESIDUALS HANDLING FACILITY

COMPARISON OF CENTRIFUGES AND FILTER PRESSES

Item	Centrifuges	Filter Presses
Odors and Noise	- Controlled odor emissions. Centrifuges are completely enclosed and odors emitted from residuals could be easily contained - High noise emissions from centrifuges - Noise can be effectively controlled	- Odor potential. Odors emitted from filter presses can not be contained directly - High noise emissions from filter press feed pumps - Noise can be effectively controlled
Space and Structural Requirements	- Smaller facility footprint - Lighter structure, smaller columns slabs and foundations	- Approximately 20 % larger area of dewatering building - Heavier structure
Future Technology Development	- Increased centrifuge speed (4,000 g vs. 2,500 g) - Higher cake concentration (35 to 40%) - More reliable motor drives - More durable bowl materials - Higher speed (4,000 g) units already available	- Lower overall cost - Improved reliability and safety - Higher level of automation - Improved filter cloth washing system

DALECARLIA WATE REATMENT PLANT
RESIDUALS HANDLING FACILITIES
CENTRIFUGE AND FILTER PRESS DEWATERING AND DISPOSAL COSTS
TWO SHIFT OPERATION

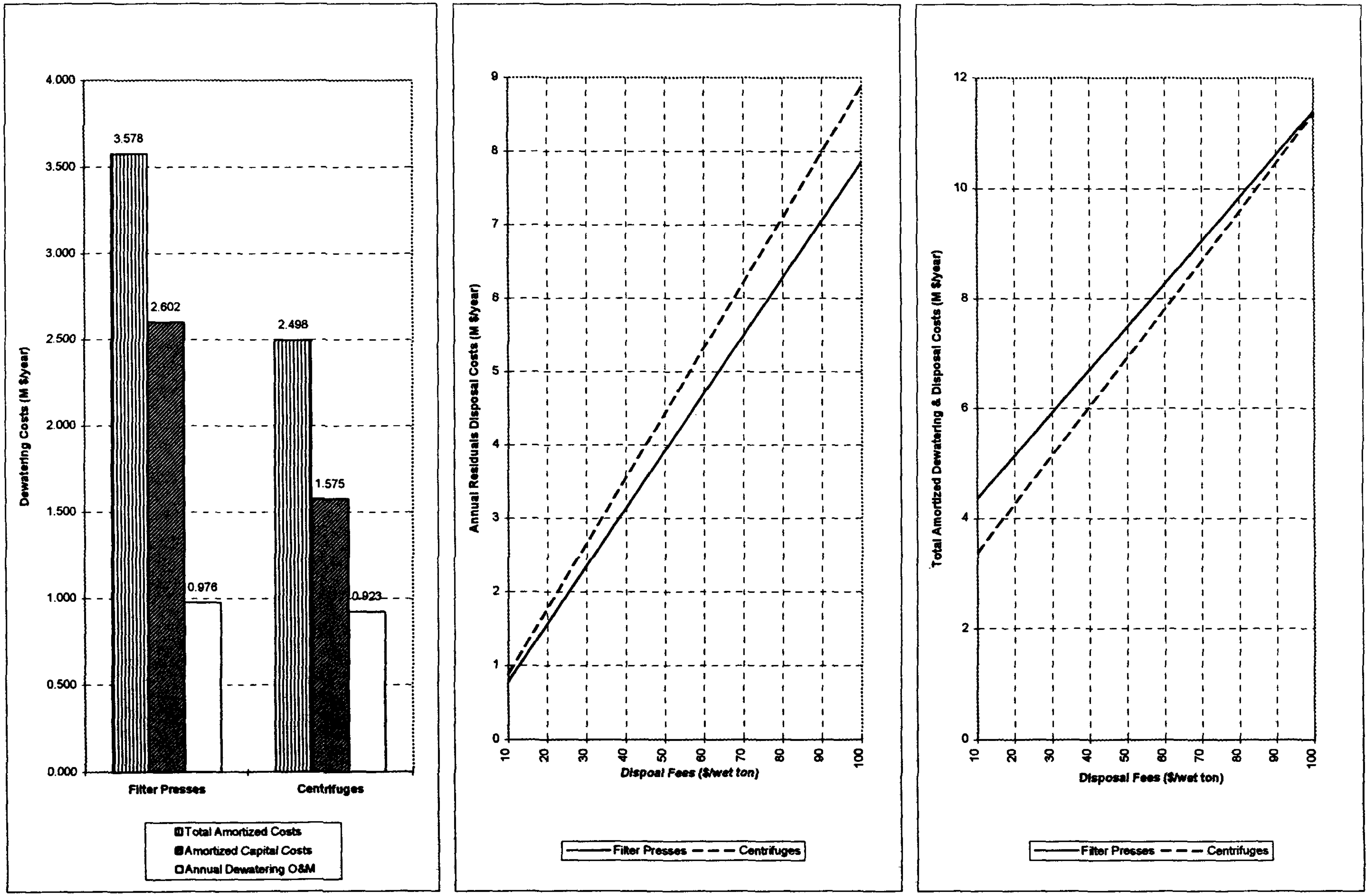


Figure 4.2

DALECARLIA WATER TREATMENT PLANT
RESIDUALS HANDLING FACILITY FACILITIES
CENTRIFUGE AND FILTER PRESS
DEWATERING AND DISPOSAL COSTS
THREE SHIFT OPERATION

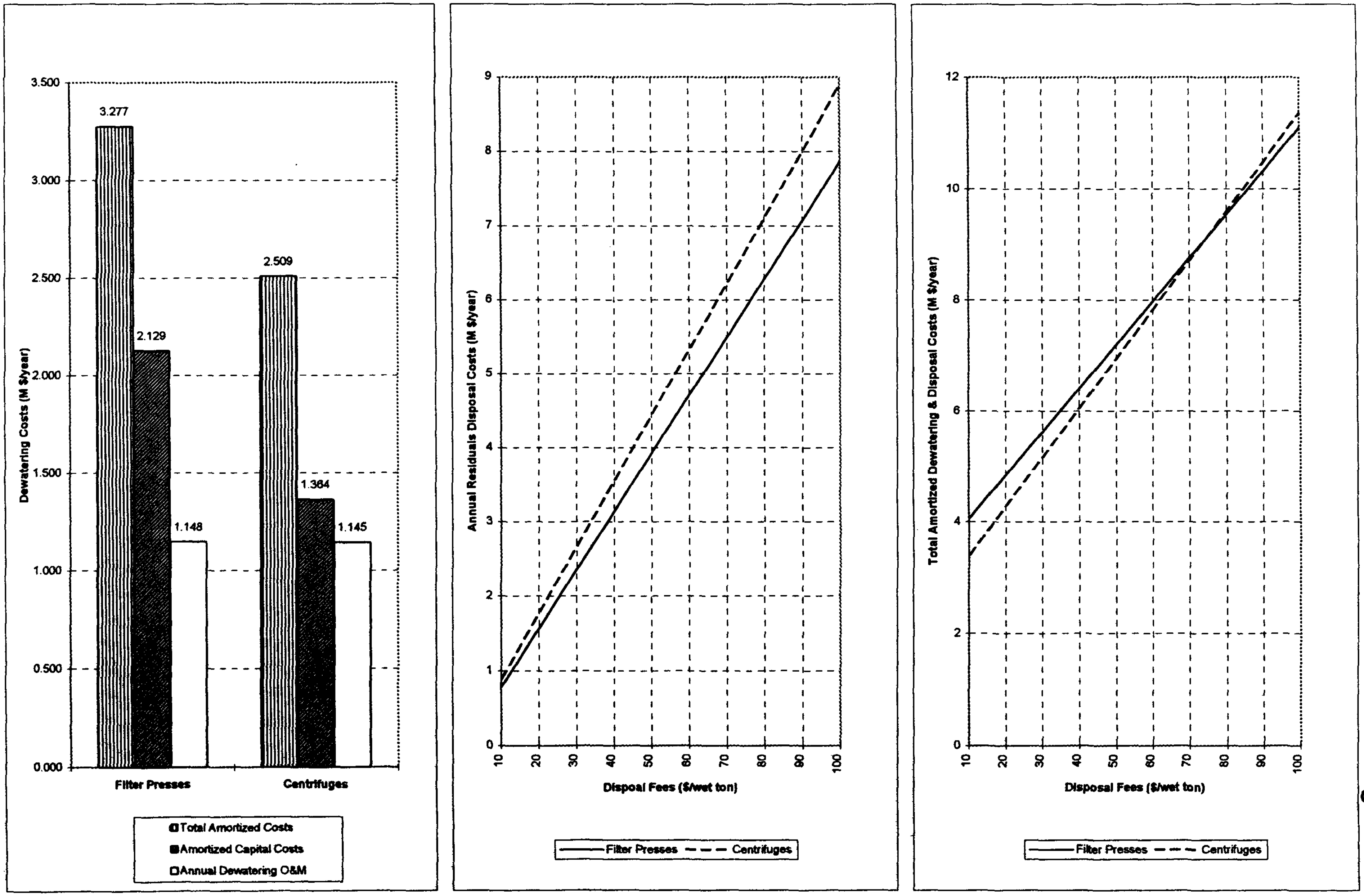


Figure 4.3

Based on preliminary investigations, the disposal fees for Dalecarlia residuals are expected to be in a range of $30/wet ton to $60/wet ton. For this disposal cost range, FIGURES 4.2 and 4.3 show that centrifuges would be more cost effective than filter presses.

The analysis of advantages and disadvantages and economics provided the basis upon which the proposal to utilize the centrifuge dewatering technology was based. The recommended dewatering concept includes centrifuges operating in two shifts, 5 days per week rather than filter presses because of the following:

- Operational and maintenance flexibility
- Minimum noise and odors during the night period
- Lower operation costs
- Higher reliability in producing high cake solids
- Less staff required for operations

The design evaluations also demonstrated the need for dewatered residuals storage at the dewatering facility. This need is based on the likelihood that disposal trucks may not always be available for loading from the centrifuge operation. Alternatives that were considered for cake solids storage included the following:

- Circular steel hoppers beneath each centrifuge
- Rectangular concrete hoppers below the centrifuges with horizontal conveyance of the dewatered residuals above the hoppers
- Rectangular or circular hoppers located adjacent to the centrifuge area with system of inclined, vertical and horizontal solids conveyance
- Rectangular concrete hoppers below each pair of centrifuges

The design proposes the use of three rectangular storage hoppers, one under each pair of centrifuge units, for dewatered residuals cake storage. Hopper storage capacity is based on providing a volume equivalent to approximately 7 hours (an entire shift) of centrifuge operation at maximum conditions. This arrangement provided the most economical building design and eliminated the requirement for a solids conveyor system.

4.4 Proposed Residuals Collection and Treatment Operation

Residuals removal, processing and dewatering rates were evaluated under several operational alternatives. Evaluation objectives were to minimize the size and capacity of the residuals collection and treatment facilities and associated costs, while simultaneously providing ample operational reliability and flexibility as well as constructability.

The initial evaluation of operating concepts was centered around whether the Dalecarlia sedimentation basins should be equipped with continuous residuals removal facilities or manually cleaned or a combination thereof. A detailed evaluation of these alternatives, including facility sizing, operating schedule and associated costs was presented in *Alternative Operating Concepts for Residuals Handling Facilities and Presentation of Proposed Design Concept-Technical Memo No. 8*. The alternatives are defined as follows:

Alternative 1- Manual Cleaning of All Basins
Alternative 2- Continuous Cleaning of Basins 1 and 2; Manual Cleaning of Basins 3 and 4
Alternative 3- Continuous Cleaning of All Basins

The manual cleaning concepts (Alternatives 1 and 2) would have required a large residuals equalization basin to receive the residuals from the sedimentations basins during a manual cleaning operation in order to avoid increasing the size of tankage associated with the thickening and dewatering operations. Regardless of the method of collecting residuals from the Dalecarlia sedimentation basins, the residuals accumulated at both the Georgetown Reservoir and Dalecarlia Forebay were to be collected by dredging to a local equalization basin and then conveyed to the Dalecarlia thickening/dewatering site. The dredging operation was proposed to occur at those two sites simultaneously over 9 months each year. Dredging would not occur during the winter months due the difficulty in operating the dredges during adverse weather conditions.

It was also determined that by processing only the sedimentation basin solids during the winter months, (typically high residuals production periods), a downsizing of the thickening and dewatering facilities could be effected. As previously noted, the proposed method for collecting residuals from the Dalecarlia sedimentation basins involves a continuous mechanical removal operation from all four basins (Alternative 3 of *Technical Memo No. 8*). A schematic reflecting the above referenced Alternative 3 residuals handling concept was presented by FIGURE 1.2, and engineering design parameters proposed can be reviewed on Sheets M-2 and M-3 (Book 2 of 5). The key reasons that Alternative 3 is proposed as the basis of facility design include the following:

- Lowest overall capital, operation and maintenance, and amortized costs
- Lowest space requirements
- Lowest staffing requirements
- Safest operation and maintenance
- Good reliability

The above-referenced operating concept (Alternative 3) involves a simultaneous dredging operation over a nine month, 5-day per week from both the Georgetown Reservoir and Dalecarlia Forebay. Accordingly, two sets of dredge crews would be required. Pursuant to WAD comments relative to *Technical Memorandum No. 8*, provided during the July 1995 Team Meeting No.10, a revised dredging operational design criteria was evaluated and subsequently determined to be a preferred mode of operation. The revised operational design criteria employs the use of a single dredge crew, for nine months each year, with 4½ months at Georgetown Reservoir followed by 4½ months at the Dalecarlia Forebay (or visa versa). *Since an equivalent quantity of total annual* residuals accumulation is to be removed at each dredging site in a 4½ month per year schedule rather than the original

9-month period schedule, the proposed removal and conveyance rates from the two residuals dredging sites have been increased correspondingly.

While adjusting the design tankage sizing to accommodate WAD's revised dredging schedule, it was determined through site sediment sampling of the accumulated residuals at Georgetown Reservoir that a higher percent solids residuals concentration could be consistently achieved during

RESIDUALS COLLECTION RATES
OVER VARIOUS OPERATIONAL COLLECTION PERIOD ALTERNATIVES
TABLE 4.3

	REQUIRED RESIDUALS COLLECTION (lbs/Day) (6)								
	Annual Average (365 Days)	**9 Month Accumulation (2) Spring, Summer & Fall (224 Days)**		**4 ½ Month Accumulation (3) Spring & ½ Summer (137 Days)**		**4 ½ Month Accumulation (4) ½ Summer & Fall (137 Days)**		**3 Month Accumulation (5) Winter Only (91 Days)**	
LOCATION OF RESIDUALS ACCUMULATION	Daily Accumulation	Daily Avg.	Max. Month	Daily Avg.	Max. Month	Daily Avg.	Max. Month	Daily Avg.	Max. Month
Dalecarlia Sedimentation Basins (1)	28,000	29,120	68,800	36,900	68,800	21,400	68,800	26,600	68,800
Georgetown Reservoir (8)	23,400	48,000	48,000	94,900	94,900	N/A	N/A	N/A	N/A
Dalecarlia Reservoir (7) (8)	20,700	42,000	42,000	N/A	N/A	83,950	83,950	N/A	N/A
TOTAL	72,100	119,120	158,800	131,800	163,700	105,350	152,750	26,600	68,800

Notes:

(1) Sed. Basin Max. Month Represents "worst case" Enhanced Coagulation Productions, Daily Average Seasonal Accumulations are from Tech Memo 5, Table 6.

(2) Georgetown & Dalecarlia Reservoirs dredged simultaneously over 9 month Operation Period.

(3) Georgetown Reservoir dredged over 4 ½ months.

(4) Dalecarlia Reservoir dredged over 4 ½ months.

(5) No Reservoir dredging.

(6) All collection rates are based upon Projected Enhanced Coagulation Residual Production (refer to Tech Memo 5). Four years of Actual Facility Data statistically evaluated.

(7) Includes solids in backwash wastewater currently recycled to Dalecarlia Reservoir.

(8) Reservoir Dredging not impacted by seasonal Avg. and Maximum Production Conditions. Dredging based on the accumulation of solids based upon Annual Avg. production numbers.

5.0 WASTE STREAMS HANDLING AND TREATMENT

Waste streams handling and treatment alternatives were evaluated and presented in *Waste Streams Handling and Treatment Alternatives, Technical Memo No. 10*, dated April 1996. This technical memo provided:

- a detailed listing of all existing waste streams generated at the Dalecarlia Water Treatment Plant site including descriptions and quantification where possible;
- additional future waste streams, including those that are by-products of the proposed residuals treatment operation;
- a discussion of regulatory requirements related to waste steam handling; results from bench test study which assessed potential impacts of waste stream recycle and of waste stream pretreatment prior to recycling;
- an evaluation of handling alternatives for each of the waste streams;
- and the evaluation of treatment alternatives for the recycled waste streams.

The evaluation objective was to minimize contaminated river discharges while ensuring that any waste streams recycled to the Dalecarlia Forebay are adequately treated and/or pose no adverse impacts. In accordance with the modified scope of work, the waste streams handling issues and alternatives have been developed fully as part of this Design Memorandum, whereas the future recycle treatment facility has been developed through conceptual design (10% complete).

5.1 *Existing Waste Streams and Conveyance Facilities*

A schematic of the existing waste streams and conveyance facilities is provided on Sheet M-9 (Book 2 of 5). Each waste stream is numbered and grouped according to area and discharge location. A description of each waste stream with pertinent information such as origin, destination, waste pollutants (if known or applicable), estimated flow rate and other clarification comments were provided as APPENDIX A of the above-referenced *Technical Memo No. 10.* Provided below is a general description of each waste stream category along with a description of the major conveyance facilities.

5.1.1 Filter Backwash Waste

Filter backwash wastewater comprises the most significant portion of the existing waste streams at Dalecarlia WTP. There are two banks of filters, generally referred to as the East and West filters. The East filters consist of 26 filters (No. 1 to 26) with a surface area of 1,674 square feet each (2 bays at 837 sf). The West filters consist of 10 filters in current operation (Nos. 27 to 36), and 11.5 filters (Nos. 37 to 48), which are not presently equipped for service. The West bank filters have a surface area of 2,442 square feet each (2 bays at 1,221 sf). All of the filter backwash waste gravity discharges into two main plant drains and flows into the Backwash Recovery Pumping Station for subsequent recycling to the Dalecarlia Reservoir. A statistical evaluation and an operational based evaluation were utilized to determine the waste volume attributed to the filter backwashing operations. The details of this backwash waste volume evaluation are presented in *Technical Memo No. 10.* The current maximum daily average backwash waste volume has been determined to be equivalent to a rate of approximately 3,150 gpm based on the evaluation of filter washing operations. Design turbidity and TSS values, ascertained during prior testing, are 20 NTU and 50 mg/l, respectively.

5.1.2 Plant Storm Drainage

Approximately 35% of the total number of waste stream sources are flows generated by rain runoff (from pervious and impervious ground surfaces and roofs. Approximately one half of the impervious runoff is from property owned by the USCOE at the Dalecarlia WTP reservation) flows directly to the Potomac River, the other half is "recycled" to the Dalecarlia Reservoir via the Backwash Recovery Pumping Station, a form of storm water management water quality treatment. The volume of runoff is obviously storm dependent and unpredictable. However, peak runoff flow rates based on a typical 1-year storm event have been estimated for each of the storm runoff sources and were presented in *Technical Memo No. 10*.

The 1-year storm event represents the 99 percentile of storm events, whereby only 1% of all storms exceed this flow. Storm flows are currently directed to the Backwash Recovery Pumping Station for recycle via the two junction chambers indicated on Sheet M-9. A larger flow, generated by a storm with significant intensity, would overflow the existing weirs in these chambers and pass to the river. The 1-year storm flow method is a criterion established pursuant to Maryland Department of Environment - Water Management Administration for a Type II, 24 hour rain event. The 1-year storm event utilizing Montgomery County design criteria is the equivalent of 2.6 inches rainfall.

Total estimated peak runoff rate for storm drainage now directed to the Backwash Recovery Pumping Station for the 1-year storm event is in excess of 13,000 gpm, or approximately 400 gpm if evenly distributed over a 24-hour period.

5.1.3 Sedimentation Basin Decant

Sedimentation Basins 1 and 2 have provisions for decanting a portion of the basin volume to the plant drain prior to a scheduled basin cleaning operation. The decant flow rate is controlled by gates, which can be lowered to elevation 132. The decant basin flow rate is controlled to prevent overflowing the existing weir plates and overwhelming the capacity of the Backwash Recovery Pumping Station, and/or to permit the continuance of filter washes, as required. Decant flows are controlled to ensure that filter washes would not be impeded, providing approximately 3 filter washes per eight hour/shift.

5.1.4 Miscellaneous Plant Leakage

Another source of waste flow is miscellaneous plant leakage. Foundation drains under the sedimentation basins discharge an estimated 2,000 gpm flow into the C&O Canal. This flow is in the process of being redirected by the Washington Aqueduct staff to the Potomac River via the existing tail race as a permitted discharge and, therefore, need not be included in the evaluation of waste stream handling alternatives. Foundation drains from the 30 mg clear water basin, Filter Building, Chemical Building and Finished Water Pumping Station contribute approximately 200 gpm to the waste stream flow. All of these sources are currently being recycled to the Dalecarlia Reservoir via the Backwash Recovery Pumping Station. Seepage to underdrains from the raw water, settled water and filtered water conduits are also directed to the station, although flow rates can not be determined. Infiltration from the Dalecarlia Reservoir into the 9-foot by-pass conduit and groundwater infiltration into the 84-inch and 102-inch spillway channel conduit underdrains contribute a small but steady flow that currently passes to the river. The leakage from the various hydraulic structures typically increases during colder months due to shrinkage of the concrete structures and corresponding joints and cracks opening slightly wider.

5.1.5 Cooling Water and Valve Operating Water

The cooling system in the Finished Water Pumping Station is another source of the waste stream as the water is discarded. The cooling system water is also directed to waste after being used to operate valves in the Chemical, Filter and Pumping Station Buildings. The total flow for these functions has been estimated at approximately 1 to 1.1 mgd, is currently directed to the Backwash Recovery Pumping Station at Junction Chamber No. 2 and recycled to the Dalecarlia Reservoir.

5.1.6 Miscellaneous Overflows

This contributor to the total waste stream volume results from infrequent and unpredictable overflows of the Dalecarlia Reservoir spillway, the 30 mg clear water basin, the Finished Water Pumping Station suction gallery, the sedimentation basins, the 84-inch/54-inch plant drain junction chamber (Junction Chamber No. 1), the wash water storage tank and the carbon facilities. A general discharge permit with MDE allows the WTP to discharge chlorinated water through the plant drain into the Potomac River (30 mg clearwell drainage and miscellaneous plant overflows).

Currently, the 30 mg clearwell overflow and suction gallery overflow streams can be handled via the plant drain and river discharged per the MDE permit. Overflows from Junction Chamber No. 1, the wash water storage tank and carbon facilities are currently recycled.

5.1.7 Miscellaneous Plant Drains

This category of waste flow is composed of contaminated water and chemical discharges into sinks and floor drains in the Chemical, Chlorine, Pumping Station and Filter Buildings. The contamination may be significant or insignificant but the flow quantities are minimal. The sampling water drains through laboratory sinks and turbidimeter drains represents the largest contributions to this water source. These various flows are all included in the total waste flow currently directed to the Backwash Recovery Pumping Station and recycled to the Dalecarlia Reservoir.

5.1.8 Sanitary Waste

Sanitary waste streams include typical domestic wastes such as from toilet rooms, showers, drinking fountains and janitor closet service sinks. These streams originate in the Chemical Building and Finished Water Pumping Station. These waste streams are currently sewer discharged.

5.1.9 Plant Drain

As noted above, leakage and previous weir plates overflows through Junction Chamber No. 1 continue in what is referred to as the 84" Plant Drain. Drainage from the Finished Water Pumping Station combines with this flow which continues on to Junction Chamber No. 2. A weir also exists at this location with submersible pumps located on the upstream side of the weir. This weir and pumps were installed in the recent past with the primary function of intercepting drainage from the Finished Water Pumping Station in order to minimize the amount of chlorinated water being directed to the river. The submersible pumps direct the flow to the Backwash Recovery Pumping Station for recycling to the Dalecarlia Reservoir.

The 84" Plant Drain continues beyond the overflow weir and combines with another 84" drain from the Reservoir overflow spillway. The combined Plant Drain continues as a 102" drain conduit to the Potomac River. An 8-inch drain collects the leakage from the 30 mg Clearwell Basin, conveys the flow below and along the 84-inch Plant Drain. This 8-inch underdrain penetrates into the wall of the 84-inch Plant Drain just prior to the junction with the other 84-inch plant drain. This flow averages an estimated 100 gpm and collects in an open tank within the 84-inch drain. It is pumped back into the upstream side of the weir at Junction Chamber No. 2 and is included in the flow now handled by the Backwash Recovery Pumping Station.

5.1.10 Finished Water Pumping Station Drain

A 7'x10' concrete drain extends along the entire length of the Finished Water Pumping Station. The current flows which enter this drain include the suction gallery overflow (large potential but infrequent source), nearby storm runoff, pump cooling water, valve operating water, foundation drains as well as discharge from equipment rooms and sump pumps. The drain transitions to an 84" diameter pipe just downstream from the station and combines with the 84" Plant Drain referred to above.

Existing drains at the east and west ends of the station now convey waste flows to sumps located at either end of the suction gallery. This flow is comprised of suction gallery floor drains, valve stuffing box drains, drinking fountains, sewage ejector pit floor drains as well as compressed air system drains. The existing sump pump now directs these waste flows from the east and west sumps to the Plant Drain. Another existing 4-inch drain at the east end of the station conveys drainage from equipment rooms (vacuum pumps, air filters, heater and refrigerant equipment) directly to the Plant Drain by gravity. An existing 6-inch drain at the west end of the station also conveys equipment room drainage directly to the Plant Drain. However, the latter drain also conveys a large volume of cooling water from the station cooling system previously referred to.

5.1.11 Filter Building Drains

Except for sanitary waste, all sources of drainage within the filter building enter either the East Filter Drain (FD-1) or the West Filter Drain (FD-2) as indicated on Sheet M-9. Due to the slope of the drain line leaving the Filter Building, significant storage volume is not available within these drain conduits for multiple concurrent filter backwashes.

The FD-2 connects to the FD-1 just upstream from Junction Chamber No.1, as shown on Sheet M-9. This chamber contains overflow weir plates that direct normal flows to the Backwash Recovery Pumping Station via a 54" gravity drain. Leakage around these plates continues into the original 84" plant drain as well as weir overflows during conditions such that the influent flow exceeds either the station capacity or the capacity of the 54" drain pipe.

5.1.12 Backwash Recovery Pumping Station

A description of the existing Backwash Recovery Pumping Station has been provided in Section 2.4 as related to its function as a "residuals generating" facility in pumping filter backwash waste. This station discharges to the Dalecarlia Reservoir via a 24-inch force main to a location near the plant intake structure. Because of the close proximity of the station discharge to the plant intake, the waste flow has a high potential to be recycled to the plant without any appreciable settling occurring in the reservoir. However, a series of pilot-scale studies conducted in January 1994 indicated that the location of the recycle waste discharge in vicinity of the plant intake does not have a significant impact on the finished water quality.

The flows currently pumped by the Backwash Recovery Pumping Station include many of the waste streams as described above. Since the flow rates for many of the above waste streams are intermittent and not readily quantified, a statistical analysis of the records for the Backwash Recovery Pumping Station was performed to determine waste flow rates now pumped by this facility. Based on this evaluation of the existing waste streams pumped by this station, the current maximum weekly average miscellaneous plant drainage/waste flow (excluding filter backwash waste) was estimated at 2,130 gpm (3.07 mgd) as noted by TABLE 5-1, and presented previously in *Technical Memo No. 10*.

The current average daily filter backwash waste rate has been determined, as noted above, to be approximately 3,150 gpm. Therefore, the Backwash Recovery Pumping Station would be expected to pump at an average daily rate of approximately 5,280 gpm (2,130 gpm miscellaneous waste + 3,150 gpm backwash waste) during periods of high miscellaneous waste stream flows.

TABLE 5 -1

STATISTICAL ANALYSIS
RANKED DATA FOR WASTE STREAM FLOWS

Total Flow Avg. Wkly. Pumped Flow (Mgd) (1)		=	**Backwash Flow Avg. Wkly. Pumped Flow (Mgd)** (2)		+	**Waste Flow Avg. Wkly. Pumped Flow (Mgd)** (3)	
Jan 94 to Nov 95	**Rank**	**Percent**	**Jan 94 to Nov 95**	**Rank**	**Percent**	**Jan 94 to Nov 95**	**Rank**
6.09	1	100.00%	4.04	1	100.00%	3.07	1
5.95	2	95.45%	3.8	2	95.45%	2.96	2
5.86	3	90.91%	3.69	3	90.91%	2.73	3
5.84	4	86.36%	3.66	4	86.36%	2.72	4
5.74	5	81.82%	3.55	5	81.82%	2.52	5
5.73	6	77.27%	3.54	6	77.27%	2.51	6
5.71	7	72.73%	3.45	7	72.73%	2.46	7
5.68	8	68.18%	3.43	8	63.64%	2.24	8
5.66	9	63.64%	3.43	9	63.64%	2.07	9
5.5	10	59.09%	3.37	10	59.09%	2.07	10
5.49	11	54.55%	3.32	11	54.55%	2.04	11
5.43	12	50.00%	3.29	12	50.00%	1.99	12
5.41	13	45.45%	3.24	13	45.45%	1.96	13
5.36	14	40.91%	3.23	14	36.36%	1.94	14
5.3	15	36.36%	3.23	15	36.36%	1.93	15
5.22	16	31.82%	3.22	16	31.82%	1.88	16
5.16	17	27.27%	3.2	17	27.27%	1.8	17
4.98	18	22.73%	3.13	18	18.18%	1.74	18
4.94	19	18.18%	3.13	19	18.18%	1.7	19
4.92	20	13.64%	2.64	20	13.64%	1.63	20
4.77	21	9.09%	2.26	21	9.09%	1.62	21
4.23	22	4.55%	1.99	22	4.55%	1.55	22
3.43	23	0.00%	1.99	23	0.00%	1.44	23

NOTES:

1) Pumped flow data based on records of Backwash Recovery Pumping Station (Run Time).
2) Backwash Flow data based on backwash flow totalizer records.
3) Waste Flow data based on difference between Pumped Flow and Backwash Flow (1-2). The 50th and 100th percentile waste flows are used on Tables 5-3, 5-4 and Table 7-13, 1380 gpm (1.99 mgd) and 2130 gpm (3.07 mgd) respectively.

5.2 Additional Future Waste Streams

The proposed residuals collection and treatment facility is to include gravity thickeners and centrifuges which would generate two new waste streams: gravity thickener supernatant and centrate.

Two other additional waste streams which could be generated in the future are: filter-to-waste flow from all filters and filter backwash waste water from the existing 11.5 filters which currently are not equipped for operation. Key characteristics of these various future waste streams were presented in *Technical Memo No. 10* and summarized below.

5.2.1 Thickener Supernatant

The proposed gravity thickeners would be operated continuously (24 hrs/day and 7 days/week). Thickener supernatant flow has been determined on the basis of total gallons per day for the various design conditions. These conditions are affected by the diurnal operational variability expected from the residuals flow rates to the thickeners and underflow rates of thickened residual withdrawn from the thickeners for dewatering. Although details of the proposed thickener operation are presented hereinafter in Section 7, the various supernatant flow conditions are summarized as follows to facilitate development of the waste stream flow design basis and impact upon the flow analysis to the Backwash Recovery Pumping Station. The maximum thickener supernatant flow would be expected to occur during the 4½ month period when the Georgetown Reservoir is being dredged simultaneously with residuals being removed from the Dalecarlia Sedimentation Basins.

Although a solids concentration of 1% for reservoir dredging solids has been used to conservatively size the hydraulic capacity of gravity thickeners, a solids concentration of 1.5% has been used, as previously noted, for sizing of the dredged residuals conveyance facilities. The 1.5% solids for dredged residuals has also been utilized for sizing the waste streams handling facilities and includes the centrate flow from the centrifuge operation returned to the gravity thickeners.

The following summarizes the design conditions for determining the maximum month solids criteria thickeners (utilizing 1.5% dredged Residuals Concentration Criteria, TABLE 7.10):

Thickener Inflows:

Dalecarlia Sedimentation Basin	(68,800 lbs/day @ 0.5% solids)	=	1,645,000 gpd
Georgetown Reservoir	(94,900 lbs/day @ 1.5% solids)	=	758,600 gpd
Centrifuge Centrate		=	890,300 gpd
	Total Inflows		3,298,900 gpd

Thickener Withdrawals:

Underflow	(202,000 lbs/day @ 2.5% solids)	=	969,300 gpd

Thickener Supernatant	(Total Inflows - Withdrawals)	=	2,329,600 gpd

Total suspended solids (TSS) concentration of 160 mg/l is used as a design parameter for the thickener supernatant. The supernatant turbidity design value is assumed to be equal to the TSS concentration (160 ntu).

5.2.2 Centrate

The centrate would be generated as a waste stream from the dewatering of the thickened residuals in high-solids centrifuges. Cationic polymer would be added to enhance residuals dewatering. The centrate would contain amounts of this polymer. The centrifuge process would operate 14 hrs/day and 5 days/week.

The maximum daily centrate flow would be expected to occur, as described above, under the thickener operation, during the proposed 4½ month residuals processing period of simultaneous dredging of the Georgetown Reservoir and continuous residuals removal from the Dalecarlia Sedimentation Basins. The maximum projected daily centrate flow under these conditions is 890,300 gpd. Based on the results of the November 1994 dewatering pilot study (Technical Memorandum No. 7), centrate TSS concentration is projected to be in the range of 50 to 200 mg/l with an average value of 120 mg/l. Representative centrate turbidity data is not available. Centrate turbidity is assumed equal to the TSS concentration for the purposes of this study.

5.2.3 Filter-to-Waste Flow

An operational method to eliminate the turbidity spikes typically associated with filter break-in following a filter backwash is referred to as "Filter to Waste". This period wastes the initial portion of the filter effluent (e.g. the first 3 to 5 minutes immediately after placing that filter back into service following a wash). The Dalecarlia WTP does not currently have valving capability to waste the initial filter effluent, however, this type of filter-to-waste modification is being considered and has, therefore, been considered herein. The estimated filter-to-waste flow rate would average 450 gpm (0.65 mgd) with turbidity and TSS concentration approximated at 1 ntu and 1 mg/l, respectively.

5.2.4 Additional Filter Backwash Water

The West filter bank contains 11.5 off-line filters, currently non-operational. In the event that these filter units are equipped and brought in service at a future time, the additional average daily flow of spent filter backwash water would be approximately 1,250 gpm (1.8 mgd).

5.2.5 Sedimentation Basin Decant

Sedimentation Basins 3 and 4 are proposed to be equipped with facilities to decant a portion of the basin volume to the plant drain as part of the Residuals Collection and Treatment project. As previously noted, Basins 1 and 2 already have such provisions. The expected frequency of basin draining and accompanying decant waste volume would decrease upon implementation of the proposed residuals collection equipment in the basins. Therefore, the total annual volume of the basin decant waste stream is expected to be no greater than the current amount. The basin decanting flow rates would be manually controlled such that the Backwash Recovery Pumping Station would not be overwhelmed and to assure that scheduled filter backwashing would not be impeded.

5.3 Regulatory Requirements for Waste Stream Handling

Regulatory requirements associated with waste stream discharge, stormwater management, and recycle issues were presented in *Technical Memo No. 10* and are summarized hereinafter.

5.3.1 Discharge Regulatory Issues

The Dalecarlia WTP engineering staff has, or is currently attempting to obtain discharge permits to allow continued Potomac River discharging of several of its existing waste streams. These permits, if not ascertained or if not renewed upon expiration, might force the Aqueduct to prepare very conservative contingency plans for handling the existing waste streams. Permits currently related to the evaluation of waste streams handling and treatment alternatives include:

- USEPA NPDES Permit - allowing continued discharge of alum residuals, standing permit DC0000019 expired May 1994.

- USEPA General WTP Discharge Permit - currently being sought for *'clean water'* flows from the sedimentation basin underdrains (basin leakage), and flows from the periodic draining of the Georgetown Conduit and City Tunnel Conduit for inspection purposes. This permit would cover Aqueduct flows discharged within Washington D.C.

- MDE General WTP Discharge Permit - currently being sought for *'clean water'* flows from the 30 mg Dalecarlia Clearwell (overflows and foundation drains), and flows from the periodic draining of Raw Water Conduits for inspection purposes. This permit would cover Aqueduct flows discharged within the state of Maryland.

5.3.2 Stormwater Management Regulatory Issues

The co-mingling of storm flows with various other plant wastes occurs within the main plant drains as described above. This practice was long accepted throughout the United States, and the Dalecarlia stormwater flows were all originally configured for discharge into the Potomac River. The present configuration has many of these storm flows intercepted and diverted into the Backwash Recovery Pumping Station due to an EPA mandate in 1980.

The proposed improvements, which involve re-routing of certain storm flows, comply with federal, state and local stormwater management requirements. A description of the proposed improvements is provided in Section 5.1, and reflected on Sheet M-9 and M-10 and C-14 through C-18.

5.3.3 Recycle Regulatory Issues

Recycling waste streams to the intake or head of a water treatment plant has the potential to adversely affect the water treatment processes and the quality of the finished water. Potential undesirable constituents in the waste streams include Giardia and Cryptosporidium cysts, manganese, iron, total organic carbon (TOC), total trihalomethane (TTHM) precursors, and taste and odor.

In September 1994 the State of Maryland Department of Environment (MDE) published a *Policy on Recycle of Waste Streams in Surface Water Treatment Plants.* According to this policy, recycling of waste streams to the head of the water treatment plant is permissible under very controlled circumstances. Future surface water treatment plants would not be allowed to recycle waste streams without additional treatment. Plants currently recycling waste streams are required to provide waste stream treatment. The implementation and a full design of any of the "multiple barrier" proposed recycle treatment alternatives would be expected to comply with this policy.

The Safe Drinking Water Act Amendments of 1996 includes provisions that USEPA promulgate a regulation to govern the recycling of filter backwash water within the treatment process of a public water system. This regulation is to be promulgated within 4 years either separately or as part or as part of the proposed Enhance Surface Water Treatment Rule.

5.4 Waste Stream Bench Test Study

A four-day bench study was completed in the week of October 17, 1995 to assess potential impacts of waste stream recycle on the raw water quality of the Dalecarlia Reservoir Forebay, and to evaluate the efficiency of waste stream pretreatment prior to recycling to the Forebay. A description of and results from the waste stream bench test study were presented in *Technical Memo No. 10* and are summarized below.

5.4.1 Bench Test Protocol

The waste stream bench study included conducting jar settling tests on eight different blends of Forebay raw water, filter backwash, thickener supernatant and centrate. The proportion of the raw water and the waste streams in the blends were estimated based on the projected proportion of these flows in full-scale conditions. All jar tests described above were performed at three conditions:

- No polymer addition
- Addition of 1 mg/l of LT22S cationic polymer
- Addition of 1 mg/l of LT20 nonionic polymer.

5.4.2. Impact of Waste Streams on Forebay Effluent Quality

Filter Backwash Water

Analysis of the jar settling test results indicates that backwash recycle would not have a significant impact on the raw water turbidity removal in the Forebay. Polymer addition to the raw water/filter backwash blend during jar testing did not result in an enhanced turbidity removal. Therefore, polymer addition to the blend of filter backwash and raw water in the Forebay may not be beneficial and is not recommended.

Blend of Filter Backwash Water, Thickener Supernatant and Centrate

Bench testing results indicate that combined waste stream recycle to the Forebay would result in a slight increase in raw water turbidity upon mixing. Nonionic polymer addition to the blend of combined waste streams and raw water would improve settleability. This combination of waste streams corresponds to the 14 hours/day when the dewatering (Centrification Process) is in operation.

Blend of Filter Backwash Water and Thickener Supernatant

This waste stream blend combination corresponds to periods when the proposed centrifuge facility would not be in operation (10 hrs/day during week days, and 24 hrs/day during weekends and holidays). Analysis of the jar test results for this condition indicates that the intermittent centrifuge operation would not have a measurable effect on the waste stream settleability in the Forebay.

5.4.3 Tentative Sedimentation Treatment Efficiency

Filter Backwash Water

The filter backwash water turbidity can be reduced significantly by sedimentation. Jar test results indicate that turbidity removal would be greatly enhanced with the addition of a cationic polymer at a dosage of 1.0 mg/l. Approximately 85 percent turbidity removal has been obtained during the bench testing.

Blend of Filter Backwash Water, Thickener Supernatant, and Centrate

The combined waste streams can be successfully treated by sedimentation. The turbidity reduction achieved by sedimentation of the combined waste streams (94 percent) was higher than that obtained by sedimentation of filter backwash water alone (85 percent) at the same cationic polymer dosage of 1 mg/l. This indicates that sedimentation of all combined waste streams would be more beneficial than providing sedimentation of the filter backwash only.

Blend of Filter Backwash Water and Thickener Supernatant

The combined waste stream of filter backwash water and thickener supernatant settles better than the filter backwash water alone. Turbidity removal efficiency during cationic polymer enhanced sedimentation (dosage of 1.0 mg/l) was approximately 90 percent. Analysis of the jar test results indicates that intermittent centrifuge performance would not have a significant impact on the waste stream sedimentation.

5.5 Waste Stream Handling Alternatives

Handling alternatives for each of the waste streams discussed above involves directing that waste stream to either existing or proposed piping/pumping. The handling alternative might also include treatment, as necessary and/or applicable. Each of the various existing waste streams presented above are to be handled by one of the following methods:

- Recycled to the Dalecarlia Forebay or Reservoir,
- Discharged to the Potomac River or C&O Canal, or
- Discharged into the Sanitary Sewer.

The determination as to which destination is most appropriate for each of the existing and future waste streams has been based upon the nature and quality of the waste stream, regulatory requirements and the feasibility of directing or re-directing a particular waste stream to that destination. TABLE 5.2, *Proposed Waste Streams Handling Improvements* provides a listing of the

TABLE 5.2

PROPOSED WASTE STREAMS HANDLING DESIGN CONCEPTS
(REVISED FROM TECHNICAL MEMORANDUM NO. 10, AS PER C.O.E. REVIEW COMMENTS, DATED APRIL 1, 1996, AND MEMORANDUM DATED MAY 16, 1996)

DALECARLIA RESERVATION AREAS - WASHINGTON AQUEDUCT DIVISION - U.S. ARMY, C.O.E.

	Description	Proposed Corrections to Existing Condition
A-1	Mapping Agency (Ruth Building) Storm Drainage	Maintain 9' by-pass conduit and 12" drain as the drainage pathway to the Dalecarlia Reservoir Spillway Channel (DRSC). Storm runoff currently goes to river.
A-2	Dalecarlia Reservoir Overflow	Maintain spillway and 7' x 6.5' culvert under Mac Arthur Boulevard as the drainage pathway to the DRSC.
A-3	Reservoir Infiltration	Maintain 9' by-pass conduit and 12" drain as the drainage pathway to the DRSC. Storm runoff currently goes to river.
B-4	30 M.G. Clear Water Basin Overflow	Remain as is. Overflows are rare and within scope of discharge permit.
B-5	Surface drainage from the AMS parking lot and garage area	Remain as is. Storm runoff currently goes to river.
B-6	Surface Drainage from the North End of the Middle Parking Lot and the Ground over and Around the 30 M.G. Clear Water Basin.	Remain as is. Storm runoff currently goes to river.
C-7	Surface Drainage from Administration Building Parking Lot, and Sub-surface Drains	Install an oil and grit separator between storm sewer and wash water sewer (also called Filter Drain, FD-1) to prevent pavement surface pollutants from entering raw water supply.
C-8	Arlington Low Lift Building Floor Drain Flows	Remain as is. Pipe invert is too deep to connect to proposed oil and grit separator for C-7 above.
C-9	Surface Runoff from Lawn Area Between Sed. Basin 1 and MacArthur Blvd.	Remain as is. Drainage area is entirely pervious. Storm runoff is recycled to reservoir.
C-10	Surface Runoff from Lawn and Road Areas over and Adjacent to 15 M.G. Clear Water Basin.	Install an oil and grit separator between the last catch basin and point of discharge into the plant drain at the drop manhole on the northeast corner of the Chemical Building.

TABLE 5.2

PROPOSED WASTE STREAMS HANDLING DESIGN CONCEPTS (REVISED FROM TECHNICAL MEMORANDUM NO. 10, AS PER C.O.E. REVIEW COMMENTS, DATED APRIL 1, 1996, AND MEMORANDUM DATED MAY 16, 1996)

	Description	Proposed Corrections to Existing Condition
C-11	Surface Runoff from Old Filter Building Roof	Remain as is. Return to raw water supply serves as storm water management quality treatment of impervious runoff without polluting raw water supply excessively.
C-12	Sediment Basins 1 and 2 Sump Drains.	Remain as is. Serves as emergency or maintenance draw down if necessary.
C-13	Backwash	Remain as is. Pollutant levels better or same as raw water supply.
C-14	Valve leakage	Remain as is. Pollutant levels better or same as raw water supply.
C-15	Filtered Water Floor Drain Flows	Remain as is. Pollutant levels better or same as raw water supply.
C-16	3" Lime Feed By-pass Drain	Remain as is. Effect on raw water pH negligible.
C-17	Chemical Building Foundation Seepage	Remain as is. Pollutant levels better or same as raw water supply.
C-18	Raw Water Conduits 12" Blow-off Drain Flow	Remain as is. Pollutant is raw water.
C-19	Surface Runoff from Chemical Building Roof	Remain as is. Return to raw water supply serves as storm water management quality treatment of impervious runoff without polluting raw water supply excessively.
C-20	Chemical and Biological Laboratory and Dark Room Sink Flows; Chlorine, Future Coagulant and Sulphur Dioxide Feeder Room Floor Drain Spills.	Intercept at drop manhole at NE corner of Chemical Building and extend to sanitary sewer directly to the north.
C-21	Surface Runoff from the west side of the New Filter Building and Chemical Building	Segregate pervious from impervious sources of runoff. Pervious should remain as is, draining to Filter Drain, FD-2. Install an oil and grit separator to the storm drain collecting runoff from the catch basins on the road to the west entrance of the Chemical Building garage.
D-22	Surface Runoff from Lawn and Parking Lot Areas North of the Chemical Building	Install an oil and grit separator between the last manhole and point of discharge into the plant drain at the drop manhole on the northwest corner of the Chemical Building.

TABLE 5.2

PROPOSED WASTE STREAMS HANDLING DESIGN CONCEPTS
(REVISED FROM TECHNICAL MEMORANDUM NO. 10, AS PER C.O.E. REVIEW COMMENTS, DATED APRIL 1, 1996, AND MEMORANDUM DATED MAY 16, 1996)

	Description	Proposed Corrections to Existing Condition
D-23	Surface Runoff from New Filter Building roof.	Remain as is. (See note for 19 above).
D-24	Backwash	Remain as is. Pollutant levels better or same as raw water supply.
D-25	Valve Leakage	Remain as is. Pollutant levels better or same as raw water supply.
D-26	Raw Water Conduit Seepage	Remain as is. Pollutant is raw water.
D-27	Seepage from New Filter Influent Conduit and Dehumidifier Chamber beneath , and between Filters 41 and 43	Remain as is. Pollutant levels better or same as raw water supply.
D-28	Filtered Water Floor Drain and Underdrain Flows	Remain as is. Pollutant levels better or same as raw water supply.
D-29	Chemical Building Garage Floor Spills and Surface Runoff from Chemical Building Roof.	Intercept and divert roof drain and floor drain at extreme southerly end of garage to the catch basin on the south side of road to west garage entrance. This flow will then pass through the oil and grit separator mentioned in C-21 above.
D-30	Carbon Tunnel Floor and Screw Conveyor Tunnel Floor Spills; Chemical Building Foundation Seepage	Remain as is. Carbon tunnel floor drain, conveyor tunnel floor drain and foundation drain pollutant levels better or same as raw water supply.
D-31	Chemical Building First Floor Area Drain Spills and Surface Runoff from Chemical Building Roof	Combined with D-32 below, under main floor level of the Chemical Building. Intercept at drop manhole at northwest corner of Chemical Building and extend to combine with D-31 above under main floor level of the Chemical Building.
D-32	Sample Receiving Room and Analytical Research Laboratory Sink Flows; Chemical Building First Floor Area Drain Spills	Intercept at drop manhole at NW corner of Chemical Building and extend to sanitary sewer directly to the north.

TABLE 5.2

PROPOSED WASTE STREAMS HANDLING DESIGN CONCEPTS (REVISED FROM TECHNICAL MEMORANDUM NO. 10, AS PER C.O.E. REVIEW COMMENTS, DATED APRIL 1, 1996, AND MEMORANDUM DATED MAY 16, 1996)

	Description	**Proposed Corrections to Existing Condition**
D-33	Overflow and Drain Flows from Wash Water Storage Tank	Remain as is. Presumed pollutant level better than raw water supply.
D-34	Carbon Facilities Overflow	Remain as is. Presumed pollutant level better than raw water supply.
E-35	Flows Through 84" Plant Drain at Junction of 54" Drain	Replace aluminum stop plates with more watertight valve and concrete weir.
F-36	Surface Runoff from Entrance Road and Adjacent Lawn Areas South of the Finished Water Pumping Station	Segregate pervious from impervious sources of runoff. Pervious should remain as is, draining ultimately to the backwash pumping station. Install an oil and grit separator between the last catch basin collecting runoff from Dalecarlia Place and the drop manhole conveying flow to the Pumping Station main drain.
F-37	Suction Gallery Overflows	Remain as is. Overflows are rare and within scope of discharge permit.
F-38	Pump Coolant and Valve Water Drains	Improve existing condition of discharge to backwash pumping station via blockage and submersible pumps.
F-39	Sump Pump Flows	Divert waste stream 41 to the respective sump pit beneath their current alignments at either end of the pumping station to combine with the sump pump flows. Divert sump pump discharge to sewage ejector pump intake, elev. 99.83, to be pumped to the public sanitary sewer in MacArthur Boulevard.
F-40	6" Air Conditioning Drain Flows, West End.	Remain as is. Finished water used as coolant in air conditioner units acceptable to recycle. Improve existing condition of discharge to backwash pumping station via blockage and submersible pumps.
F-41	4" Air Filter Drain Flows, East End	Divert discharge to new ejector pit in suction gallery. (See note 39 above).
F-42	6" Foundation Drain Seepage	Improve existing condition of discharge to backwash pumping station via blockage and submersible pumps.
G-43	30 M.G. Clear Water Basin 36" Blow-Off Drain	Install a submersible pump in the bottom of the 30 M.G. Clear Water Basin Dry Well to decant the last 15 million gallons by discharging through the existing 24" FM currently used by the Backwash Recovery Pump Station into the reservoir.

TABLE 5.2

PROPOSED WASTE STREAMS HANDLING DESIGN CONCEPTS (REVISED FROM TECHNICAL MEMORANDUM NO. 10, AS PER C.O.E. REVIEW COMMENTS, DATED APRIL 1, 1996, AND MEMORANDUM DATED MAY 16, 1996)

	Description	Proposed Corrections to Existing Condition
G-44	Chlorine Building Flows	Scrubber room spills are contained; remain as is. Remain as is. Presumed pollutant level negligible due to the low flows.
G-45	Surface Runoff From Lawn, Road and Parking Lot Areas Between the Chlorine and Chemical Buildings	Remain as is. Storm runoff currently goes to river.
G-46	30 M.G. Clear Water Basin Foundation Drains Flow	The upgrade to the 84" Plant Drain submersible pumps for Items F-39, 40 and 42 requires the severing of the 84" Drain. Divert the 8" drain into this pump station as it must be severed also.
G-47	84" The DRSC Conduit Underdrain Flows	Remain as is. Storm runoff currently goes to river.
G-48	Surface Runoff from Lawn, Road and Parking Lot Areas Associated with the Shops and Storehouses	Remain as is. Storm runoff currently goes to river.
H-49	Seepage from Sediment Basins 1 Through 4	Remain as is. Discharge allowed under current permit.
H-50	Overflow and Drawdown of Sed. Basins 1 Through 4	Install 36" valve just downstream of Sed. Basin 4 in order to divert flow into future Sed. Basins 1-4 pumping station to be pumped to future dewatering facilities. Also allows emergency Basins 1-4 discharge to river.
I-51	Proposed Thickener Overflow from Dewatering Facility	See Drawings C-2 and C-5 contained in the *Design Memorandum - Drawings, Book 2 of 5* for the Proposed Residuals Collection and Treatment Project, February 1996.
I-52	Proposed Stormwater Drainage from Extended Detention Basin	See Drawings C-2 and C-5 contained in the *Design Memorandum - Drawings, Book 2 of 5* for the Proposed Residuals Collection and Treatment Project, February 1996.
I-53	Proposed Sanitary Connection from Dewatering Facility	See Drawings C-2 and C-5 contained in the *Design Memorandum - Drawings, Book 2 of 5* for the Proposed Residuals Collection and Treatment Project, February 1996.

existing and future waste streams along with the proposed modifications as to discharge destination and applicable improvements. These modifications are presented in the *Proposed Waste Stream Schematic*, Sheet M-10 (Book 2 of 5), accompanying TABLE 5.2 .

The following is a description of several of the key elements covered in the proposed modifications.

5.5.1 Plant Storm Drainage

The evaluation presented by Technical Memo No. 10 maintained that storm runoff from impervious areas (roads and roofs) should ultimately be diverted to the Potomac River following stormwater management practices rather than recycled via the Backwash Recovery Pumping Station. However, it was subsequently determined that, while feasible, it would not be cost effective to divert these flows from the recycle waste streams. Therefore, stormwater management practices such as oil and grit separators have been proposed to improve the water quality of the recycle storm flows. This approach will remove the sediment and solids carried in a rain event corresponding to a first one-half inch of runoff.

5.5.2 Miscellaneous Plant Leakage, Drains and Overflows

Several alternatives were presented in *Technical Memo No. 10* for handling the miscellaneous plant leakage, drains and overflows. These flows are primarily associated with the Finished Water Pumping Station, 30 mg clearwell drain and overflow/leakage from the Plant Drain weir located just upstream from the Backwash Recovery Pumping Station. As previously noted, the above flows are now directed to the Backwash Recovery Pumping Station via submersible pumps located just upstream from a weir at Junction Chamber No. 2. These pumps were installed as a temporary measure to intercept potentially chlorinated water from being directed to the river. The total daily flow now pumped by this facility has been determined to be nearly 2,150,000 gallons (approximately 1,500 gpm) estimated from an evaluation of Aqueduct pump operational data. The alternatives included various arrangements for a permanent pumping facility located either adjacent to Junction Chamber No. 2; approximately 150 feet upstream from that junction chamber; or adjacent to the 30 mg clearwell. It was subsequently determined that the most feasible solution was to construct two pumping facilities to handle these miscellaneous leakage and drain flows.

The first and primary pumping facility, designated as the 84" Plant Drain Pumping Station, is proposed to be constructed approximately 20 feet upstream from Junction Chamber No. 2. This facility would consist of a vertical access structure constructed above and into the 84" Plant Drain. A weir installed downstream of the structure would create the water pool within the 84" Plant Drain to serve as a wet well for proposed submersible pumping units. The proposed design capacity of this station is 1,500 gpm and is based upon a quantification of the daily flows now pumped by the existing temporary pumping facility located at Junction Chamber No. 2.

The second pumping facility would consist of a submersible pump periodically placed into service in the existing 12-foot square drain chamber within the 30 mg clearwell. The purpose of this facility would be to drain the bottom half of the 30 mg clearwell for periodic maintenance functions in lieu of the river discharging this volume of chlorinated water via the Plant Drain. The pumped flow could be directed to Dalecarlia Reservoir via the existing 24-inch force main now utilized by the Backwash Recovery Station, since as described hereinafter, a new 30-inch force main is proposed for that facility (to the Forebay).

5.5.3 Sanitary Wastes

Several of the existing waste streams now directed to either the Reservoir (recycled) or the River are proposed to be intercepted and directed to the sanitary waste system. The types of waste streams in this category include sample line sink drains, laboratory sink and floor drains, chemical room floor drains, drinking fountain drains and other similar waste streams that are typically connected to the sanitary as a matter of current design practice. Since the majority of these waste streams are now recycled to the Reservoir, these improvements would provide protection against an accidental spill of chemicals or other potential contaminants. This proposed increase to existing sanitary flow may actually assist in preventing recurring line blockages now experienced in the sanitary line on the north side of the Chemical Building understood to result from the low flow conditions.

Within the Finished Water Pumping Station, discharges from the drinking fountains, elevator shaft drains, suction gallery floor and valve drains, air conditioning condensate drains, electric manhole drains, sewer ejector pump floor drains, vacuum pump drains, heater and refrigeration unit drains and compressed air system drains would be diverted and pumped to the public gravity sanitary sewer main in MacArthur Boulevard.

From the east and west wings of the Chemical Building, the discharge from laboratory and sampling sinks and floor drains in rooms with containers of chlorine and other chemicals would be directed by gravity into the sanitary sewer on the north end of the building.

5.6 Recycled Waste Stream - Treatment Alternatives

Three treatment alternatives were developed for the recycled waste streams and presented in *Waste Streams Handling and Treatment Alternatives - Technical Memorandum No. 10.* These alternatives were based on the analysis of existing waste stream handling facilities, the review of pertinent regulatory requirements, and the results from the bench test study. The three treatment alternatives that were presented are:

- Recycle Waste Stream to Forebay Without Pretreatment
- Recycle Waste Stream Sedimentation Prior to Forebay
- Filter Backwash and Plant Drainage Microfiltration

As noted in Section 1.2, the scope of this Design Memorandum is to include preliminary planning and conceptual design (10% complete) for the future recycled waste streams treatment facility. That task was performed and presented under the above-referenced Technical Memo. No. 10 and is summarized under Section 7.

5.6.1 Alternative No.1 - Recycle Waste Stream to Forebay Without Pretreatment

This alternative involves the conveyance of all plant recycle waste streams to the Forebay via the existing Backwash Recovery Pumping Station. The waste streams would be discharged to a inlet portion of the Forebay where it would blend with the influent raw water. Cationic polymer at a dosage of 1.0 mg/l would be added to the waste streams at the pumping facility as may be required to enhance sedimentation and turbidity removal. The current practice of waste stream recycle to the Dalecarlia Reservoir near the plant intake would be discontinued. A new 30-inch diameter force main would be constructed from the existing pumping facility to the Forebay. The turbidity removal projections for the recycle waste stream is based on the construction of a silt curtain within the Forebay to provide a separate sedimentation zone for the recycle stream. This concept would provide the "multiple barrier" approach to the removal of contaminants from the recycle stream. Basic design criteria for this alternative are summarized in TABLE 5-3.

Alternative No.1 could be implemented with minimum modifications to the existing waste stream handling facilities. Key disadvantage of this alternative is that the turbidity removal efficiency in the Forebay (with or without the separate sedimentation area) would be less consistent than that in conventional sedimentation basins.

5.6.2 Alternative No.2 - Recycle Waste Stream Sedimentation Prior to Forebay

This alternative involves the blending and settling of all plant recycle waste streams in new sedimentation basins prior to conveyance to the Forebay. Cationic polymer at a dosage of 1 mg/l would be added to enhance setting and improve turbidity removal. A high-rate inclined plate technology would be applied to optimize turbidity removal and limit the space required for the sedimentation basins. Sedimentation facility supernatant would be conveyed to the Forebay by a new pumping station. The residuals settled in the sedimentation facilities would be conveyed to the gravity thickeners that are proposed to be provided as part of the residuals treatment facilities.

There are two sites that had been considered for locating the recycle stream sedimentation facilities. The first site, identified as "Site A", is adjacent to, and to the south of, the proposed residuals dewatering facility. The second location, identified as Site "B", is adjacent to (north end of the west side of) the Dalecarlia Forebay. "Site B" is the preferred location for the possible future recycle sedimentation facilities, since it would eliminate the need for the supernatant pumping facility as the supernatant could flow to the Forebay by gravity.

The recycled waste stream sedimentation facility would generally include polymer addition with 2-stage rapid mixing, 2-stage flocculation followed by the inclined plate sedimentation area. Basic design criteria and sedimentation basin spatial requirements are summarized in TABLE 5-4. Preliminary design calculations and facility layouts are also contained in the Design Memorandum, Book 5 of 5 - Design Calculations. Key advantage of this alternative is the controlled waste stream treatment conditions in the sedimentation basins which would provide a consistent and reliable operation. It is this option that has been integrated into the Design Memorandum drawings (Book 2 of 5).

TABLE 5.3

ALTERNATIVE 1 - WASTE STREAM RECYCLE TO FOREBAY WITHOUT PRETREATMENT

DESIGN CRITERIA

Design Criterion	**Value**	
Waste Stream Flowrate, gpm	Average	Maximum
- Filter Backwash Water (1)	4,400	4,400
- Filter-to-Waste Flow	450	450
- Thickener Supernatant	990	1,610
- Centrate	690	1,060
- Plant Drainage (2)	1,380	2,130
Total Flowrate gpm	7,910	9,650
Avg. Surface Overflow Rate, gpm/sq ft	0.3	
Average Turbidity Reduction, %	98	
Total Sedimentation Area, sq ft	32,000	
Polymer System - Type of Polymer - Polymer Dosage, mg/l	 Cationic 1.0	

Note: (1) Backwash flows are 3,150 gpm (Section 5.1.1) and 1,250 gpm (Section 5.2.4).

(2) Statistical History "Waste Flows"of plant drainage are off 50% (average) and 100% (maximum) , Refer to Table 5-1 which reflects 1.99 and 3.07 respectively.

TABLE 5.4

ALTERNATIVE 2 - WASTE STREAM SEDIMENTATION PRIOR TO RECYCLE TO FOREBAY

DESIGN CRITERIA

Design Criterion	**Value**	
Waste Stream Flowrate, gpm	Average	Maximum
- Filter Backwash Water [(3)]	4,400	4,400
- Filter-to-Waste Flow	450	450
- Thickener Supernatant	990	1,610
- Centrate	690	1,060
- Plant Drainage [(2)]	1,380	2,130
Total Flowrate gpm	7,910	9,650
Effective Surface Overflow Rate, gpm/sq ft	0.3	
Average Turbidity Reduction, %	98 [(1)]	
Type of Sedimentation Basins	High-rate plate settlers	
Number of Sedimentation Basins	3	
Unit Size (Length x Width), ft	100 x 75	
Total Area, sq ft	22,500	
Polymer System - Type of Polymer - Polymer Dosage, mg/l	 Cationic 1.0	

Note: (1) Based on Figure 1, with an effluent turbidity over the sedimentation basins of 1.2 ntu, and an influent turbidity of 54.9 ntu.

(2) Statistical History "Waste Flows"of plant drainage are off 50% (average) and 100% (maximum) , Refer to Table 5-1 which reflects 1.99 and 3.07 respectively.

(1) Backwash flows 3,150 gpm (Section 5.1.1) and 1,250 gpm (Section 5.2.4).

5.6.3 Alternative No. 3 - Filter Backwash and Plant Drainage Microfiltration

This alternative involves the treatment of the filter backwash waste and plant drainage by microfiltration (membrane process), while the centrate and thickener supernatant would be recycled directly to the Forebay without pretreatment (other than polymer addition). Key requirements for reliable operation of microfiltration systems are continuous flow and consistent charge density of the waste stream particles. Significant fluctuations in particle charge density could be detrimental to the performance of the microfiltration membranes. The filter backwash and plant drainage are waste streams with predominantly negatively charged particles. These waste streams have relatively consistent quality and could be treated successfully by microfiltration using negatively charged membranes.

A predominant portion of the particles contained in the residuals treatment centrate and thickener supernatant is positively charged. Thickener supernatant and centrate quality and flow could vary significantly throughout the day and throughout the year depending on the mode of residuals handling facility operation. Previous experience indicates that the particle charge density renders microfiltration technology infeasible for treatment of these waste streams.

If the two types of streams are blended, the combined waste stream particle charge density could be predominantly negative, positive or neutral depending on the current waste stream flow, the quantity of polymer used for thickening and dewatering, and on the operational mode of the residuals handling facility. The variability of the particle charge density renders microfiltration technology infeasible for treatment of combined waste streams. The residuals gravity thickener supernatant would, therefore, be conveyed directly to the Forebay with solids removal to be accomplished by gravity settling in the Forebay similar to that described for Alternative No. 1 (and possible optional use of a silt curtain area in the Forebay).

The microfiltration facility would have one main stream (filtrate) and one waste stream (backwash). Filtrate from the microfiltration facility would have the quality of a finished water and could be recycled to the head of the plant or blended with the plant finished water. Backwash water from the microfiltration facility would be conveyed to the gravity thickeners and treated along with the rest of the plant residuals. The proposed location for the microfiltration facility is adjacent to the proposed residuals dewatering facility due to its proximity to the gravity thickeners as well as to the finished water storage facilities.

Basic design criteria and space requirements for implementation of this alternative are summarized in TABLE 5-5. For the purposes of determining the preliminary space required for microfiltration facility, a typical microfiltration unit (i.e. Memcor 90M10C) currently manufactured by Memtec America Corporation was used.

The key advantage of this alternative is the high level of treatment provided for the filter backwash water. The main disadvantage is the high capital, operation and maintenance cost for waste stream treatment.

TABLE 5.5

ALTERNATIVE 3 - MICROFILTRATION FACILITY

DESIGN CRITERIA

Design Criterion	**Value**	
Waste Stream Flowrate, gpm	Average	Maximum
- Filter Backwash Water	4,400	4,400
- Filter-to-Waste Flow	450	450
- Plant Drainage (2)	1,380	2,130
Total Flowrate gpm	6,230	6,980
Minimum Water Temperature, °F	55	
Microfiltration Membrane Type	Anionic	
Flux Rate, gpm/sq meter	0.35	
Maximum Influent Turbidity, NTU	200	
Membrane Cleaning Cycle, days	3	
Backwash Cycle Length, min	15	
Number of Microfiltration Units	24 (1)	
Unit Size (Length x Width), ft	21 x 11	
Total Area Needed for Microfiltration System, sq ft	13,200	
Area Site Size (Length x Width), ft	110 x 120	

Note: (1) Based on Microfiltration Unit Memcor 90M10C-Type.

(2) Statistical History "Waste Flows" of plant drainage are off 50% (average) and 100% (maximum); refer to Table 5-1 which reflects 1.99 and 3.07, respectively.

6.0 CODE, OCCUPANCY DETERMINATIONS AND PERMITTING

The existing Dalecarlia Water Treatment Facilities are located along the boundary between the District of Columbia and Montgomery County, Maryland. The proposed site for the dewatering facilities lies within both jurisdictions. Construction would be on federally owned land which is operated by the US Army Corps of Engineers (C.O.E) (a Federal agency). Design and construction projects within the greater Washington, D.C. area generally undergo a building code and agency plan review process. However, since this project is sponsored by a Federal agency and is on Federal land partially in Washington, D.C., the Montgomery County building code review officials have indicated that they do not have jurisdiction. The Corps of Engineers, nevertheless, is obligated to obtain the review approval and concurrence from the National Capital Planning Commission (NCPC).

United States Corps of Engineers' projects are required to comply with a variety of their own technical memoranda that guide and direct the design process. The policy of the C.O.E. is to develop and maintain its facilities in such a manner that they are "good neighbors" in their environment. This would include creating a design which complies with both C.O.E. guidance documents and the local jurisdictional codes and laws to as much a degree as possible. This "good neighbor" policy attempts to ensure that the design creates as pleasant an environment as possible around C.O.E. facilities. The intent of the "good neighbor" policy was adhered with during evaluation and application of required local codes. The following presents these code determinations which were utilized to configure the proposed facilities.

It should be noted that, as described in Section 1, the Safe Drinking Water Act Amendments of 1996 passed in August 1996, includes provisions that essentially stipulate that the facilities known as the Washington Aqueduct now owned and operated by the US Army Corps of Engineers be transferred to a non-Federal public or private entity. This transfer is to occur within 3 years and would occur prior to commencement of final design documents for the facilities proposed herein. Therefore, many of the COE guidance documents referred to within this and other sections of the Design Memorandum may not apply to the future design of the proposed facilities.

6.1 *Applicable Codes*

BOCA 1993: The proposed Dewatering Facility site is located in Montgomery County, Maryland and this jurisdiction uses the 1993 BOCA Code as amended by "Executive Regulation Number 20-94"; January 31, 1995.

Use of the proposed Dewatering Facility is classified as a low hazard factor (F2) and its type of construction is classified as 2C. There are no height or area limitations and exterior and interior walls are not required to be fire-rated, except the elevator shaft and exit stair enclosures require a two hour fire rating. In general, there would be no difficulty in designing the building to conform with the BOCA 1993 code requirements. The following are the code considerations for the proposed Dewatering Facility Building.

BOCA Summary:

The building type and construction is to be as follows:

1. Use: "F-2" low hazard factory and industrial use (Water Treatment Plant).
   Use: "utility" (pumping stations).
2. Type of construction: 2C (all buildings).
3. No height and area limitations.
4. Walls require one (1) hour fire rating (except North Stair Water Treatment Plant requires 2 hours).
5. Finish types for floor, wall, ceiling will be minimal so as not to interfere with fire rating requirements.
6. Mechanical louvers and ducts will require fusible link to preserve fire rating integrity.
7. Rated doors to be throughout stairways.

The occupancy and exiting requirements are as follows (all buildings):

1. One (1) occupant per 100 square feet.
2. Exiting requirements require two (2) exits with no special considerations.
3. Sprinklers are not required but if provided would increase allowable exiting distances.

NFPA 101 (1994): Pursuant to this code, the proposed Dewatering building is categorized as a special purpose industrial building with design assumptions similar to the ones used in the BOCA code analysis. The occupancy is assumed to be one occupant per 100 square foot of area. There will be no difficulty in designing the building to conform with the NFPA 1991 requirements.

NFPA 101 Summary: (All Buildings). The building type and construction is to be as follows:

1. "Special Purpose Industrial" with essentially the same design requirement of BOCA.
2. One (1) occupant per 100 square feet maximum number of persons to occupy the area.
3. Exiting requirements - no special considerations.
4. Stair construction allowed such as "open riser".
5. No sprinklers are required.
6. Stairways Do Not have to be pressurized

ADA (American Disabilities Act): The proposed Dewatering Building must be designed such that office, public areas, toilets, and circulation routes are fully accessible. Equipment rooms and mechanical areas must be accessible for approaching, entering, and exiting of supervisory personnel. Because the building would be multi-level, it must be provided with an elevator and handicapped parking with ramp access and required signage. A handicapped accessible shower would be provided. There will be no difficulty in designing the building to conform with these requirements.

ADA Summary: (Dewatering Facility)

This Code applies to the Dewatering Building, but not to pumping stations:

1. Offices, public areas, toilets, and circulation components must be fully accessible.
2. Equipment rooms and mechanical areas must be accessible for supervision
3. An elevator is required because of multi-level building.
4. HC parking, ramps, and signage are required.

5. HC shower provided for employees.
6. HC parking space and curb cut are required.
7. Door hardware required to be levered handles

OSHA: The design of the proposed Dewatering Building would conform to OSHA in all respects affecting ladder, stairs, etc. Attention was given to operating safety around all openings and penetrations that are hazardous. Distances between equipment and access for maintenance were studied and adequate space is provided. Emergency provisions are made for eyewash, fire extinguishers, and general protection of the personnel throughout the building. Attention is given and provisions would be included for sound reduction by sound absorbing materials and vibration reducing connections. Containment floor curbs are utilized for potential spills of hazardous materials.

OSHA Summary: (All Buildings)

1. Ladders and stairs will meet OSHA standards.
2. Distances between equipment and machinery is specified.
3. Emergency provisions are provided as required (i.e. Eyewash, etc.).
4. Protection of personnel is considered (i.e. general safety throughout).
5. Sound reduction wall and floor construction is provided.
6. Containment floor curbs to limit areas where hazardous material can spill (mainly lubricating oil) are provided.

6.2 *Pumping Station Code Analysis*

Two below-grade pumping station structures are proposed: the Thickened Residuals Pumping Station on the dewatering site (in Montgomery County, Maryland) and the Sedimentation Basin Residuals Pumping Station at the existing basin area (in Washington, D.C.).

The principle code governing the evaluation of the pumping station is the 1993 BOCA code. Since these pumping stations do not explicitly fall within the defined category of this code, as a matter of judgment, it can be viewed as a "utility structure" which is incidental to the function of the proposed Dewatering Facility. Under this section of the BOCA code, an underground structure with one exit, must be limited to one-story; intermediate floors are not allowed and the maximum depth shall be thirty (30) feet and the maximum travel distance to exit can be a total of one hundred (100) feet, (See Section 405.1.5 of the BOCA code that addresses these issues).

These proposed pumping stations have been evaluated from a point of view of a utility structure and the evaluation philosophy is that the structure should follow all "industry standards" that are considered prudent and appropriate for proper safety and protection of life in the pumping stations. To satisfy this requirement, a single stairway in each of the two pumping stations would be enclosed by a one-hour fine-rated enclosure with entry vestibule.

In general, these pumping stations would be 40 to 45 feet below grade and have travel distances in excess of 75 feet. Two means of egress from the pumping station could be used, however, to avoid the excessive cost of this approach, one exit stairway with an entrance vestibule is being proposed. In addition to reducing overall cost, this approach meets the Montgomery County code # 20-94 as a utility building with the requirement of "...accepted industry practice and standards." Based upon preliminary discussions with the Montgomery County code officials, it was determined that the enclosure for the stairway can be a one-hour rated wall. The stairway with vestibule, does not have to pressurized, but it requires a forty-two (42) inch high guardrail, on the open side of the stair.

6.3 Regulatory Requirements - Construction Permits

The work culminating with this Design Memorandum has addressed three major areas of study: *first*, residuals handling/treatment; *second*, residuals disposal; and *third*, existing waste streams handling. The regulatory requirements associated with the third item, discharge, stormwater management, and recycle issues, has been addressed in SECTION 5.3 above. The regulations associated with the second item, residuals disposal aspects, has been presented in SECTION 3 of the *Residuals Disposal Study*, November 1995 (a separate and concurrent report of the overall comprehensive design project). This section addresses the first item, namely, regulatory requirements to build the proposed residuals handling/treatment facilities.

A survey was conducted to determine the extent of construction permits required. The proposed residuals handling facilities would be constructed on five separate sites, located within both Maryland and Washington D.C. Utility work connecting the five construction sites cross between Maryland and Washington D.C. These sites have been referred herein as the *Dalecarlia*

Sedimentation Basin Site, Georgetown Reservoir Site, Dalecarlia Reservoir Forebay Site, Dalecarlia Dewatering Facility Site, Utilities Connecting New Facilities, and *Backwash Recovery Pumping Station Upgrades.* The construction permits which were identified during the survey are required by federal, state, local jurisdiction (D.C.), and other local entities. These potentially required permits have been summarized on TABLE 6.1.

TABLE 6.1
CONSTRUCTION PERMITS

AGENCY	PERMIT TYPE	TIME TO ACQUIRE	COMMENTS
COE/MDE Joint Permit	Construction in or near waters of the U.S. (ie., Wetlands)	Wetlands not impacted Permit not required, otherwise up to 6 months.	Permit would address endangered species protection provisions but is not likely to be required. All construction work will be within areas previously disturbed and/or in operation. Construction at the Reservoirs would constitute improvements to operations. Pre-EA Report dated Nov.1995 elaborates on the extent of potential environmental impacts. Since no wetlands are expected, a letter of notification would most likely suffice.
US Army COE District - review approvals	Document review & approvals	12 to 16 weeks	Review and approval of 60% and 90% plans & specs by the District Engineering Divisions are necessary. This would not be a permit, but rather an approval process required before construction would proceed.
MD-National Capital Parks and Planning Commission (Capital Crescent Trail)	Utility crossings at roads and trail - construction	14 to 16 weeks	Work within the existing bike trail tunnel would require approval as would utility crossings.
National Capital Planning Commission (NCPC) - review approvals	Project approval for construction	16+ weeks	Preliminary and Final Project Plans approval (with completed EA) is required. These should be pursued at the 60% design, whereby any necessary revisions could be incorporated. Schematic approval from NCPC was obtained in June 1996. NCPC also will assists with numerous agency coordination reviews, pursuant to the EA

TABLE 6.1
CONSTRUCTION PERMITS

AGENCY	PERMIT TYPE	TIME TO ACQUIRE	COMMENTS
Soil Conservation Service (Montgomery County SCS)	Construction Sediment & Erosion	8 weeks	Approval from the local SCS would be concurrent w/ MDE and DC sediment and erosion control during construction.
EPA - Construction Permit	NPDES - Construction over 5 acres	See Comments	Typically a letter of notification would suffice 15 to 20 days prior to work commencement.
Maryland DNR	Water Use Permit	10 to 12 weeks	Permit would be for "dewatering during construction"
MDE - Construction Permit	Sediment/Erosion Control	10 to 12 weeks	
Montgomery County - Construction Permit	Storm Water Management	8 to 10 weeks	Additionally, a Flood Plain District Permit would be necessary.
MDE - Construction Permit	Construction Permit - Water Project	10 weeks	A review with MDE's Surveillance and Technical Assistance Div., Public Drinking Water Program would also be needed as related to the recycle issues.

TABLE 6.1
CONSTRUCTION PERMITS

AGENCY	PERMIT TYPE	TIME TO ACQUIRE	COMMENTS
Washington D.C. DPW and Maryland Department of Transportation	Right-of-Ways, in-road permits	8 to 10 weeks	Primary power source will be off MacArthur Blvd and the conveyance forcemain from Georgetown will cross from the Blvd's center grass area. Permit for road crossing work.
MD Historical Trust and Advisory Council on Historical Preservation	Plans approval/review	See Comments	COE Balt. District has undertaken responsibility for Section 106 compliance. Resolution of these issues is necessary to complete an EA and obtain NCPC Preliminary and/or Final Plans approvals (see above).
Montgomery County Government	Utilities within road (MacArthur Blvd w/ DPW)	8 - 10 weeks	Refer to Technical Memo No.9 (pp 23), Montgomery County has NO jurisdiction of zoning, structural, construction, and/or grading issues related to the project. Coordination would be limited to the forcemain crossing work within MacArthur Blvd.
D.C. Government	Utilities within road (MacArthur Blvd w/ DPW)	Up to 6 months	Refer to Technical Memo No.9 (pp 23), DC DPW has NO jurisdiction of zoning, structural, construction, and/or grading issues related to the project. Coordination would be limited to utility (electrical) work at MacArthur Blvd.
Montgomery and DC Fire Marshall	Plan Reviews and Approvals	8 to 10 weeks	No formal approval process required, compliance with current BOCA per discussion in Section 6 would apply.

TABLE 6.1
CONSTRUCTION PERMITS

AGENCY	PERMIT TYPE	TIME TO ACQUIRE	COMMENTS
D.C. DPW	Sediment & erosion control, SWM, and Road Closure (Norton St.)	Up to 6 months	Construction around the Sedimentation Basin area lies within the D.C. area. Upon preparation of plans & specs, coordination and permits with D.C. DPW would be perused regardless of earlier statements denying jurisdiction. This would be in the form of a courtesy submission.

7.0 PROCESS and MECHANICAL SYSTEMS DESIGN

Section 7 presents the process and mechanical systems for each of the proposed facilities. As previously discussed, residuals are to be collected and conveyed from: Georgetown Reservoir (alum residuals), Dalecarlia Forebay (river solids), Dalecarlia Sedimentation Basins (alum residuals), and Dalecarlia Filter Backwashing (alum residuals). The HVAC design and requirements are described under Section 11. Refer to Sheets M-1 through M-35, *Book 2 of 5*, for the process and mechanical systems and processes presented herein. Site plans which indicate the locations of the proposed facilities are provided on Sheets C-5 and C-6. Additional details and calculations are provided in *Design Calculations, Book 5 of 5.*

7.1 Standards and Criteria

The following is a listing of the various engineering and design standards, (including U.S. Army Corps of Engineer documents) upon which the mechanical design has been based.

IEEE	Institute of Electrical & Electronics Engineers
AMCA	Air Moving and Conditioning Association, Inc.
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration & Air Conditioning Engineers
AWS	American Welding Society
AWWA	American Water Works Association
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturer's Association
OSHA	Occupational Safety and Health Act
UL	Underwriters Laboratory
NSF	National Sanitation Foundation
SMACCNA	Sheet Metal and Air Conditioning Contractors National Association

Additional Reference Material:

ASHRAE Fundamentals	1993
Hydraulic Tables - Williams and Hazen	1963
Hydraulic Institute Standards	1983
Cameron Hydraulic Data	1992

US Army Corps of Engineers Standards utilized:

TM 5-805-4	Noise and Vibration Control for Mechanical Equipment	12/83
TM 5-805-9	Power Plant Acoustics	
TM 5-810-1	Mechanical Design Heating, Ventilation and Air Conditioning	6/91
TM 5-810-4	Compressed Air	1/12/90
TM 5-814-2	Sanitary and Industrial Wastewater Collection Pumping Stations and Force Mains	
1110-2-5025	Dredging and Dredge Material Disposal	
1110-2-3102	General Principles of Pumping Station Design and Layout	2/28/95
1110-2-3105	Mechanical and Electrical Design of Pumping Stations	3/30/94

7.2 Georgetown Reservoir Residuals Collection and Conveyance

Settled Georgetown Reservoir alum residuals are proposed to be removed by the use of electrically operated dredge units. A single dredge unit is proposed for the removal of accumulated treatment residuals from Georgetown Reservoir Basin No. 1 and No. 2. Dredging of an equivalent year's worth of residuals would be removed from the two basins over a 4 ½ month processing schedule (refer to the *Residuals Processing Schedule*, FIGURE 4.1). The single Georgetown dredge would be employed for both Georgetown Basins (No. 1 and No. 2), transferred as needed during the 4 ½ month processing schedule established. Transferring would occur through a dam-like structure (see Sheet C-9 and S-7) which utilize aluminum plates as stop logs to separate the two basins.

The dredging operation would remove and pump the settled material into temporary on-site equalization storage. The equalization basin has been sized to handle a seven hour influent dredge flow (under zero effluent pumping from the basin). This provides an equivalent of one full operational dredging day's flow (under a pump outage), and sufficient equalization for an overtime operation (9 to 10 hours a day) when effluent submersible pumps are in service.

Conveyance of the residuals from the equalization basin to the dewatering facility would be performed by submersible pumps positioned on the lower end of the sloped bottom of the equalization basin. Use of a well would allow proper pump submergence without dropping the overall depth of the basin. Submersible pumps are proposed in lieu of end-suction pumps for the following reasons:

- Dry-pit construction would require additional tankage and would be more expensive.
- Noise would be dissipated by the water in submersible pump operations while a dry pit facility would require acoustical louvers at ventilation intakes/discharge points.

Established criteria upon which the Georgetown facilities has been based are provided below. Proposed dredge, equalization basin and pumping equipment have all been sized pursuant to the following key design points:

- Georgetown Reservoir accumulation of residuals totals 23,400 dry pounds per day.

- Daily deposition of residuals accumulation estimated to be 1/3rd into Basin 1 and 2/3rds into Basin 2.

- 4 ½ month operational processing schedule of annual accumulation is equivalent to the removal of 94,900 dry pounds per day. The 4 ½ month schedule includes 137 calendar days, 90 operating dredge days (5 days/week).
- 1 ½ percent residuals solid content dredged to equalization and conveyance.

The sizing of facilities to collect and convey settled alum residuals is critically linked to the percent concentration of the dredged material. Dredge operator control and the thickened concentration of the residuals before dredging will always be variable conditions. In an effort to validate the anticipated concentration of settled alum residuals a Sediment Sampling Field Study was conducted in August, 1996. Samples taken were analyzed for total solids to reveal the percent concentration of residuals at various depths for the deposits accumulated in Georgetown Basin 1 and 2. This exercise was also conducted at the Dalecarlia Forebay. The results validated that a 1.5 percent concentration could be reliably dredged, assuming operator attentiveness to gauge discharge pressures, which should correlate to the solids concentration of the pumped flow.

Components comprising the Georgetown Reservoir residuals COLLECTION, handling and conveying equipment have been established utilizing the above criteria. TABLE 7.1 reflects these design points and supplements the following presentation of the proposed design of each element:

7.2.1 Georgetown Reservoir - Dredge Design

- 94,900 lbs/day dry solids removal at 1 ½% solids equates to 760,200 gallons/day.
- 7 hour standard dredge operating day, 8 hour day includes ½ hour start-up and ½ hour shut-down period.
- 1810 gpm dredging rate required for removal of 760,200 gpd of basin residuals.
- 5 dredging days per week as standard work week.
- Three dredge tensioning cable system set-ups are proposed (zones) in Basin No.1 (Refer to Sheet C-7).
- Four dredge tensioning cable system set-ups are proposed (zones) in Basin No.2

GEORGETOWN RESERVOIR EQUALIZATION BASIN and PUMPING STATION - BASIS OF DESIGN

SITE CONDITIONS:

Reservoir Hydraulics (elev, ft):	146
Top of Divide Dam (elev, ft):	146.5
Bottom of Basin 1 (elev, ft):	128 - 131

Proposed Tank Elevations:

Top Elev of EQ Basin	147
Ave. Bottom Elev of EQ Basin	130.4
Proposed Tank Depth (ft) =	***16.6***

Proposed Equalization Basin Volume:

SIZE: 80' X 80' X 16.6'
MAX. VOL. 796,800 gallons

REQUIRED DREDGE OPERATIONS:

Annual Average Residuals Accumulations	23,400	(lbs/day)
Dredge Period (month/year)	4.50	(month/yr)
Dredging Required During Period	94,900	(lbs/day)
Average Dredged Residuals Concentration	1.50%	
Dredging Rate Required	1,810	(gpm)
Daily Dredging Operation	7	(hours)
Overtime Dredging Operation	9	(hours)
Average/Standard Daily Volume Dredged	760,200	gal/day
Overtime Operation Volume Dredged	977,400	gal/day

EQUALIZATION BASIN ANALYSIS and PUMPING REQUIREMENTS

(under varying daily dredging operations)

Dredging Period *hrs/day*	Dredging Rate *gpm*	Volume Removed *gpd*	Pumps Operating *No.*	Pumping Rate From EQ Basin *gpm*	Actual Active EQ Basin Vol. *gallons*	Freeboard *vertical ft*	Total Required Pumping Period To Empty EQ Basin *Hours*
7	1,810	760,200	1	632	494,760	**6.26**	20.05
8	1,810	868,800	1	632	565,440	**4.79**	22.91
9	1,810	977,400	1	632	636,120	**3.31**	25.78
9	1,810	977,400	2	715	591,300	**4.25**	22.78
10	1,810	1,086,000	2	715	657,000	**2.88**	25.31
7	1,810	760,200	0	0	760,200	**0.72**	Emergency off-line

EQ Basin Design Basis

TABLE 7.1

EQTANK1.XLS

- The dredge would have a 8 to 15 feet per minute travel speed with a 16 inch diameter by 8 feet wide cutter head. Basin cleaning cycle time is expected to vary largely dependent upon deposition and operator control.

- Dredge is proposed to be electrically powered.

- Bottom of Basin No. 2 would be leveled to readily enable dredging of basin.

- Dredge locomotion would utilize a cable positioning system, employing winch and cable tensioners. Dredge anchor posts would be positioned approximately every 200 feet.

- Dredge movement and transferring between Basin No. 1 and No. 2 would be through a stop log dam. This arrangement was determined to be the simplest and most cost effective solution. Refer to Sheet C-7 and C-8.

7.2.2 Georgetown Reservoir - Equalization Basin Design

- 7 hour standard dredge operating day (at 1810 gpm rate)

- Basin sized for one full day's worth of dredging flow (at 1½ % concentration) and the following design points:

  - Dredge Flow = 1810 gpm
  - Tank Volume = 760,200 gallons
  - Size provides for dredge operation without danger of tank overflow
  - Tank overflow spills over to influent distribution channel (see M-23)

- Tank Size: 80' x 80' x 16.6' (bottom elevation varies)

- An open channel comminutor would be provided for shredding any debris picked up by the dredge as it enters the Equalization Basin in order to protect the submersible pumps.

7.2.3 Georgetown Reservoir - Pumping Station Design

- The dredged residuals conveyance forcemain, 10 inch diameter, would be 14,000 lf long. 10,000 lf of the forcemain (material: HDPE) would be routed inside existing nine foot diameter Georgetown Conduit under MacArthur Boulevard. Refer to Sheet C-5.

- Constant rate submersible pumps are proposed. A single pump would handle the equalized flow from a 7-hour dredge schedule at a design point rate of 632 gpm. An overtime dredge schedule (9-hours input to Equalization Basin) requires dual pump operation at a design point rate of 715 gpm. The dual pumping operation is not anticipated under standard operating conditions, but is a flexible provision of the design. Refer to FIGURE 7.1.

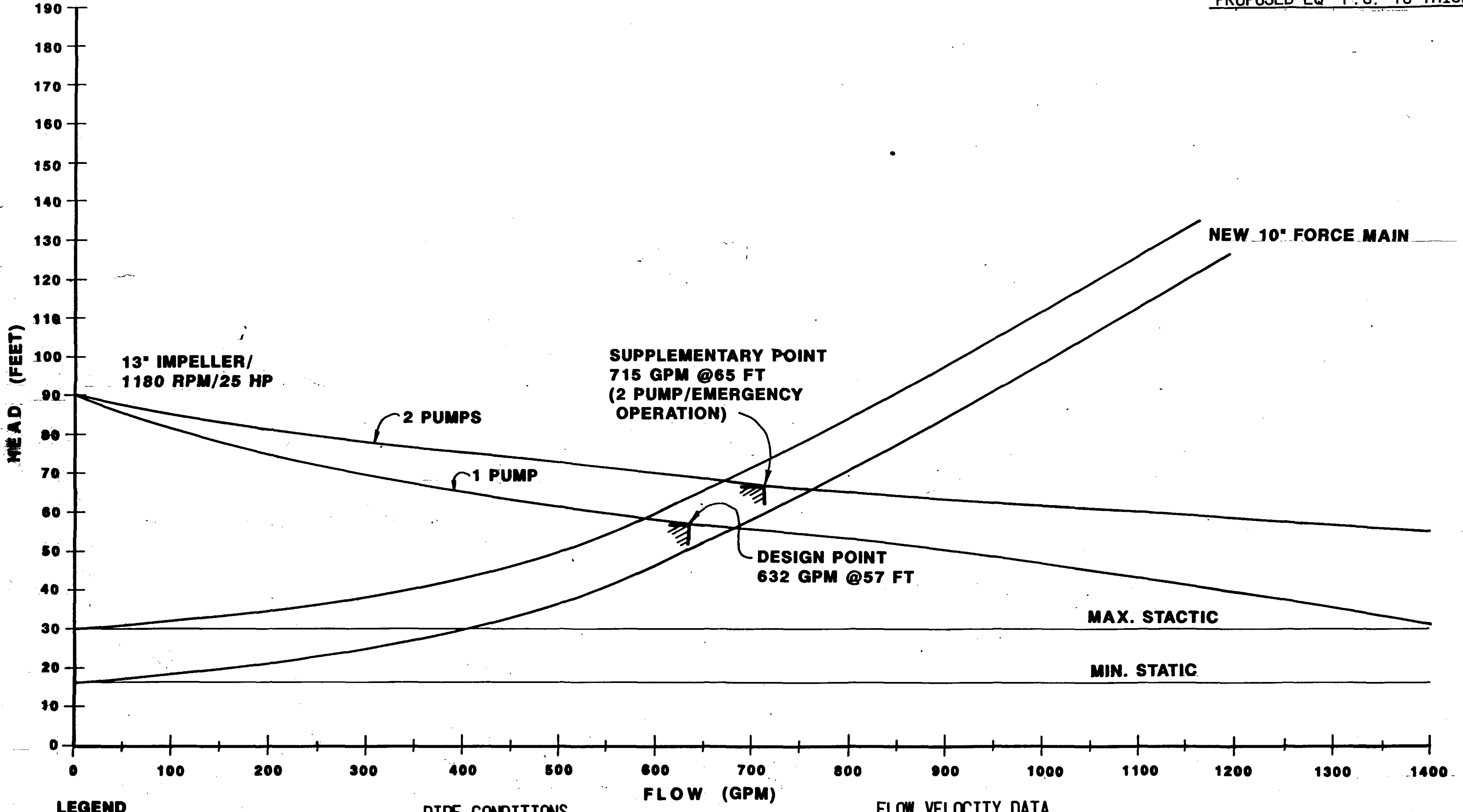
- 10 inch forcemain handling a pumping range of 632 to 810 gpm. Consideration also included the possible use of an 8-inch force main. The proposed 10-inch size enabled an overtime operation without imposing excessive dynamic pumping conditions. Refer to *Pumping System Head Curves*, FIGURE 7.1.

- Provisions to flush and/or utilize a pigging device in the 14,000 foot long conveyance forcemain.

7.3 Dalecarlia Forebay Solids Collection and Conveyance

Dalecarlia Forebay solids would be removed by electric operated dredge, similar to the proposed Georgetown's residuals removal system. The Forebay dredge would remove a year's equivalent of residuals over a 4 ½ month processing schedule. Refer to FIGURE 4.1, and Sheet C-7.

GEORGETOWN RESERVOIR
PROPOSED EQ P.S. TO THICKENERS



LEGEND

D.I. DUCTILE IRON
HDP HIGH DENSITY

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

PIPE CONDITIONS

14,000 LF.

SEC.1	200	D.I.	C = 120
SEC.2	10,000	HDP	C = 140
SEC.3	3,800	D.I.	C = 120

FLOW VELOCITY DATA

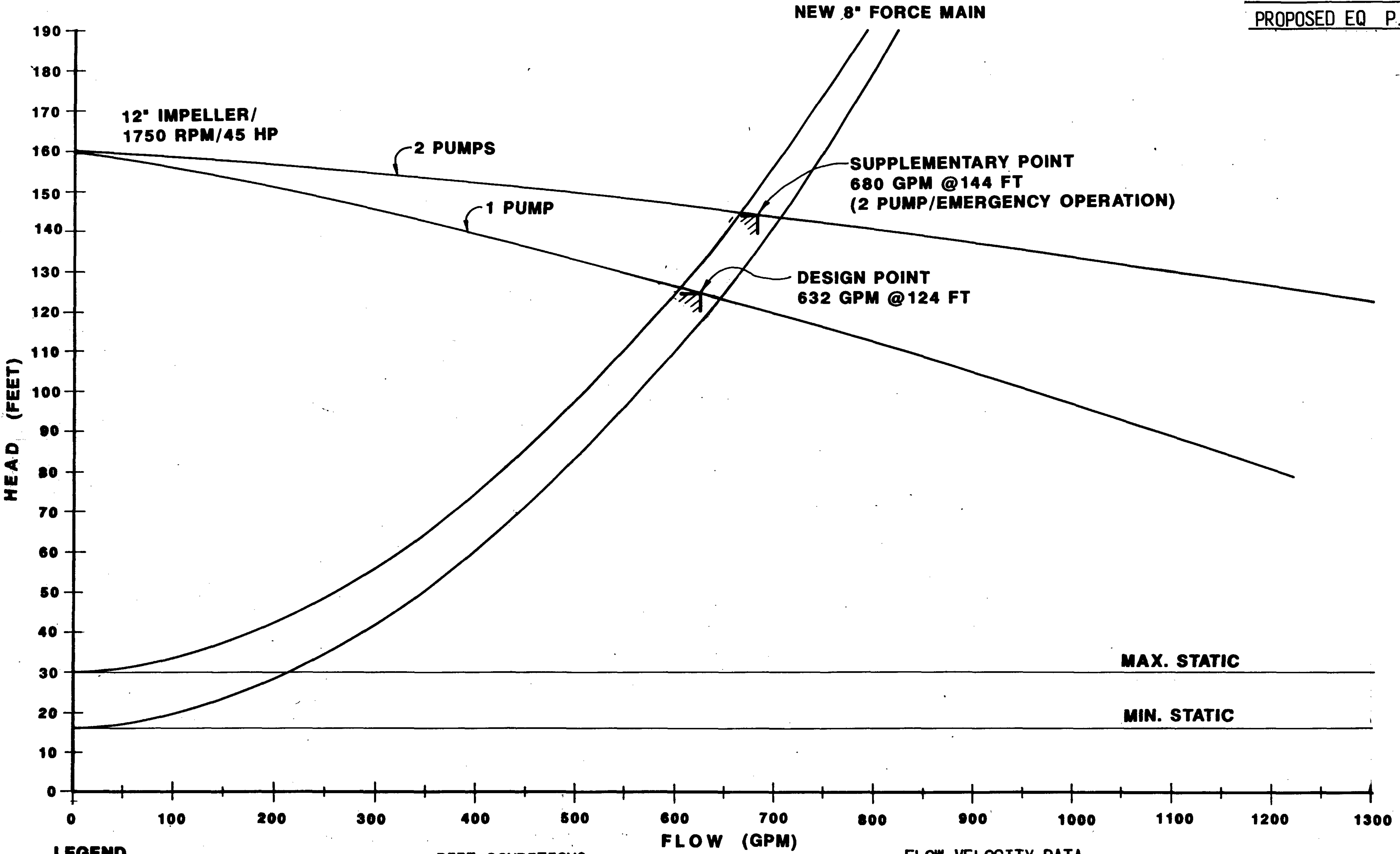
GPM	8"	10"
600	3.83 FT/SEC.	2.45 FT/SEC.
650	4.15	2.66
700	4.47	2.86
750	4.79	3.1
800	5.11	3.27

GEORGETOWN
RESERVOIR RESIDUALS

PUMPING SYSTEM HEAD CURVES

FEBRUARY 1996 FIGURE 7.1

GEORGETOWN RESERVOIR
PROPOSED EQ P.S. TO THICKENERS



LEGEND

D.I. DUCTILE IRON
HDP HIGH DENSITY

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

PIPE CONDITIONS

14,000 LF.
SEC.1 200 D.I. C = 120
SEC.2 10,000 HDP C = 140
SEC.3 3,800 D.I. C = 120

FLOW VELOCITY DATA

GPM	8"	10"
600	3.83 FT/SEC.	2.45 FT/SEC.
650	4.15	2.66
700	4.47	2.86
750	4.79	3.1
800	5.11	3.27

GEORGETOWN
RESERVOIR RESIDUALS

PUMPING SYSTEM HEAD CURVES

FEBRUARY 1996 FIGURE 7.1a

The dredge unit would convey a 1½ percent solids concentration flow directly into the equalization basin located to the south-west end of the Dalecarlia Forebay. The equalization basin is sized to allow a seven hour influent dredge flow (when there in no effluent pumping from the basin). This provides for a volume equivalent to one full operational dredging day, and for an overtime (or emergency) operation (9 to 10 hours a day) when effluent submersible pumps are in service.

Conveyance from the equalization basin to the dewatering facility would be achieved by submersible pumps positioned on the lower end of the sloped bottom of the equalization basin. Use of a sump well would allow proper pump submergence without dropping the overall depth of the basin.

Design points and established criteria upon which the Georgetown facilities has been based are provided below. Proposed dredge, equalization basin and pumping equipment have all been sized pursuant to the following key design points:

- Dalecarlia Forebay accumulation of solids totals 20,700 dry pounds per day.

- 4 ½ month operational processing schedule of annual accumulation is equivalent to the removal of 83,950 dry pounds per day. The 4 ½ month schedule (spring and ½ summer) includes 137 calendar days, 90 operating dredge days (5 days/week).

- 1 ½ percent residuals solid content dredged to equalization and conveyance.

Components comprising the Dalecarlia Forebay residuals collection, handling and conveying equipment have been established utilizing the above criteria. TABLE 7.2 reflects these design points and supplements the following presentation of the proposed design of each element.

7.3.1 Dalecarlia Forebay - Dredge Design

- 83,950 lbs/day dry solids removal at 1 ½% solids equates to 672,000 gallons/day.

DALECARLIA FOREBAY EQUALIZATION BASIN and PUMPING STATION - BASIS OF DESIGN

SITE CONDITIONS:

Forebay Hydraulics (elev, ft):	141'
Aprox. Grade around Forebay	150'
Bottom of Forebay (elev, ft):	Varies

Proposed Tank Elevations:

Top Elev of EQ Basin	157
Ave. Bottom Elev of EQ Basin	138.61
Proposed Tank Depth (ft) =	***18.40***

Proposed Equalization Basin Volume:

SIZE: 70' X 70' X 18.4'
MAX. VOL. 672,000 gallons

REQUIRED DREDGE OPERATIONS:

Annual Average Residuals Accumulations	20,700	(lbs/day)
Dredge Period (month/year)	4.50	(month/yr)
Dredging Required During Period	83,950	(lbs/day)
Average Dredged Residuals Concentration	1.50%	
Dredging Rate Required	1,600	(gpm)
Daily Dredging Operation	7	(hours)
Overtime Dredging Operation	9	(hours)
Average/Standard Daily Volume Dredged	672,000	gal/day
Overtime Operation Volume Dredged	864,000	gal/day

EQUALIZATION BASIN ANALYSIS and PUMPING REQUIREMENTS

(under varying daily dredging operations)

Dredging Period	Dredging Rate	Volume Removed	Pumps Operating	Pumping Rate From EQ Basin	Actual Active EQ Basin Vol.	Freeboard	Total Required Pumping Period To Empty EQ Basin
hrs/day	*gpm*	*gpd*	*No.*	*gpm*	*gallons*	*vertical ft*	*Hours*
7	1,600	672,000	1	560	436,800	**6.48**	20.00
8	1,600	768,000	1	560	499,200	**4.78**	22.86
9	1,600	864,000	1	560	561,600	**3.08**	25.71
9	1,600	864,000	2	740	464,400	**5.73**	19.46
10	1,600	960,000	2	740	516,000	**4.32**	21.62
7	1,600	672,000	0	0	672,000	**0.07**	Emergency off-line

EQ Basin Design Basis

TABLE 7.2

EQTANK2.XLS

- 7 hour standard dredge operating day, 8 hour day includes ½ hour start-up and ½ hour shut-down period.

- 1600 gpm dredging rate required to removal of 672,000 gpd of basin solids.
- 5 dredging days per week used for standard work week.

- Three dredge tensioning cable system set-ups are proposed (Zones) for the Forebay.

- The dredge would have a 10 to 15 feet per minute travel speed with a 16 inch diameter by 8 feet wide cutter head. Basin cleaning cycle time is expected to vary largely dependent upon deposition and operator control.

- Dredge is proposed to be electrically powered.

- Dredge locomotion would utilize a cable positioning system, employing winch and cable tensioners. Dredge anchor posts would be positioned every 200 feet, approximately. Layout is provided on Sheet C-4

7.3.2 Dalecarlia Forebay - Equalization Basin Design

- 7 hour standard dredge operating day (at 1600 gpm rate)

- Basin sized for one full day's worth of dredging flow (at 1½ % concentration), and the following design points:
  - Dredge Flow = 1600 gpm,
  - Tank Volume = 672,000 gallons (1600 x 7 x 60), and
  - Tank overflow (emergency condition) flows back into the Forebay.

- Tank Size: 70' x 70' x 18.4'

- Equalization Basin effluent (under a 7-hour standard dredging day): 560gpm (20 hours operation) via single constant rate unit (1 + 1 stand-by). Refer to the system curves on FIGURE 7-2 and basin layout on Sheet M-24.

- The additional residuals volume required to be pumped under an occasional overtime operation (9-hour dredging day) would be capable of being conveyed by a single pump.

- An open channel comminutor would be provided for shredding any debris picked up by the dredge as it enters the Equalization Basin in order to protect the submersible pumps.

7.3.3 Dalecarlia Forebay - Pumping Station Design

- 1,200 lf of 10 inch forcemain, 500 lf routed in the existing Capital Crescent Trail (recreational path), refer to Sheets C-2 and C-6.

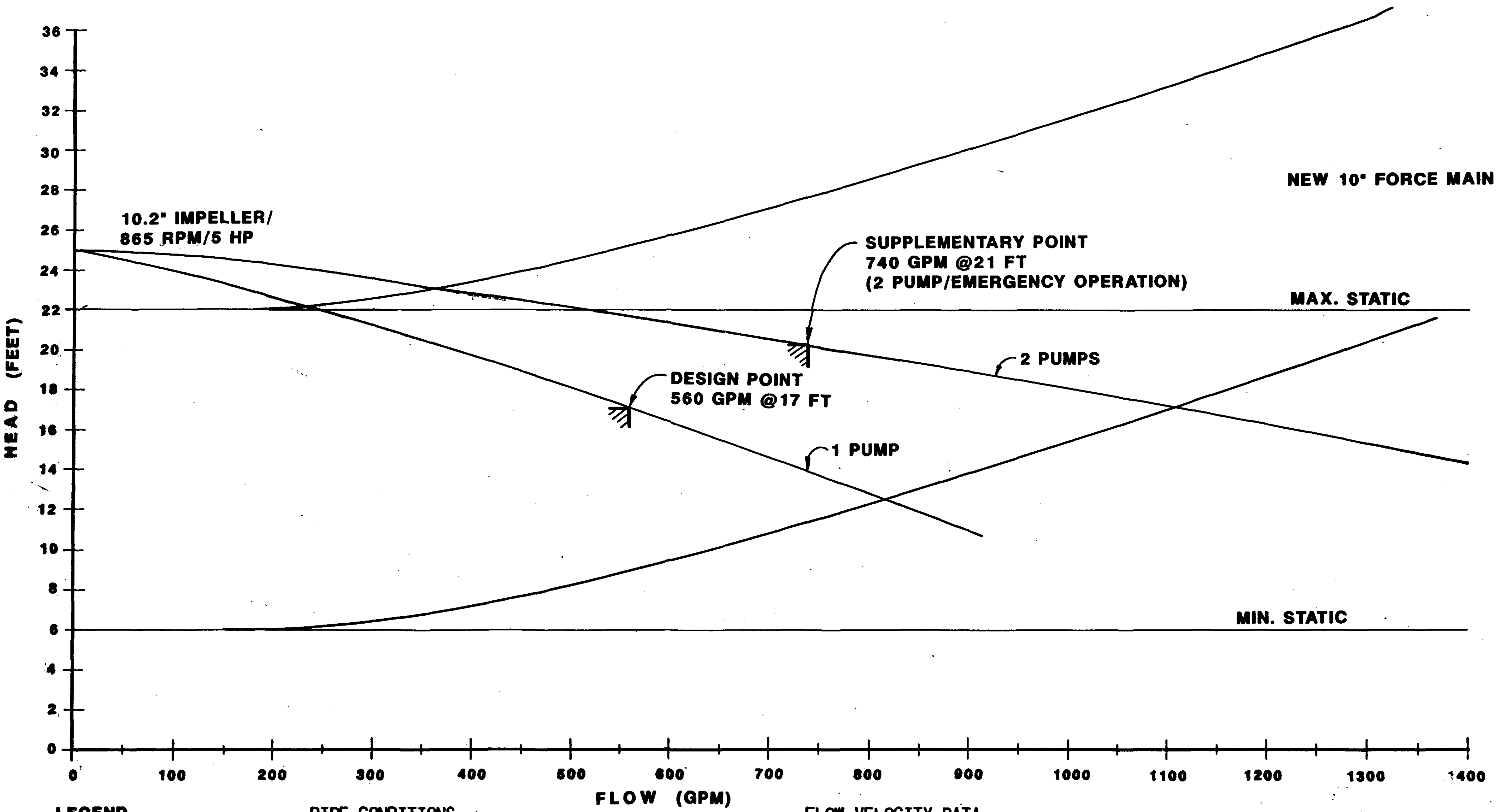
- 10 inch forcemain handling a pumping range of 560 to 740 gpm and total system head losses of up 35 ft. Refer to FIGURE 7-2.

- Flushing provisions of the 1,120 foot long conveyance forcemain would be achieved using the submersible pumps and clean Reservoir water.

7.4 Dalecarlia Sedimentation Basin Residuals Removal and Conveyance

The proposed removal of alum residuals settled in Dalecarlia Sedimentation Basins (No. 1 through 4) will be via a suction header and guide rail system. Removal is physically driven by a differential hydrostatic gradient. The free discharge of the header piping, a minimum of eight feet below basin hydrostatic operating elevation (Elev. 144), imposes the driving gradient to convey the settled solids from the basin's bottom. A header pipe with orifice openings travels along the basin bottom on a stainless steel guide rail. Locomotion would be achieved by cable linking the header to

DALECARLIA FOREBAY
PROPOSED EQ P S TO THICKENERS



LEGEND

D.I. DUCTILE IRON

PIPE CONDITIONS

1120 L.F. D.I. C=120

FLOW VELOCITY DATA

GPM	8"		10"	
550	3.51	FT/SEC.	2.25	FT/SEC.
600	3.83		2.45	
700	4.47		2.86	
900	5.74		3.86	
1100	7.02		4.49	

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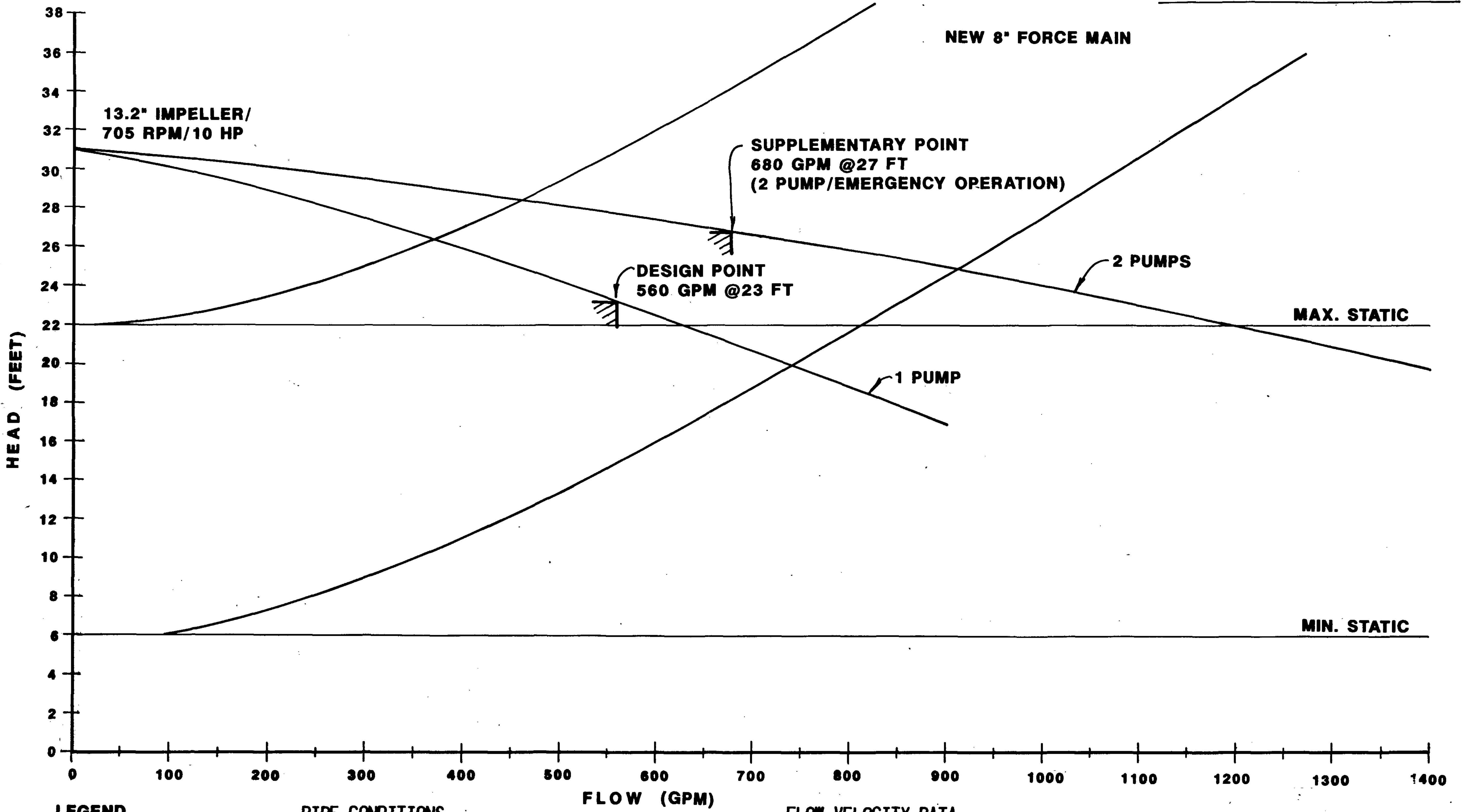
Engineers and Planners

DALECARLIA FOREBAY RESIDUALS

PUMPING SYSTEM HEAD CURVES

FEBRUARY 1996 FIGURE 7.2

DALECARLIA FOREBAY
PROPOSED EQ P S TO THICKENERS



LEGEND

D.I. DUCTILE IRON

PIPE CONDITIONS

1120 L.F. D.I. C=120

FLOW VELOCITY DATA

GPM	8"		10"	
550	3.51	FT/SEC.	2.25	FT/SEC.
600	3.83		2.45	
700	4.47		2.86	
900	5.74		3.86	
1100	7.02		4.49	

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DALECARLIA FOREBAY RESIDUALS

PUMPING SYSTEM HEAD CURVES

FEBRUARY 1996 FIGURE 7.2a

a motor drive, mounted along each basin's walkways. The suction pipe traverses a section of basin, connected by discharge hose to a stationary discharge header.

Removal of settled residuals from Basins No.1 and 2 would employ 12 individual header units per basin. Each basin would be sectioned into removal "zones", whereby three individual header system pipes connect into a common collection pipe. Basin No.1 and 2 each would have four zones (or four individual common collection header pipes). The four common collection header pipes would all tie into a single conveyance pipe leaving each Basin. Basin No.1 and 2 would each have that single pipe routed to the wetwell of the Sedimentation Basin Pumping Station. Each zone would enable flow (collection of settled residuals) via electronically actuated control valves. Each individual control valve would actuate the flow from its corresponding zone (tied together on a single collection pipe to three individual header systems).

Similarly, Basins No.3 and 4 would employ 16 header units each, with four suction pipe sections connected per zone to a common collection pipe (four zones per basin). All components submerged beneath the water except collection hose, skids, and guides are proposed to be type 304 stainless steel. The flexible collection hose would be high-density polyethylene, six inch diameter. Referring to Sheets M-13 through M19, the features of the suction header technology are as follows:

- Settled residuals in Dalecarlia Sedimentation Basins (No. 1 thru 4) would be removed by multiple traveling suction header systems. Removal is physically driven by a differential hydrostatic gradient developed by the difference in basin operating gradient and free discharge of conveyed residuals to the Sedimentation Basins Residual Pumping Station.

- The drive system would be a bi-directional cable trolley style imposing a maximum of 700 lbs. of cable tension to ensure smooth continuous header movement through residuals blanket depths ranging from between 1 to 4 feet in depth.

- Maximum recommended blanket depth would be 48 inches, estimated to correspond to the maximum residuals concentration that would be conveyable through the suction header system (2.0 percent)

- Manual controls would be provided to enable settled solids removal when the 2.0 percent maximum concentration of residuals is exceeded and the headed becomes "stuck". The manual control would allow operators to address this jammed condition.

- Automatic cycle controls would be accessed via a network control data-link.

7.4.1 Sedimentation Basins - Design Criteria

Detailed design criteria, schedules, and parameters are denoted as follows, with reference made to TABLE 7.3 through TABLE 7.7. TABLE 7.3, *Collection Header Design Parameters*, provides the summary of the suction header system.

Operations Schedule: 30 days/month, 7 days/week, and 24 hours/day

Process Flow Criteria: utilizing maximum and average month residuals production rates from *Technical Memo No.5*

	Average	***Max.***
• Flow (into all four basins)	120 mgd	110 mgd
• Basin Residuals Deposited (requiring removal)	233 lbs/mg 28,000 lb/day	625 lbs/mg 68,800 lb/day

- Estimated Residuals Distribution:

  Basin No.1 and 2 with 18 % per basin,
  and Basin No. 3 and 4 with 32 % per basin.

Hydraulic Loading covering the upper and lower range anticipated of residuals concentrations has been presented on TABLE 7.4 through TABLE 7.6.

COLLECTION HEADER SYSTEM DESIGN PARAMETERS (Basis of Design):

Sedimentation Basin No.1 through No.4

	Annual Average			Maximum Month	
Total Accumulation, All Basins ***Total Flow Removal, All Basins***	28,000	*lbs/day*		68,800	*lbs/day*
Residuals Concentration	0.50%	*2.00%*		0.50%	*2.00%*
Flow Removal Required (gal/day)	672,000	168,500		1,650,000	421,000
Flow Removal Per Basin	(gal/day)	(gal/day)		(gal/day)	(gal/day)
Basin 1 18%	121,000	30,250		297,000	74,250
Basin 2 18%	121,000	30,250		297,000	74,250
Basin 3 32%	215,000	54,000		528,000	132,000
Basin 4 32%	215,000	54,000		528,000	132,000

	Units	*BASIN No 1 OR 2*		*BASIN No 3 OR 4*
Collector Header Width	*LF*	32.75 to 33.08		10, 12 or 14
Collection Track length (Basin Width)	*LF*	135		138.25
Quanity of Units per Basin	*Quantity*	12		16
Collection header travel lenght per CYCLE	*LF*	270		276.5
Speed range of sludge collection header:	*Ft / Min*	4 to 12		4 to 12
Cycle Time	*Min / Cycle*	22 to 68		22 to 68
Header System Withdrawal rate:	*gpm / LF width of header*	4		4
Units Per Zone	*Quantity*	3		4
Zones per basin	*Quantity*	4		4
Removal Rate per Zone	*gpm per zone*	400		225

TABLE 7.3

SEDIMENTATION BASIN REQUIRED RESIDUALS REMOVAL RATES

(per Zone, per Sedimentation Basin)

	Annual Average		Maximum Month	
	@ 0.5% (gal/day)	*@ 2.0% (gal/day)*	*@ 0.5% (gal/day)*	*@ 2.0% (gal/day)*
Basin 1 and 2 combined				
TOTAL Flow Required gal/day	**242,000**	**60,500**	**594,000**	**148,500**
Basin 1 or 2 Total gal/day per each basin:	***121,000***	***30,250***	***297,000***	***74,250***
Zone 1 flow (40%)	48,400	12,100	118,800	29,700
Zone 2 flow (30%)	36,300	9,075	89,100	22,275
Zone 3 flow (20%)	24,200	6,050	59,400	14,850
Zone 4 flow (10%)	12,100	3,025	29,700	7,425

	Annual Average		Maximum Month	
	@ 0.5% (gal/day)	*@ 2.0% (gal/day)*	*@ 0.5% (gal/day)*	*@ 2.0% (gal/day)*
Basin 3 and 4 combined				
TOTAL Flow Required gal/day	**430,000**	**108,000**	**1,056,000**	**264,000**
Basin 3 or 4 Total gal/day per each basin:	***215,000***	***54,000***	***528,000***	***132,000***
Zone 1 flow (40%)	86,000	21,600	211,200	52,800
Zone 2 flow (30%)	64,500	16,200	158,400	39,600
Zone 3 flow (20%)	43,000	10,800	105,600	26,400
Zone 4 flow (10%)	21,500	5,400	52,800	13,200

TABLE 7.4

OPERATIONAL OPTIONS - Removal Required for "ANNUAL AVERAGE" Residuals Production

Removal of Residuals in either Basin 1 or 2

	Residuals Concentration @ 0.5%				*Residuals Concentration @ 2.0%*		
Header Travel Speed (Ft/Sec)	4	8	12		4	8	12
Header Travel Time (Minutes / Cycle)	67.50	33.75	22.50		67.50	33.75	22.50
Required Volume Removal (gal/day)	121,000	121,000	121,000		30,250	30,250	30,250
Basin Total Zone Operating time (hr/day)	5.08	5.08	5.08		1.27	1.27	1.27
Basin Total Zone Cycles / Week	32	63	95		8	16	24

Removal for Residuals in either Basin 3 or 4

	Residuals Concentration @ 0.5%				*Residuals Concentration @ 2.0%*		
Header Travel Speed (Ft/Sec)	4	8	12		4	8	12
Header Travel Time (Minutes / Cycle)	67.50	33.75	22.50		67.50	33.75	22.50
Required Volume Removal (gal/day)	215,000	215,000	215,000		54,000	54,000	54,000
Basin Total Zone Operating time (hr/day)	16.00	16.00	16.00		4.02	4.02	4.02
Basin Total Zone Cycles / Week	32	63	95		25	50	75

* gpm per zone = gpm per sludge header x No. of sludge headers

* gal/day per zone = gal/day per basin x % distribution

* min/day per zone = gal/day per zone / gpm per zone collected

* hr/day per zone = min/day per zone / 60

* zone Cycles per week = [gpd removal needed] / [Gal removed per Header Cycle]

* gpm per basin = gpm per zone x No. of zones

* gal/day per basin = gal/day / 2

* cycles per week per zone = cycles per day x 7 days

* cycle per day per zone =(mpd x fpm) / LF per trip

TABLE 7.5

OPERATIONAL OPTIONS - Removal Required for "MAXIMUM MONTH" Residuals Production

Removal of Residuals in either Basin 1 or 2

	Residuals Concentration @ 0.5%				*Residuals Concentration @ 2.0%*		
Header Travel Speed (Ft/Sec)	4	8	12		4	8	12
Header Travel Time (Minutes / Cycle)	67.50	33.75	22.50		67.50	33.75	22.50
Required Volume Removal (gal/day)	297,000	297,000	297,000		74,250	74,250	74,250
Basin Total Zone Operating time (hr/day)	12.47	12.47	12.47		3.12	3.12	3.12
Basin Total Zone Cycles / Week	78	155	233		19	39	58

Removal for Residuals in either Basin 3 or 4

	Residuals Concentration @ 0.5%				*Residuals Concentration @ 2.0%*		
Header Travel Speed (Ft/Sec)	4	8	12		4	8	12
Header Travel Time (Minutes / Cycle)	67.50	33.75	22.50		67.50	33.75	22.50
Required Volume Removal (gal/day)	528,000	528,000	528,000		132,000	132,000	132,000
Basin Total Zone Operating time (hr/day)	39.29	39.29	39.29		9.82	9.82	9.82
Basin Total Zone Cycles / Week	244	489	733		61	122	183

* gpm per zone = gpm per sludge header x No. of sludge headers
* gal/day per zone = gal/day per basin x % distribution
* min/day per zone = gal/day per zone / gpm per zone collected
* hr/day per zone = min/day per zone / 60
* zone Cycles per week = [gpd removal needed] / [Gal removed per Header Cycle]

* gpm per basin = gpm per zone x No. of zones
* gal/day per basin = gal/day / 2
* cycles per week per zone = cycles per day x 7 days
* cycle per day per zone =(mpd x fpm) / LF per trip

TABLE 7.6

SEDIMENTATION BASIN RESIDUALS REMOVAL and PUMPING STATION DESIGN SUMMARY

BASIN	*HEADER SYSTEM or ZONE "RUN TIME" (Hrs/day)*	*No. of Zones Required (Zones/day)*	*PROPOSED ZONE OPERATION (Zones/day)*	*DESIGNED HEADER FLOW RATE (gpm)*	*Sed. Basin Pumping Station Required Handling Capacity*
Basin 1	12.47	0.62	1	400	400
Basin 2	12.47	0.62	1	400	400
Basin 3	39.29	1.96	2	225	450
Basin 4	39.29	1.96	2	225	450

REQUIRED P.S. CAPACITY = 1700 gpm

NOTES: 1) **Based Upon 0.5% Residuals Concentration, "MAXIMUM MONTH" Loading Criteria**
2) **Calculations utilze 20 hrs/day Continual Removal Operations**

TABLE 7.7

Suction Header System Drive Unit Assembly:

Suction Header (Qty) Drive Unit	1
Horsepower (Max.)	½ hp.
Electrical Service	120 Volt, 1- Phase
DC Controller	Variable
Cable Tension (Max.)	700 lbs.
Header Flow Rate (orifice opening)	4 gpm/LF

7.4.2 Operational Impact of Basin Residuals Collection on Pumping Station Equipment

The proposed Sedimentation Basin Residuals Pumping Station design criteria would be impacted by the physical limitations of the suction header residuals collection equipment. A 1,400 gpm pumping station rate would be needed if continually removed residuals from all four Sedimentation Basins could be achieved, 20 hour/day, 365 day/year (and treating the four basins as a single source). The physical constraints of header removal rates, piping head losses, operational removal "zones", and cost factors were all evaluated. As denoted above, "zones" were established based upon maximum header sizing possible for each basin. The concern was to minimize the number of header removal units and thereby reduce capital costs.

Removal zones and equipment have been indicated on Sheets M-13 and M-16. Due to physical obstructions within particular areas of each basin, header lengths would be fixed for a given zone. Based upon a fixed header length, flow would be correspondingly fixed also. A zone would either be flowing or off (enabled by its corresponding control valve). These header removal rates are independent of the travel speed at which a suction header is capable of traversing. Basin No.1 and 2 have each been designed with a 400 gpm removal rate per zone; Basin No.3 or 4 with a 225 gpm removal rate per zone. These rates are a direct function of header length (in total linear feet per zone) and orifice openings. Application of these rates provide the total flow rates which would be conveyed into the wetwell of the Pumping Station.

Maximum month residuals production rates, (with two zones from each basin simultaneously flowing) are proposed to hydraulically size the conveyance piping to the Pumping Station.

TABLE 7.3 through TABLE 7.7 presents the design details of the proposed Sedimentation Basin Residuals Suction Header Collection System. TABLES 7.6 and 7.7 reflect both the operational limitations and flexibility of the proposed suction header design. One limitation is that a zone, when "on" or valve open, yields a certain design flow. These design flows impose pumping requirements upon the proposed Sedimentation Basin Residuals Pumping Station. Pumping station equipment is proposed to handle the equivalent residuals flowing from a combination of four basin 3 and 4 zones (225 gpm/each, 4 x 225 = 900 gpm), and two Basin 1 and 2 zones (400 gpm/each, 400 x 2 = 800 gpm). The station's total required pumping capacity is, therefore, proposed to convey at a rate of 1700 gpm. Refer to TABLE 7.7

7.4.3 Sedimentation Basins - Retrofit Work

The unique retrofit variations between the sedimentation basins necessary to facilitate the installation of the suction header technology include the following:

Basins No. 1 and No. 2

- Relocate existing basin flushing water service lines as required for drive cable clearance.

- Modify walkway hand railing sections to accommodate installation of drive systems.

- Concrete fill basin drainage trenches, while retaining sumps as indicated on drawings.

Basins No. 3 and No. 4

- Basin 4 only (west end) - build new concrete slab on grade as a platform for drive units and maintenance access.

- Basin 3 only (east wall abutting basin ½ influent structure) - modify handrails to house drive units.

- Core-drill existing middle deck and install cable sleeves as required for drive cable down to lower level of the sedimentation basin.

- Place concrete fill to create smooth transition for suction header paths as required.

- Construct concrete diverters between existing basin columns to direct settling solids into the suction header travel paths.

- Retrofit the abandoned 18-inch drain adjacent to Basin No. 3. Provide 18-inch valved decant piping connections to Basins No. 3 and No. 4. This will allow for decanting operations of Basin No.1 and 2 down to elevation 120.00 whenever basins are to be drained for periodic maintenance.

7.5 Dalecarlia Sedimentation Basin Residuals Pumping Station

The pumping station would convey the settled residuals collected from the bottom of the four Dalecarlia Sedimentation Basins. The station is proposed to be located at the south end of Basin 3, refer to C-3. The range of flows and conditions anticipated to be handled by the proposed design are presented as follows:

7.5.1 Pumping Station - Design Features

- The Sedimentation Basin Residuals Pumping Station would convey basin residuals to the Gravity Thickener Facilities. Residuals concentrations could range from 0.25 to 2.0 percent solids. The design point of 0.5 percent solids concentration has been utilized for all equipment and pipe sizing. Refer to TABLE 7.7 presented above.

- The existing utility lines located at the proposed Pumping Station site would be relocated and sequenced with appropriate construction phases, as would be shown on the Contract Drawings. Section 14 contains additional discussions of proposed sequencing.

- Each residuals conveyance pump (denoted RS) draws from the wetwell, proposed as a single chamber with filleted interior corners to promote solids conveyance to respective pump suction inlets. The pump discharge configuration would provide for recirculation and flushing of the wet well.

- The RS pump process would utilize two on-line units with one standby pump of equal capacity.

- The pumping facility would utilize flow and wet well level measurement instrumentation for an automatic process control scenario.

- Hoisting requirements would include a portable mobile mast and boom jib-crane located at grade with appropriate rigging accessories to allow for proper positioning of equipment.

- The effluent residuals pipe header has been configured to accommodate pig launching facilities, proposed to prevent clogging of the conveyance lines. These facilities would include process isolation and launcher assembly suitable for attachment.

- The station design includes provisions for a 20-inch overflow below the structural level housing the electrical control equipment.

The detailed design calculations, schedules and criteria, for this station are presented as follows. Criteria supports the proposed design reflected on Sheets M-20 and M-21.

7.5.2 Pumping Station - Design Criteria

A. Operations Schedule: 30 days/month, 7 days/week, and 24 hours/day

B. Process Load and Flow Requirements (to remove projected residuals production):

• Annual Average	28,000 lbs/day
• Maximum Monthly	68,800 lbs/day
• Maximum Weekly	95,900 lbs/day
• Design Flow to Handle Removal System	1700 gpm
• Process Pipe Size	10 inches
• Process Velocities:	
1 Pump Operation (1,300 gpm)	5.30 fps
2 Pump Opeation (1700 gpm)	6.92 fps

C. RS Pumps:

- Type: Vertical Non-Clog Centrifugal Dry-pit Solids Handling Pump

• Quantity	2 + 1 Standby
• Control	Variable (rpm)
• Design Capacity	850 gpm
• Design Total Head	130 ft.
• Suction Size (min.)	6-inch
• Discharge Size (min.)	4-inch
• Motor Horsepower (max.)	50 Hp
• Speed (max.)	1,780 rpm.
• Electrical Service	460 volt, 3-phase
• Unit Weight	2,000 lbs.

D. Flow Meter:

Type	Magnetic
Design Flow	1,700 gpm
Size	6 inches
Velocity at Design Flow	19.29 fps
Electrical Service	120 volt, 1-phase

7.6 Influent Splitter Box

The proposed thickener influent splitter box (shown on Sheet M-27), would be installed within the proposed Thickened Residuals Pumping Station (TRS). This location would provide accessibility to all influent piping and appurtenances, including process chemical addition and pigging facilities. A separate structure for the splitter box would require a sizeable vault adjacent to the TRS structure, complicating process piping, site arrangement and increasing cost, and was therefore eliminated from further consideration.

The splitter box is proposed to utilize an up-flow center feed chamber, with adjacent motor-operated weir gates. The influent flow to each gravity thickener would be controlled by these weir gates, which provide distribution adjustability. The splitter box would be fabricated from carbon steel to suit configuration shown on the Sheet M-27. A steel construction was chosen for ease of modular design, reliability and ability to perform maintenance as compared to a concrete tank design.

The influent flow structure is designed to utilize an in-line static mixer to ensure proper mixing of polymers added to aid in the thickening process. Dependent upon flow conditions, 5 to 50 seconds of hydraulic retention time would be provided prior to the distribution weirs and an additional 1.50 to 4 minutes of retention time would be provided following the distribution weirs. The splitter box design criteria is as follows:

Process Pipe Size	14 inches
Normal Flow Range	300 - 3200 gpm
Process Velocities	
3200 gpm (max.)	6.75 fps
2000 gpm (avg.)	4.22 fps

300 gpm (min.)	0.63 fps
• Solids concentration	0.25 - 1.0%

7.7 Gravity Thickeners

Four 90-ft diameter, 20-ft deep thickening units are proposed to provide three key functions: residuals concentration, flow equalization and residuals storage. An efficient centrifuge operation requires a steady, unchanging influent feed concentration in order to provide a consistent dewatered cake. The following is a description of the process and mechanical design of these critical gravity thickening units, followed by the criteria and parameters utilized. Refer to Sheet M-25 for the layout configuration and TABLES 7.8 through 7.11 for hydraulic and loading requirements.

7.7.1 Gravity Thickeners - Design Features

- The gravity thickener equipment would be the first stage in separating the solids from the bulk liquid in the residuals dewatering process. Influent flow would be a combination of Georgetown reservoir dredged residuals, Dalecarlia forebay dredged residuals, Dalecarlia sedimentation basins residuals and dewatering process centrate.

- The gravity thickeners would utilize low transitional velocities coupled with chemical enhancement and hydraulic retention sufficient for proper residuals settling. Blanket concentration and compaction would be a function of solids density.

- The proposed top elevations for the gravity thickeners were established to help provide for a balanced site, and hydraulic considerations.

- Thickeners would be equipped with heavy duty, high-torque drives to accommodate river silt and sand-like influent. Drive access would be provided by a bridge spanning the thickener from one side to the center column.

TABLE 7.8
THICKENER HYDRAULIC LOADING (7) - WITH CENTRATE RECYCLE
(Conservative Operation with 1.0% Georgetown Res. Dredging)

With Centrate Recycle (4)	**Average Yearly Conditions**		**Maximum Month Conditions**	
Thickener Criteria	3 Months (6)	4½ Months (6)	3 Months (6)	4½ Months (6)
Days per Month	30	30	30	30
Days per Week	7	7	7	7
Hours per Day	20	24	20	24
Residuals (lbs/day) (6)	28,000	122,900	68,800	163,700
Centrate Solids (lbs/day, 5 days/week)	860	2,800	2,100	4,100
Total (lbs/day)	28,860	125,700	71,000	167,500
Residuals Flow (gpd)	671,500	1,809,400	1,649,900	2,788,000
Centrate Flow (gpd)	188,800	615,300	463,800	890,300
Total Influent (gpd)	860,300 (8)	2,424,700 (3)	2,113,700(8)	3,678,300 (3)
Influent Solids Conc. (%)	0.40 (8)	0.60 (3)	0.40 (8)	0.55 (3)
Total Units	4	4	4	4
Units On-Line (5)	2	4	4	4
Solids (lbs/day/ft^2)	2.2	4.9	2.8	6.6
Maximum (lbs/day/ft^2)	7	7	7	7
Underflow Solids Processed (lbs/day) 20 days/month Operational Basis	43,000	140,000	105,300	202,100
Underflow Solids Conc. (%)	2.5	2.5	2.5	2.5
Underflow (gpd)	206,240	671,500	505,000	969,300
Blanket SWD Depth (ft) (1)	7	7	7	5 (1)
Hydraulic Loading (gpd/ft^2)	67.6	95.3	83.1	144.5
Retention (hours)(2)	34.5	24.5	28.1	18.6
Peak Hour Flow (gpm) (4)	785	2,100	1,930	3,200

Notes:
(1) Thickener is 20 Ft. to top of cone. Sludge depth (SWD) is measured from the top of the cone.
(2) Minimum Hydraulic Retention Time = 18.0 Hrs. per MPI with a safety factor of 3 (actual hydraulic retention time varies throughout the day).
(3) Total Influent concentration and flows shown reflect the highest daily composite solids and flows resulting due to Basins, Reservoir Dredging and Centrate.
(4) Occurs during 14-hour dewatering period.
(5) Thickener quantity reflects maximum residuals blanket depth in accordance with required process retention time.
(6) Residual: 4 ½ months = Sed. Basins (@0.5%) and Georgetown Reservoir (@1.0% Dredging.)
3 Months = Sed. Basins only (@0.5% with no dredging).
(7) Thickener Design: 90 ft. diameter, 20 ft. SWD above conical section, 35.33 ft. total depth including conical section.
(8) Total Influent concentration and flows shown reflect daily composite solids and flows from Basins and Centrate.

TABLE 7.9
THICKENER HYDRAULIC LOADING (6) - WITHOUT CENTRATE RECYCLE
(Conservative Operation with 1.0% Georgetown Res. Dredging)

Without Centrate Recycle(4)	**Average Yearly Conditions**		**Maximum Month Conditions**	
Thickener Criteria	3 Months (5)	4½ Months (5)	3 Months (5)	4½ Months (5)
Days per Month	30	30	30	30
Days per Week	7	7	7	7
Hours per Day	20	24	20	24
Residuals (lbs/day) (5)	28,000	122,900	68,800	163,700
Centrate Solids (lbs/day)	0	0	0	0
Total (lbs/day)	28,000	122,900	68,800	163,700
Total Influent Flow (gpd) (4)	671,500 (7)	1,822,550 (2)	1,649,900 (7)	2,801,000 (2)
Influent Solids Conc. (%) (4)	0.5 (7)	0.8 (2)	0.5 (7)	0.7 (2)
Total Units	4	4	4	4
Units On-Line	1	3	3	4
Solids (lbs/day/ft^2)	4.4	6.5	5.4	6.5
Maximum (lbs/day/ft^2)	7	7	7	7
Underflow Solids Conc. (%)	2.5	2.5	2.5	2.5
Underflow solids to Proceessing (lbs/day) 20 days/month Operational Basis	42,000	136,900	103,200	198,100
Underflow (gpd)	201,400	656,600	495,000	950,100
Blanket SWD Depth (ft) (3)	7	7	7	7
Hydraulic Loading (gpd/ft^2)	105.6	97.4	129.7	110.9
Retention (hrs) (1)	18.4	22.7	22.5	18.9
Solids Storage (days)	3.70	2.50	4.52	2.51
Peak Hour Influent Flow (gpm) (4)	560	1,359	1,375	2,174

Notes:

(1) Minimum Hydraulic Retention Time = 18 Hours Per on MPI with a Safety Factory of 3 (actual hydraulics retention time varies throughout the day)

(2) Total Influent Concentration and Flows Shown Reflect the Highest Daily Composite Solids and flows resulting due to Basins and Reservoir Dredging.

(3) Measured at 20 Ft. Side Water Depth (SWD).

(4) Occurs 10 hrs/day during non-dewatering period.

(5) Residual: 4 ½ Month = Sed. Basins (@ 0.5%) and Georgetown Reservoir (@ 1.0% Dredging)
3 Month = Sed. basins only (@ 0.5% with no dredging).

(6) Thickener Design: 90 ft. diameter; 20 ft. SWD above conical section, 35.33 ft. total depth including conical section.

(7) Total Influent Concentration and Flow from Sed. Basins only.

TABLE 7.10
THICKENER HYDRAULIC LOADING (7) - WITH CENTRATE RECYCLE
(Predicted Operation with 1.5% Georgetown Res. Dredging)

With Centrate Recycle (3)	Average Yearly Conditions		Maximum Month Conditions	
Thickener Criteria	3 Months (6)	4½ Months (6)	3 Months (6)	4½ Months (6)
Days per Month	30	30	30	30
Days per Week	7	7	7	7
Hours per Day	20	24	20	24
Residuals (lbs/day) (6)	28,000	122,900	68,800	163,700
Centrate Solids lbs/day 5 days/week)	860	2,800	2,100	4,100
Total (lbs/day)	28,860	125,700	71,000	167,500
Residuals Flow (gpd)	671,500	1,430,600	1,649,900	2,408,600
Centrate Flow (gpd) (days/week)	188,800	615,300	463,000	890,300
Total Influent (gpd)	860,300 (8)	2,045,900 (3)	2,113,700 (8)	3,298,900 (3)
Influent Solids Conc. (%)	0.40 (8)	0.60 (3)	0.40 (8)	0.55 (3)
Total Units	4	4	4	4
Units On-Line (5)	2	4	4	4
Solids (lbs/day/ft^2)	2.3	4.9	2.8	6.6
Maximum (lbs/day/ft^2)	7	7	7	7
Underflow Solids to Processing (lbs/day) 20 days/month Operational Basis	43,000	140,000	105,300	202,100
Underflow Solids Conc. (%)	2.5	2.5	2.5	2.5
Underflow (gpd)	206,240	671,500	505,000	969,300
Blanket SWD Depth (ft) (1)	7	7	7	7
Hydraulic Loading (gpd/ft^2)	67.6	80.4	83.1	129.6
Retention (hours)(2)	34.5	29.0	28.1	18.0
Peak Hour Influent Flow (gpm) (4)	785	1,820	1,930	2,960

Notes:

(1) Thickener is 20 Ft. to top of cone. Sludge depth (SWD) ismeasured from the top of the cone.

(2) Minimum Hydraulic Retention Time = 18.0 Hrs. per MPI with a safety factor of 3 (actual hydraulic retention time varies throughout the day).

(3) Total Influent concentration and flows shown reflect the highest daily composite solids and flows resulting due to Basins, Centrate and Reservoir Dredging.

(4) Occurs during 14-hour dewatering period.

(5) Thickener quantity reflects maximum residuals blanket depth in accordance with required process retention time.

(6) Residual: 4 ½ months = Sed. Basins (@0.5%) and Georgetown Reservoir (@1.5% Dredging.)
3 Months = Sed. Basins only (@0.5% with no dredging).

(7) Thickener Design: 90 ft. diameter; 20 ft. SWD above conical section, 35.33 ft. total depth including conical section.

(8) Total Influent concentration and flows shown reflect daily composite solids and flows from Basins and Centrate.

TABLE 7.11
THICKENER HYDRAULIC LOADING (6) - WITHOUT CENTRATE RECYCLE
(Predicted Operation with 1.5% Georgetown Res. Dredging)

Without Centrate Recycle	**Average Yearly Conditions**		**Maximum Month Conditions**	
Thickener Criteria	3 Months (5)	4½ Months (5)	3 Months (5)	4½ Months (5)
Days per Month	30	30	30	30
Days per Week	7	7	7	7
Hours per Day	20	24	20	24
Residuals (lbs/day) (5)	28,000	122,900	68,800	163,700
Centrate Solids (lbs/day)	0	0	0	0
Total (lbs/day)	28,000	122,900	68,800	163,700
Influent Flow (gpd)	671,500(7)	1,430,600(2)	1,649,900(7)	2,408,600(2)
Influent Solids Conc. (%)	0.5(7)	0.8(2)	0.5(7)	0.7 (2)
Total Units	4	4	4	4
Units On-Line	1	3	3	4
Solids (lbs/day/ft^2)	4.4	6.4	5.4	6.4
Maximum (lbs/day/ft^2)	7	7	7	7
Underflow Solids to Processing (lbs/day) 20 days/month Operational Basis	42,000	136,900	103,200	198,100
Underflow Solids Conc. (%)	2.5	2.5	2.5	2.5
Underflow (gpd)	201,400	656,600	495,000	950,100
Blanket SWD Depth (ft) (3)	7	7	7	7
Hydraulic Loading (gpd/ft^2)	105.6	75.4	129.7	94.7
Retention (hrs) (1)	22.1	31.1	36.0	24.6
Peak Hour Influent Flow (gpm) (4)	560	1,359	1,375	2,174

Notes:
(1) Minimum Hydraulic Retention Time = 18 Hours Per on MPI with a Safety Factory of 3 (actual hydraulics retention time varies throughout the day)
(2) Total Influent Concentration and Flow Shown Reflect the Highest Daily Composite Solids and flows resulting due to Basins and Reservoir Dredging.
(3) Measured at 20 Ft. Side Water Depth (SWD).
(4) Occurs 10 hrs/day during <u>non</u>-dewatering period.
(5) Residual: 4 ½ Month = Sed. Basins (@ 0.5%) and Georgetown Reservoir (@ 1.5% Dredging)
3 Month = Sed. only Basins (@ 0.5% with no dredging).
(6) Thickener Design: 90 ft. diameter; 20 ft. SWD above conical section, 35.33 ft. total depth including conical section.
(7) Total Influent Concentration and Flow from Sed. Basins only.

- Thickener influent arrangement would be of the center column syphon feed type. Optimum center feed velocities will be 0.50 to 4.0 fps.

- Gravity thickener hopper truss and scrapper assembly would include extended sludge blanket agitation pickets to aid compaction and optimize concentration of thickener underflow.

- Sludge draw-off hopper would be of the 60-degree incline type with scrapper blades.

- The effluent (overflow) configuration would consist of a surface scum removal assembly, tube settling packs with support, scum baffle and effluent V-notch weir.

- Tube settling packs are proposed to increase thickener effluent clarification. Estimated efficiency of solids removal is enhanced 20 percent or greater.

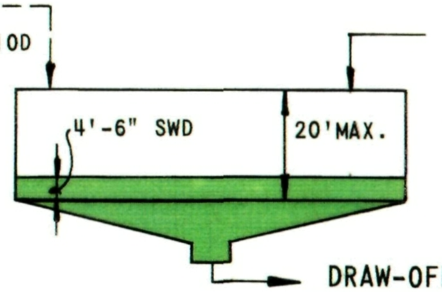
- Flotation of debris and scum within the thickener would be handled by a scum conveyance and disposal system, including: a scum collection well, a portable grinder pump and hoisting equipment.

- Seasonal residuals loading and dredging schedules would provide operational flexibility, facilitating variable storage periods during yearly operations.

- The four thickener units would be able to receive influent solids from the Sedimentation Basin (no dredging residuals) under maximum loading criteria, for up to three days with no withdrawal of thickened residuals. This proposed three-day thickened residuals storage volume is based on starting with empty gravity thickeners.

- The proposed thickeners would operate under an intermittent draw-down of 14 hours/day. This corresponds to the proposed 14 hour/day dewatering operation. Thickener draw-down would only occur when the centrifuge process is running.

• SLUDGE BLANKET SWD @ START OF DEWATERING WEEK •
(14 HR/DAY DRAW-OFF)



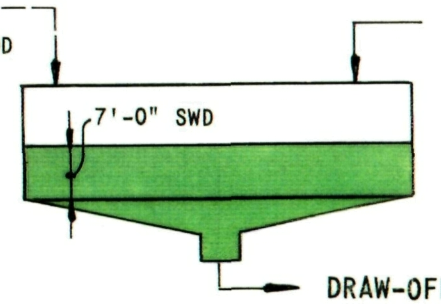
INFLUENT DURING
NON-DEWATERING PERIOD
(10 HR/DAY)
1,716 LBS/HR.@
0.82% SOLIDS
FLOW = 25,180 GPH

INFLUENT DURING DEWATERING PERIOD - (14 HR/DAY)
1,787 LBS/HR.@ 0.53% SOLIDS
FLOW = 40,743 GPH
(INCLUDES CENTRATE)

DRAW-OFF (14 HR/DAY)
3,504 LBS/HR.@ 2.5% SOLIDS
FLOW = 16,808 GPH

MAXIMUM MONTH CONDITION

(TYPICAL OF 4 THICKENERS)



INFLUENT DURING
NON-DEWATERING PERIOD
(10 HR/DAY)
1,722 LBS/HR.@
1.03% SOLIDS
FLOW = 19,984 GPH

INFLUENT DURING DEWATER PERIOD - (14 HR/DAY)
1,788 LBS/HR.@ 9.62% SOLIDS
FLOW = 34,570 GPH
(INCLUDES CENTRATE)

DRAW-OFF (14 HR/DAY)
3,284 LBS/HR.@ 2.5% SOLIDS
FLOW = 15,754 GPH

AVERAGE MONTH CONDITION

(TYPICAL OF 3 THICKENERS)

NOTES:

1. DRAW-OFF PERIOD SIMULTANEOUS WITH DEWATERING PERIOD (14 HR/DAY).
2. NO EQUALIZATION REQUIRED AT DEWATERING BLEND TANK.
3. SIDE WATER DEPTHS ARE MAXIMUM ALLOWABLE TO PROVIDE 18 HR. HYDRAULIC DETENTION TIME.
4. MAXIMUM SIDE WATER DEPTH = 20'

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

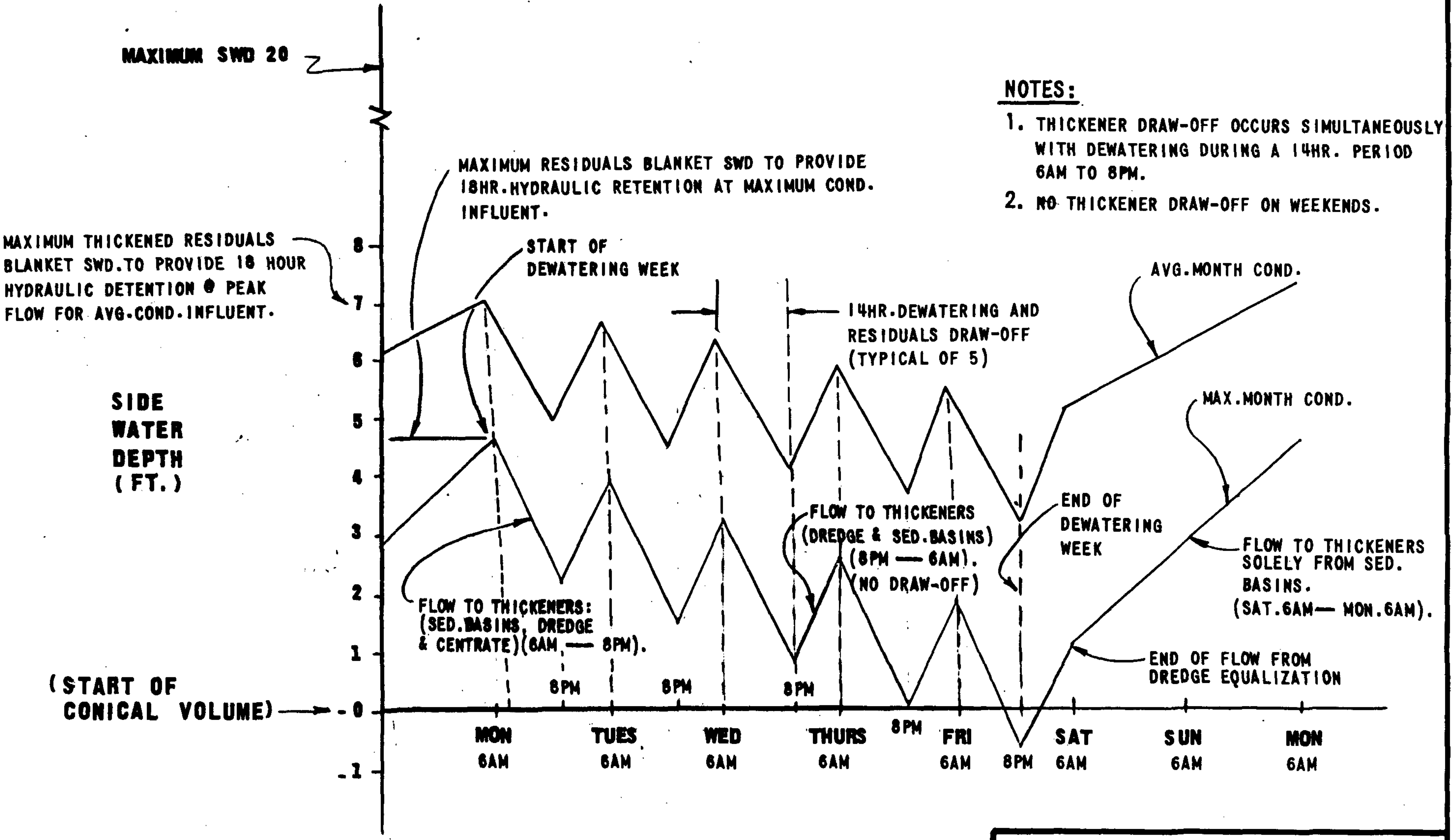
THICKENER SYSTEM ANALYSIS-LOADINGS

14 HR/DAY DRAW-OFF

FEBRUARY 1996

FIGURE 7.3

• WEEKLY THICKENED RESIDUALS BLANKET SWD LEVEL FLUCTUATIONS •
(DURING 14 HR/DAY THICKENER DRAW-OFF PERIOD)



NOTES:

1. THICKENER DRAW-OFF OCCURS SIMULTANEOUSLY WITH DEWATERING DURING A 14HR. PERIOD 6AM TO 8PM.
2. NO THICKENER DRAW-OFF ON WEEKENDS.

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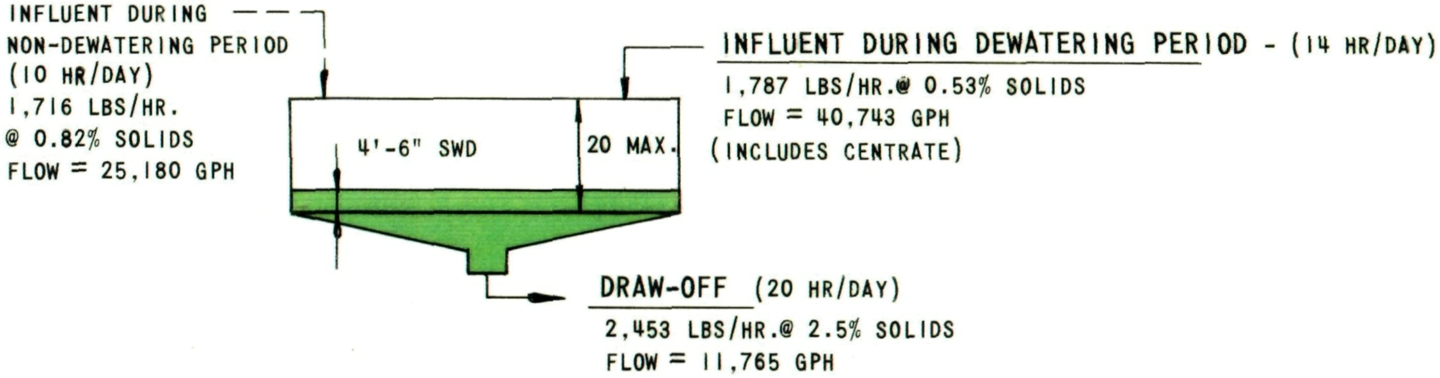
THICKENER SYSTEM ANALYSIS-WITHDRAWAL

14 HR/DAY DRAW-OFF

FEBRUARY 1996

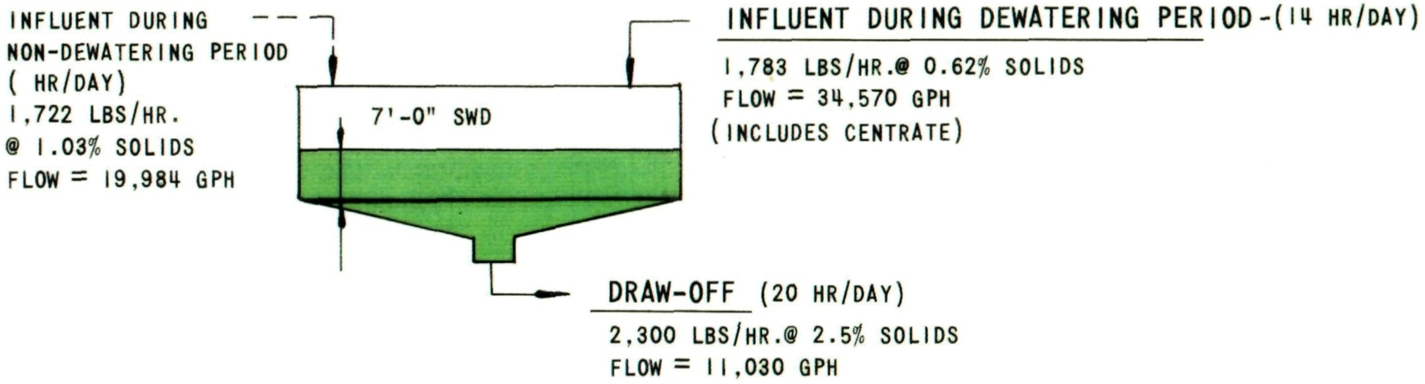
FIGURE 7.4

• SLUDGE BLANKET SWD @ START OF DEWATERING WEEK •
(20 HR/DAY DRAW-OFF)



MAXIMUM MONTH CONDITION

(TYPICAL OF 4 THICKENERS)



AVERAGE MONTH CONDITION

(TYPICAL OF 3 THICKENERS)

NOTES:

1. DEWATERING OCCURS DURING FIRST 14HR.OF 20HR. DRAW-OFF PERIOD.
2. EQUALIZATION REQUIRED AT DEWATERING BLEND TANK.
3. SIDE WATER DEPTHS ARE MAXIMUM ALLOWABLE TO PROVIDE 18 HR. HYDRAULIC DETENTION TIME.
4. MAXIMUM SIDE WATER DEPTH = 20'.

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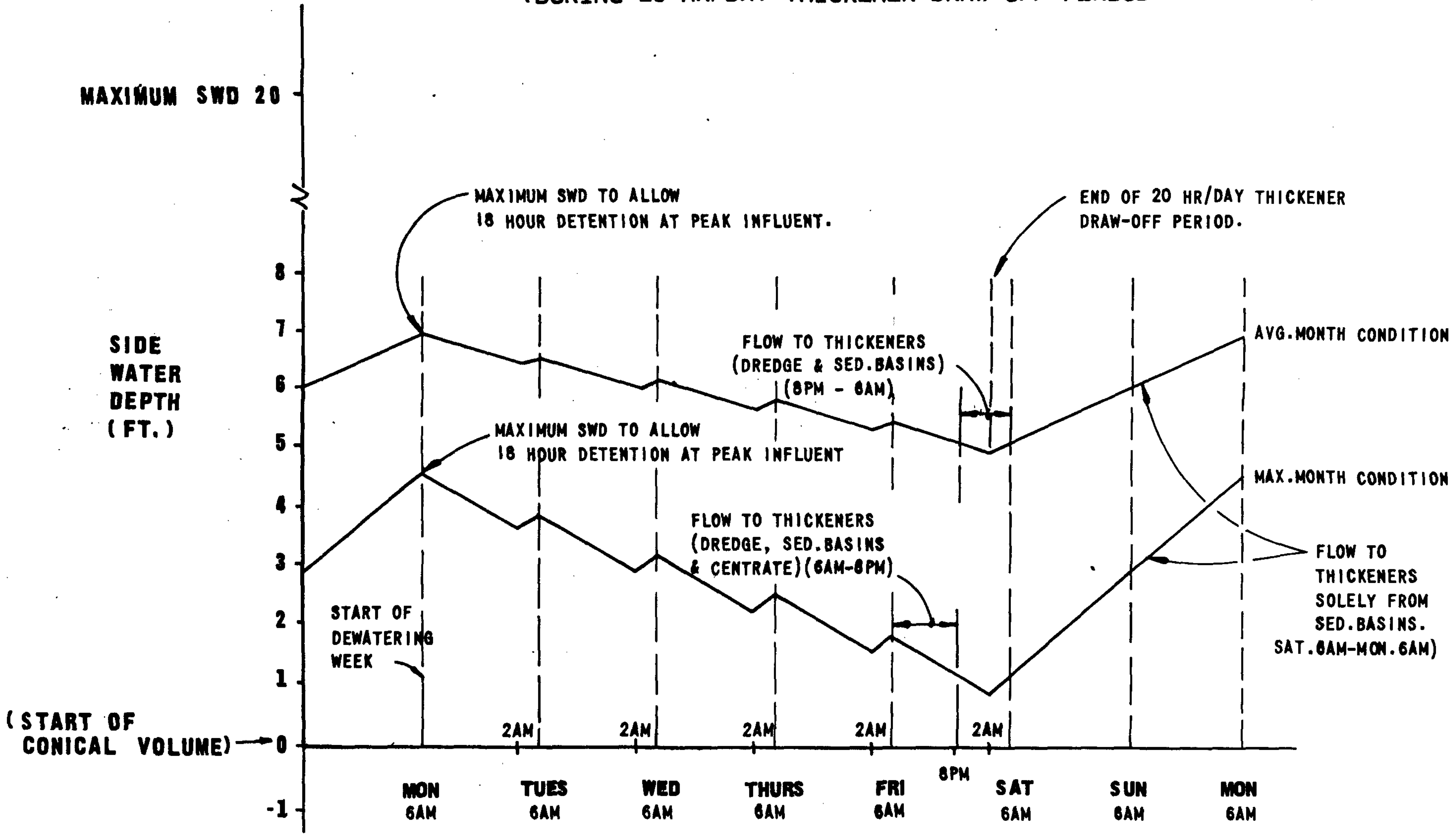
THICKENER SYSTEM ANALYSIS-LOADINGS

20 HR/DAY DRAW-OFF

FEBRUARY 1996

FIGURE 7.5

• WEEKLY THICKENED RESIDUALS BLANKET SWD LEVEL FLUCTUATIONS •
(DURING 20 HR/DAY THICKENER DRAW-OFF PERIOD)



NOTES:

1. REQUIRES 400,000 GALLON RESIDUALS BLEND TANK EQUALIZATION. (THICKENER DRAW-OFF = 20 HR/DAY, DEWATERING PERIOD = 14HR/DAY.
2. THICKENER DRAW-OFF DAILY FROM 6AM TO 2AM.
3. NO THICKENER DRAW-OFF ON WEEKENDS.

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THICKENER SYSTEM ANALYSIS-WITHDRAWAL

20 HR/DAY DRAW-OFF

FEBRUARY 1996 FIGURE 7.6

The depth of the residuals blanket within the thickener units would be expected to vary due operational processing schedules. FIGURE 7.3 through FIGURE 7.6 present an analysis of how the thickeners and the residuals blending tank might be utilized under various operational considerations. This analysis was conducted to compare a 14 hour/day, intermittent thickener operation against a more continuous withdrawal rate from the thickeners (a 20 hour/day withdrawal). A 20 hour/day operational withdrawal would require either a larger thickened residuals blending tank or other requalization. FIGURE 7.3 and FIGURE 7.4 present how a 14 hour/day withdrawal would effect the thickened residuals blanket, and validates the feasibility and sufficiency of this intermittent operation. Accordingly, the proposed 14 hour/day rate was found to be more cost effective due to less tankage.

7.7.2 Thickener - Design Criteria.

Presented earlier, TABLE 7.8 through TABLE 7.11 provide the hydraulic and loading design requirements. The following are the specific proposed elements of the thickener units meeting the range of influent flows and loads.

Operations Schedule: 30 days/month, 7 days/week, 24 hrs/day (process varying)

Unit Configuration:

• Type	Circular
• Construction	Concrete
• Hopper rise every 12 inches	2.75 Inches

Hydraulic/Solids:

• Solids Loading Rate (max.)	7 lbs/ft^2
• Hydraulic Loading Rate (max.)	200 gpd/ft^2
• Polymer Retention Time (min.)	6 hours
• Hydraulic Retention Time	18 hours
• Sludge Blanket Depth (SWD max.)	7 feet

• Hoist	Portable
• Hoist Capacity	500 lbs.

7.8 Thickened Residuals Pumping Station

The proposed Thickened Residuals Pumping Station is designed to convey thickened residuals to the Dewatering Facility Blending Tank, as withdrawn from the gravity thickeners. Thickened residuals concentration is anticipated to range between 2.0 and 5.0 percent solids. The thickened residuals pumping operation has been designed to respond to meet the variable flows required to feed the dewatering (centrifuge) process. Pumping from the thickeners into the blending tank would be controlled by tank level indication and centrifuge operations. The Thickened Residuals Pumping Station would include the pumps, polymer feed equipment, monitoring, control and power equipment, and the thickener influent splitter box (presented in Section 7.6 above).

A dedicated Thickened Residuals Transfer (TRS) Pump via 6-inch underflow pipe would be connected to the underflow pipeline of each thickener. A stand-by TRS pumps would be configured with the ability to draw down any of the four thickeners. The overall depth of the station was established: to maintain gravity flow through the TRS pumps; allow for thickener tankage draining; and to prevent trapping thickened solids in the 6-inch underflow pipeline. Draw-down of the thickener blanket is proposed as an intermittent operation (pumping only if the dewatering process is on-line). This cycling of the pumps would tend to create a greater opportunity for solids build up in the 6-inch underflow pipe. The gravity flow arrangement would help minimize this clogging potential, whereas a piping configuration creating a trapped leg would increase the clogging potential.

7.8.1 Thickened Residuals Pumping Station - Design Features

The proposed Thickened Residuals Pumping Station is presented on Sheets M-26 through M-28. A major element proposed within the station, but functionally tied to the thickener unit influent, is the splitter box. The splitter box would be designed to receive the flow of residuals conveyed from the Sedimentation Basin Pumping Station, Georgetown Equalization Basin Pumping Station and the Dalecarlia Forebay Equalization Basin Pumping Station. The other major functions and elements proposed within the thickened Residuals Pumping Station include:

- Each TRS Transfer Pump would have an automatic check valve to provide positive isolation. The valve would also prevent undesired gravity feed through the process pump when off line.

- Each thickener would utilize dedicated solids density and flow measurement instrumentation as a manual or automatic process variable as desired. Solids density analyzers using Gamma-Ray technology would be used with adjustable pipe harnesses. Flow meters are proposed to be magnetic type to provide unobstructed flow and accurate measurements.

- The transfer pumping (TRS) units would employ one standby pump (4 + 1). Pump design capacity would be able to handle maximum thickener loading with up to two of the five pumps off line or out-of-service. This corresponds to three pumps drawing down four on-line thickeners under maximum loading, with these three pumps operating at maximum.

- Two monorail hoist systems are proposed. The Pump Room monorail would facilitate equipment access placement. Another monorail system would handle grade level equipment.

7.8.2 Thickened Residuals Pumping Station - Design Criteria

A *Process Conditions*:

(1) Thickener Influent Piping System

• Process Pipe Size	10 inches
• Normal Flow Range	300 - 800 gpm
• Process Velocities	
800 gpm (max.)	3.22 fps
500 gpm (avg.)	2.01 fps
300 gpm (min.)	1.21 fps
• Solids concentration	0.25 - 1.0%

(2) Thickener Underflow Piping System

Process Pipe Size	6 inches
Normal Flow Range	200 - 300 gpm
Maximum Anticipated Flow	600 gpm
Process Velocities at 100 to 600 gpm flow	1.12 fps to 6.69 fps
Solids concentration	2.0 - 5.0%

(3) Thickened Residuals to Blending Tank Piping System

Process Pipe Size	10 inches
Normal Flow Range	400 - 900 gpm
Maximum Anticipated Flow	1,200 gpm
Process Velocities at 200 to 1,200 gpm flow	0.80 fps to 4.83 fps
Solids concentration	2.0 - 5.0%

B. *TRS Transfer Pumps*:

Type	Progressive Cavity
Quantity	4 + 1 Standby
Control	Variable (rpm.)
Design Flow Range	100 - 400 gpm
Design Total Head	46 ft.
Suction Size (min.)	8 Inches
Discharge Size (min.)	8 Inches
Motor Horsepower (max.)	20 hp.
Speed (max.)	250 rpm.
Electrical Service	460 Volt, 3-Phase
Unit Weight (lbs.)	2,500
Auxiliary Equipment	Seal Water System

C. *Solids Density Analyzer:*

Type	Gamma-Ray
Density Range	0.5 - 5.0%
Carrier Density	1.0 gm/cc
Electrical Service	120 Volt, 1-Phase

D. *Flow Meter*:

Type	Magnetic
Design Flow	400 gpm
Size	4 inches
Velocity at Design Flow	9.81 fps
Electrical Service	120 Volt, 1-Phase

E. *Hoisting Systems*:

Type	Manual Geared
Quantity	2
Monorail Capacity (max.)	2.5-Ton
Hoist Capacity (max.)	2-Ton
Lift (max.)	50 Ft.

F. *Splitter Box:*

Distribution Device	Weir Gate
Motor Horsepower (max.)	1/3 Hp.
Gear Type	Worm
Electrical Service	460 Volt, 3-Phase

7.8.3 Gravity Thickener Polymer System

A Gravity Thickening Polymer System comprised of a skid batching system and metering feed pumps is proposed to be located within the Thickened Residuals Pumping Station. The polymer batching system would be fully automatic and capable of preparing a homogenous polymer solution from stock dry or liquid polymer products. The system would be capable of batching solutions at 0-1.5 percent concentration. The system would be an integrated package, pre-piped, pre-wired and skid mounted.

The metering feed pumps would be variable speed via a DC-drive controller. Metering pumps would provide a capacity range in accordance with a 100:1 turn down ratio. The metering pumps would be of a dual head style to achieve required dosage rates. The following summarizes the design criteria for the gravity thickener polymer system:

(1) Process Criteria:

• Peak Process Flow	3,600 gpm
• Average Process Flow	2,000 gpm
• Minimum Process Flow	300 gpm
• Polymer Dosage (max.)	2.0 mg/l
• Polymer Dosage (avg.)	1.0 mg/l
• Polymer Dosage (min.)	0.5 mg/l
• Optimum Batch Concentration	0.50%
• Batch Aging Time (min.)	1 hour
• Applied Chemical Concentration	0.10%
• Polymer (max.)	87 lbs/day
• Polymer (avg.)	24 lbs/day
• Polymer (min.)	1.8 lbs/day
• Polymer Solution (max.)	87 lbs/day
• Polymer Solution (avg.)	24 gph
• Polymer Solution (min.)	1.8 gph
• Polymer Types	Liquid Emulsion and Dry
• Liquid Polymer, Active Weight	36%, Varies
• Liquid Polymer (weight/gal.)	8.7 lbs. Varies
• Dry Polymer Density	40 lbs/ft.^{3} Varies

(2) Storage Criteria:

Storage Variables	3,600gpm@1.0mg/l dosage
Storage Period	30 days
Liquid Polymer Storage	420 gallons
275 gal, Tote Container (Qty.)	2
Dry Polymer Storage	1,320 lbs.
50 lb. bags (30/Pallet)	1

(3) Polymer Preparation Criteria:

System Type	Dry and/or Liquid Batching
Batching System (qty)	1
Control	Variable (rpm.)
Dry Feeder Type	Volumetric
Motor Horsepower (max.)	3 hp.
Feeder Hopper Volume	3.0 ft^3
Feeder Hopper Storage	3 days
Liquid Feed Pump type	Progressive Cavity
Mix Tank capacity	50 gallon
Age Tank Capacity	100 gallon
Mix Tank (Qty.)	2
Age Tank (Qty)	1

(4) Polymer Metering Criteria:

Metering Pump Type	Duplex Diaphragm
Metering Pump Quantity	2
Control (DC)	Variable (rpm.)
Design Capacity	1 - 90 gph
Motor Horsepower (max.)	1 hp
Electrical Service	230 Volt, 3-Phase

7.9 *Thickened Residuals Blending Tank*

A split-well thickened residuals Blending Tank is proposed to receive flow from the Thickened Residuals (TRS) Pumping Station. The purpose of the blend tank is to ensure that a homogenous mixture is obtained for consistency in centrifuge dewatering (i.e., feed rates and polymer usage). The split well design allows one-half of the tank to be taken down for periodic cleaning of any settled solids. An open slide gate between the two sides allows for equal tank levels. The proposed 225,000 gallon blend tank allows approximately four hours of centrifuge operation at maximum condition (5 units on-line) with no influent to the tank. Homogenous solution would be accomplished by using automatically operated mixers. The influent to the blend tank would be flow paced from the variable speed pumps in the Thickened Residuals Pumpingh station to maintain the tank at maximum capacity via a bubbler level control system. Safety overflow piping in the blend tank would be provided to prevent overfilling. The overflow would be directed back to the thickener influent splitter box. Each side of the blend tank would be naturally (gravity) ventilated via goose neck piping. Specific design criteria includes the following:

Blend Tank	
Design	Split Well with slide gate and overflow safety
Volume	225,000 gallons
Ventilation	Gravity
Level Control	Bubbler System
Dewatering Capacity	4 hours @ max. condition
Mixer Type	Vertical
Mixer Operation	24 hrs/day, 5 day/week
Quantity of Mixers	2

7.10 Residuals Dewatering Facility Systems

The Residuals Dewatering Facility includes multiple systems which support the centrifuge dewatering process. Each of the following subsections will: describe the system and, list the design criteria/parameters corresponding to that description.

7.10.1 Centrifuge Dewatering - Features and Design Criteria

The dewatering process is the heart of the project. All systems are designed to maximize the efficiency of this operation to as much a degree as can be provided. Each centrifuge would have a dedicated feed pump (denoted "CF" for centrifuge feed) conveying thickened residuals drawn from the thickened residuals blend tank. The proposed piping arrangement would enable the stand-by pump to feed to any of the five centrifuge units, in the event that the designated pump for that unit has failed. The pumps are designed to be VFD controlled so that the feed rate may be adjusted for optimal centrifuge performance. Lockout function would be included in the design to prevent a centrifuge feed pump from operating unless its corresponding centrifuge is operating. A flow meter would be located on the discharge of each CF feed pump to facilitate efficiency and optimal polymer dosage for each centrifuge.

During centrifuge start-up, the desired high cake concentration will take time to generate. The initial feed processed through the unit is expected to produce a low solids concentration discharge. A centrifuge unit's output, when still fluid, would be automatically diverted to the centrate discharge by use of a motorized knife gate and valve. The motorized knife gate would be designed to direct the centrifuge output with lower solids content (liquid) to be discharged into the centrate discharge. This system component would provide for an adjustable period, with timed durations set to assure higher cake concentrations. Centrifuge Centrate discharge will be recycled by gravity to the thickener splitter box. The quantity of centrate flow would be monitored by utilizing a magnetic flow meter.

The centrifuge feed lines (CF) from the blending tank to the centrifuge units are proposed to be furnished with flushing water connections. Each CF feed is proposed to have one flushing connection. The dewatering system is proposed to have 4 flushing connections on each centrifuge unit (2 at the bowl, 2 at the chute and centrate discharge). Refer to Sheets M-3 and M-12 for connection locations. Sampling feed points are proposed for the cake, centrate and CF feed of each centrifuge. Refer to Sheets M-29 through M-33 for details. Additionally, the proposed detailed design criteria has been provided below, utilizing the proposed processing rates computed from maximum month and average month residuals production rates (*Technical Memo No. 5 and 8*).

Centrifuge Unit Operation:

Quantity	5 + 1 (stand-by)
Operation	5 days/week, 2 shifts/day, 7 hrs/shift
Feed Rate	150-250 gpm
Feed Concentration	2.5% solids
Residual Feed Conditions:	
Max. Month	202,200 lbs/day (5 units in operation)
Avg. Condition	139,700 lbs/day (4 units in operation)
Polymer Dosage	4-12 lbs/dry ton
Solids Recovery	97-99%
Cake Concentration	25-32% solids
Solids discharge/centrifuge (Based upon 30% solids cake concentration):	
Max. Condition	2,120 ft^3/day (150 ft^3/hr) (5 units in operation)
Avg. Condition	1,825 ft^3/day (130 ft^3/hr) (4 units in operation)

Centrifuge Feed Pump

Type	Progressive Cavity
Capacity	100-400 gpm
Quantity	6 + 1 stand-by (One designated per centrifuge)
Speed	Variable

7.10.2 Bridge Crane - Features and Design Criteria

A bridge crane is proposed to be provided and would include: a motorized trolley, a motorized hoist and a motorized bridge capable of lifting the heaviest load of the centrifuge assembly. Specific design criteria includes the following:

Application	Centrifuge installation/maintenance
Span	65 ft.
Capacity	7 ½ ton
Power Equipment:	Motorized hoist w/ Motorized trolley and Motorized bridge

7.10.3 Polymer System - Features and Design Criteria

Bulk liquid and dry polymer storage provisions have been included in the proposed design of the polymer feed system. Space allocation for bulk liquid storage, via two 2,500 gallon resin storage tanks, are proposed on the basement level of the Dewatering Facility (Sheet M-29). Dry polymer storage would be provided on the grade level (Sheet M-30). Dry polymer would be shipped and stored in 2,560 lbs bags (called "Super-Sac"), and then feed by a volumetric dry feed batching system into the aging tanks. Either system (storage type, bulk liquid or dry) would generate a proposed 0.5 percent concentration of polymer solution feed stock. The feed solution of polymer would be temporarily stored in aging tanks (see Sheets M-29 and M-12). TABLE 7.12 provides a comparison of the two polymer systems.

This feed stock would then be available for use in the dewatering process, where polymer feed pumps would be flow paced to deliver a pre-set dose. A feed pump would be designated for each of the centrifuge units and be applied into the CF line (see M-12). The polymer solution feed pump would be VFD controlled so that polymer application may be automatically adjusted for optimal dewatering, based on CF feed flow pacing. The dosage is proposed, pursuant to *Dewatering Equipment Pilot Testing - Technical Memo No. 7,* to range from 4.0 to 14.0 lbs polymer per dry ton residuals processed. An average polymer dose of 8.0 lbs per dry ton residuals is anticipated, fed in the 0.5 percent solution.

The evaluations reported in the *Pilot Testing - Technical Memo No. 7*, utilized Allied Colloids' Percol LT Series polymers. It was found that the LT-22S (cationic) and LT-20 (nonionic) polymers provided the most optimal dose and results in thickening and centrifuge dewatering of Dalecarlia WTP residuals. Due to recycling of the centrate and thickener overflow, polymers would need to comply with food grade polymer industry standards. Allied Colloids' LT Series polymers have received EPA approval for use in water treatment facilities, but are available only in a "dry" form. Pursuant to additional investigations with regional polymer manufactures and distributors, it was discovered that currently, neither dry nor bulk liquid polymers are commercially available with

TABLE 7.12
POLYMER SYSTEM COMPARISON

Polymer Type	Dry Polymer System	Liquid Polymer System
Availability	- EPA Approved Manufacturers - NSF Approval Currently Pending (Expected NSF Approval 1996)	No current EPA or NSF Approved Manufacturers (Expected NSF Approval 1998)
Handle-ability	- Good - "Super-Sac" self-contained bulk supply. Requires forklift use for connection to feeder. - Fair - "55 lb. bags" - manual and frequent application to a hopper. Dust housekeeping concerns.	Excellent. Truck supplied directly to closed system bulk tanks *
Spillage Management	- Easily collected when dry; slip hazard when wet. - No bulk storage spill containment necessary	- Hazardous - extremely slippery * - Requires large bulk storage spill containment
Activity by Weight	100%	36-50% *
Bulk Storage	- Lower on-site storage volume required for equivalent polymer usage period. - Long shelf life - Avoid exposure to moisture	- 50 to 70% Greater on-site storage volume required for equivalent polymer usage period * - Requires tank recirculation or mixing to keep solution from stratifying
Cost	Lower cost per active weight of polymer purchased.	Significantly higher cost per active weight of polymer purchased *
Health Safety	- Airborne vapor - slight irritation - Sufficient dust concentration = slight fire hazard.	Vapor - slight irritant *
System Maintenance	*More Maintenance* - Bulk handling required by maintenance staff - Frequent bag (55 lb.) loading (4 times/shift) OT weekly. "Super-Sac" loading. - Inherent maintenance concern with undesired coagulation, improper wetting, or polymer plugging/build-up in the wetting chamber.	*Less Maintenance needed.* - No bulk handling by maintenance staff
Space Usage	Equal Footprint Sizes	
System Operation	Equivalent with respect to training, attention, operation and staff involvement	

*Based on information of currently manufactured liquid polymers used in wastewater treatment.

an NSF rating. NSF ratings are pending on all LT-Series dry polymers and approval is anticipated in 1996. Manufacturers have indicated that their NSF approvals on bulk liquid polymers are expected to follow within several years. The proposed design would allow for WAD selection and preference for either bulk liquid or dry polymer. The benefits and detractors of either type of storage system are indicated on TABLE 7.12. Proposed design feature of both a dry and bulk liquid polymer storage and feed system are provided below along with the balance of the proposed polymer feed system design features.

Proposed Design Features:

- Storage capability of either dry or bulk liquid polymer.
- System lockouts to enable polymer feed pump operation only when its corresponding centrifuge is operating.
- Flushing water connections at multitude of points throughout the polymer system (14 total, refer to Sheet M-12).
- Provisions to sample polymer solution at points en route to the CF line of each centrifuge.
- Truck delivery access for either bulk-liquid or dry polymer: bulk-liquid would utilize fill connections provided in the delivery bay within the facility; dry would utilize monorail system for off-loading of "Super-Sac" 2,560 lbs polymer containers.

Proposed Polymer System (common elements to both dry and bulk-liquid)

Feed Solution Activity (mass polymer/mass dilution water)	0.5%
Polymer Dose Range (lbs polymer per dry ton residuals processed):	
Average Anticipated Dose	8.0 lbs/dry ton
Maximum Anticipated Dose	14.0 lbs/dry ton
Dewatering Operational Schedule	14 hrs/day

Age Tank Size (based upon 1 hour feed capacity)	2,500 gallons
Polymer Feed Pumps	Progressive Cavity
Quantity (dedicated by centrifuge CF line)	6 + 1 stand-by
Capacity	10 to 50 gpm

Proposed Bulk-Liquid Polymer System Design Details:

Bulk Liquid Polymer Activity (of total mass)	35 to 50%
Polymer Density (varies by manufacturer)	8.7 lbs/gal
Polymer Feed Rates (on a dry wt equivalency)	175 to 450 gal/day
Polymer Transfer Rates (drawn-off bulk storage tanks)	12 to 35 gph
Active Solution Feed Rates (0.5% stock)	15 to 40 gpm
Polymer Storage:	Fiberglass Resin Tank
Volume	2,500 gallons
Quanity	2 units
Storage and Capacity	11 to 20 Operating Days

Proposed Dry-Polymer System Design Details:

Dry Polymer Activity (of total mass)	100%
Polymer Feed Rates	550 to 1400 lbs/day
Polymer Dilution Rates (batch process to day tanks)	40 to 100 lbs/hr
Active Solution Feed Rates (0.5% stock)	15 to 40 gpm
Polymer Storage:	Containers ("Super-Sac")
Size	2,560 lbs containers
Storage and Capacity	9 to 16 containers for 30 operating days

7.10.4 Fork Lift - Features and Design Criteria

Provisions for an electric forklift would enable handling of the dry polymer "super sac" and the handling of other equipment as necessary. The dry polymer system is located on the grade level of the dewatering facility. The 2,560 pound packages of polymer can be truck-off loaded.

Application	Dry Polymer handling
Capacity	4000/1800 lbs.
Lift Height	24/130 inches
Power	24 volt lead acid battery
Recharge	Outlet connection
Motor	Heavy duty hydraulic
Operation	Manual-walk behind.

7.10.5 Cake Storage and Disposal - Features and Design Criteria

The two-shift, 14 hour dewatering operation (typical hours of 7:00 am - 11: pm) gives rise to a need for dewatered residuals cake storage. Cake removal would be required throughout an operating day and, in an effort to eliminate a second-shift (evening hours) truck traffic at the facility, temporary storage is proposed. Each pair of centrifuge units would share a single steel receiving hopper, proposing a total of three steel cake storage hoppers below six centrifuge units. Each hopper would provide an equivalent of 7 hours of storage under maximum processing conditions from two centrifuges. Ribbon conveyors would facilitate cake discharge through electrically actuated knife gates into truck containers below. Dewatered cake removed from the site would be monitored by an on-site truck weigh station indicated on the civil site plans. Proposed design details of the cake storage hoppers are as follows:

Fabrication: Steel hopper w/ ribbon conveyors & knife gates.

Quantity of Hoppers	3
Quantity of Centrifuges per Hopper	2
Total volume	2,640 ft^3/Hopper
Hopper Freeboard	540 ft$^{3'}$/Hopper

Dewatered Cake Production (based upon Dewatering Processing Rates):

	Avg. Rates	Max Rates
Storage equivalents (hrs, dewatering)	7 hrs	8 hrs
Trucks (Size: 20 yd^3, loads/day)	13 to 14	19 to 20
Tonnage Processed (tons/day)	65 to 70	95 to 100

The overall height of the dewatering facility structure has been established to meet the storage and truck loading requirements. Alternate configurations of cake storage and handling were considered and eliminated for cost considerations. Team meetings No. 10 (July 1995) through No. 12 (September 1995) reviewed these alternatives.

7.10.6 Laboratory - Features and Design Criteria

The design of the Dewatering Facility proposes the use of a laboratory sized only to handle analyses specific to the dewatering process. This lab would be utilized to verify and document residual cake production and concentrations. Proposed equipment required to conduct the necessary analyses of the dewatering process would include: analytical balances, microwave/drying oven, desiccant chambers, and the typical cabinetry, counter tops, sinks, storage and glassware. This laboratory would be limited to conducting only total solids and total suspended solids analyses.

The potential need for a larger, more extensive laboratory could be required should employment of the "contract hauling residuals disposal" approach be deemed necessary by WAD. Implemention plans for a "contract hauling" disposal approach has been presented thoroughly in the *Residuals Disposal Report*. A more extensive lab could be designed whereby WAD would be able to routinely conduct tests and analyses of dewatered cake content for organic and metal levels (without need of outside lab testing contract). An expanded lab in the Dewatering Facility would also ensure and provide for distinct and separate operations between the existing lab (in the Dalecarlia Chemical Building, 2nd floor) which handles the water treatment process analyses, and the lab work to be performed for the dewatering process.

Implementation of a "contract hauling" for ultimate residuals disposal could require a higher degree of dewatered cake analysis by on-site WAD staff. The additional functions potentially necessary for a residuals hauling contract arrangement could include the ability to perform organic, and metals analyses at the Dewatering Facility. The equipment needed to conduct this higher level of on-site testing would include a titrator with glass electrode, muffle furnace, fume hood, atomic absorption spectrometer, pH meter, distillation apparatus, autoclave and a gas chromatograph/mass spectrometer system.

Alternatively, WAD could opt to have a contract lab conduct the extensive metals analysis, or opt to handle the same at the existing Dalecarlia "water-side" laboratory (2nd floor of filter building). This would enable the Dewatering Facility laboratory size to be at a minimum. However, the proposed design has been sized to accommodate the full size, full service type of laboratory.

7.11 Waste Stream Handling Facilities

Alternatives for waste stream handling were evaluated and presented in *Waste Stream Handling and Treatment Alternatives, Technical Memo No.10,* dated April 1996 and were summarized hereinbefore in Section 5. This section provides the description and design criteria of the proposed waste stream handling improvements and facilities.

7.11.1 Chemical Building Waste Piping

All proposed modifications to the waste piping within and in the vicinity of the Chemical Building are shown on Sheet C-14. The primary piping modifications that are proposed include re-directing certain floor drains and laboratory drains from entering the plant drain, where it would eventually be recycled, to instead entering the sanitary sewer system. Although hazardous chemicals or contaminated spills into these drains are considered unlikely and subject to dilution in the backwash waste volume and raw water, it is generally preferred, and safer to connect floor drains and laboratory drains to the sanitary sewer system.

Two of the existing miscellaneous drain lines from the Chemical Building are proposed to be intercepted from the drop manholes (to the Plant Drain) on the north side of the building and redirected by gravity to the nearby sanitary sewer line as shown on Sheet C-14. The existing floor drain in the garage area also is proposed to be re-directed from the Plant Drain to the sanitary sewer due to the potential for potentially hazardous truck spills. However, as indicated, this drain is now too low to connect to the existing sanitary line by gravity. Therefore, a sump pit manhole and sump pump is proposed to facilitate this connection. The existing roof drain now connected to the garage drain piping would be separated and directed to an existing storm drain inlet on the west side of the Filter Building as shown on Sheet C-14.

Several "Stormceptors" are to be provided in the vicinity of the Chemical Building to improve the quality of stormwater collected from impervious areas and recycled. A detailed description of these facilities is provided in Section 8.4.5.

7.11.2 Finished Water Pumping Station Waste Piping

Proposed modification to the waste piping within the Finished Water Pumping Station are shown on Sheet C-15. As previously noted, all miscellaneous drain flows within this station (except sanitary wastes) are conveyed from a 7' x 10' concrete drain that is piped to the 84" Plant Drain. This large concrete drain within the station also serves to direct potentially large volumes of water away from the station in the event of a major piping failure from the pump suction gallery. The miscellaneous waste flows within the station are, where feasible, proposed to be re-directed from the Plant Drain to the sanitary sewer system.

Existing drains at the east and west ends of the station now convey waste flows to sumps located at either end of the suction gallery. This flow is comprised of suction gallery floor drains, valve stuffing box drains, drinking fountains, sewage ejector pit floor drains as well as compressed air system drains. Two existing sump pumps now direct these waste flows from the east and west sumps to the Plant Drain. Another existing 4-inch drain at the east end of the station conveys drainage from equipment rooms (vacuum pumps, air filters, heater and refrigerant equipment) directly to the Plant Drain by gravity. An existing 6-inch drain at the west end of the station also conveys equipment room drainage directly to the Plant Drain. However, the latter drain also conveys a large volume of cooling water from the station cooling system previously referred to.

As described in Section 5 (existing conditions), there are several drain lines within the station which convey waste to the Plant Drain either directly (by gravity) or via sump pumps. It is proposed that the waste flow now directed from the two sumps (one each at east end and west end of suction gallery) be re-directed to the existing sewage ejector system as shown on Sheet C-15. The existing sump pumps were originally designed with a 150 gpm rating, which is larger than necessary. The proposed design is to replace these existing pumps with pumps rated at approximately 40 gpm. The smaller size pumps would ensure that the sewage ejector system is not overwhelmed during normal operations, particularly if there should be a flood in the suction gallery. It is also proposed that the existing 4-inch equipment room drain at the east end of the station now directed by gravity to the Plant Drain be re-directed to the sump at the location for subsequent pumping to the ejector system as described. The existing 6-inch equipment room drain at the west end of the station is proposed to remain directed by gravity to the Plant Drain since it conveys a large volume of cooling water, which would otherwise exceed the capacity of the sewage ejector system.

In order to facilitate the above referenced drain piping modifications, improvements to the sewage ejector system are required as indicated on Sheet C-15. The improvements would consist of a new 460 gallon equalization tank upstream from the existing sewage ejectors. This tank would provide storage and equalization for the increased flow to be directed to the ejectors. The existing ejectors are now under utilized and would not require replacement to accommodate the increased flow.

7.11.3 30 mg Clearwell Drain Pumping Station

Proposed modifications to facilitate draining of the existing 30 mg clearwell are shown on Sheet C-16. As previously noted, a new pumping facility is proposed to be constructed within the existing 12 foot square drain chamber within the 30 mg clearwell. This station would be utilized to drain the 30 mg clearwell for routine maintenance, as required, on an annual or less frequent basis. A single submersible pump is proposed which would be lowered into position via a permanently maintained rail system within the existing drain chamber. When not in use, the pump would be stored in the clearwell gate house superstructure.

The facility design is based on pumping down the bottom half of the 30 mg clearwell within three days. A continuous pumping operation during clearwell draining would equate to a pump capacity of 3,500 gpm. Prior to a scheduled draining of the clearwell, the upper 15 mg storage volume would be utilized and pumped to the distribution system by the Finished Water Pumping Station.

As shown on Sheet C-16, the discharge line from the proposed pump would be connected into the existing 24-inch force main now utilized by the Backwash Recovery Pumping Station. That force main would be available for connection to this clearwell dewatering pump since, as described hereinafter, a new 30-inch force main is proposed to be provided to direct the discharge from the Backwash Recovery Pumping Station to the Dalecarlia Forebay.

7.11.4 Junction Chamber No. 1

Junction Chamber No. 1, described in Section 5, was constructed in 1980 to divert the waste and drain flows (primarily filter backwash waste) from the filter and chemical building to the Backwash Recovery Pumping Station. All of these flows originally were directed to the Main Plant Drain and then to the river. Aluminum stop plates constructed within this junction chamber deflect the flows to the station , but are set to also provide emergency overflow relief to the Plant Drain. The aluminum stop/weir plates often receive an approach velocity as high as 22.5 fps. The weirs do not form a water tight seal and leakage past the plates continue to the Plant Drain. This leakage currently flows into the plant drain and is stopped by a temporary downstream weir near Junction Chamber No. 2. This leakage flow is then pumped up into the Backwash Recovery Pumping Station via the temporary pumping facility at Junction Chamber No. 2. Elimination of this weir leakage would be desirable in order to minimize costs due to repumping.

As indicated on Sheet C-18, a new reinforced concrete weir is proposed to be constructed within Junction Chamber No. 1 to replace the existing aluminum plate weir. This replacement weir would be constructed at the same overflow elevation as the existing weir and would be provided with a 24-inch manually operated valve. Such a valve would be utilized to pass the normal plant drainage/leakage (not including filter backwash waste) through the Junction Chamber No. 1 in the event that the Backwash Recovery Pumping Station was temporarily out of service.

7.11.5 84" Plant Drain Pumping Station

The proposed 84" Plant Drain Pumping Station, would replace the temporary pumping facility located at Junction Chamber No. 2. The existing pumps would be removed and the proposed facility constructed approximately 20 feet upstream from Junction Chamber No. 2, as detailed on Sheet C-17.

The facility would be constructed through and below the existing 84" Plant Drain, requiring the Plant Drain to be temporarily blocked during construction. During this period, the temporary pumps now located at Junction Chamber No. 2 could be relocated upstream of the construction at the juncture of the Plant Drain and the main drain from the Finished Water Pumping Station. The discharge from these pumps could be directed to the nearby Junction Chamber No.1 and thus directed to the Backwash Recovery Pumping Station during the construction period.

Three pumps are proposed to be provided with any two pumps capable of pumping at a combined rate of 1500 gpm. This is the estimated flow now handled by the temporary pumping facility at Junction Chamber No. 1. The third pump would serve as a stand-by, able to handle larger than normal flows. An existing 8-inch diameter drain line carrying approximately 100 gpm from the 30 mg clearwell underdrain system parallels the 84" Plant Drain and would be intercepted and conveyed by the proposed pumping facility.

Although reinforced concrete is proposed for this facility, an alternate method had been investigated. This method would involve the drilling of a large diameter caisson down to the 84" Plant Drain and breaking out the top portion of the drain. Limitations on the maximum caisson size could restrict the size for the submersible pumps and the proposed ladder/platform arrangement. While this caisson concept might result in a slight construction savings, this unproven technology of tapping to an existing drain is risky and has, therefore, not been recommended at this time.

7.11.6 Backwash Recovery Pumping Station

The existing Backwash Recovery Pumping Station is located to the south-east corner of the proposed Dewatering Facility Site. This station currently handles and conveys primarily two major waste stream flows: filter backwashing and plant drainage waste flows. These waste streams are now recycled to the Dalecarlia Reservoir. Section 2.4 described the existing features and design criteria of this station. The current and projected waste streams and other flows to be directed to and conveyed by this station have been evaluated as described in Section 5. At present, the proposed recycle waste stream treatment alternative which meets Aqueduct requirements would be that as described in Section 5.6-1, Alternative No. 1 - "Recycle Waste Stream to Forebay Without Pretreatment". The proposed improvements to the Backwash Recovery Pumping Station, therefore, are based on implementation of that alternative. The requirements would be similar for Alternative No. 2 - "Recycle Waste Stream Sedimentation Prior to Forebay". The requirements for Alternative No. 3 - "Filter Backwash and Plant Drainage Microfiltration" would differ from the other alternatives since the thickener supernatant and centrifuge centrate would not be handled by the Backwash Recovery Pumping Station.

TABLE 7.13 presents a summary of the estimated current and projected future flows along with proposed corresponding pumping station capacity. As shown in this table, a peaking factor of 30% has been added to the estimated maximum daily average flow requirements. This factor has been included to account for the fact that the current available equalization storage volume in the waste collection system (wetwell of the Backwash Recovery Pumping Station) at approximately 550,000 gallons is limited and that the pump design capacity should exceed the projected maximum daily average rates to ensure that the pump would not be required to operate continuously during those conditions.

The required pumping station capacity under the proposed condition of existing flows with the thickener supernatant and centrate recycle is nearly 10,000 gpm as indicated by TABLE 7.13. The required capacity under the possible future conditions (added filter backwash waste and filter-to-waste) is 12,000 gpm.

The discharge of the station is proposed to be rerouted to the Dalecarlia Forebay (Treatment Alternative No. 1) via the Capital Crescent Park Trail rather than to continue discharging to the Dalecarlia Reservoir near the intake to the treatment facilities. A revised system curve has been developed for the station with the proposed recycle alignment into the Dalecarlia Forebay as shown on FIGURE 7-7. The system curve was developed utilizing record drawings for the station and pump curve shop drawings for the existing pumps. The force main has been sized at 30" diameter to suit the projected possible future flow conditions.

Three improvement alternatives were considered to address these design objectives. These included the evaluation of: *first*, possible replacement of impellers of the existing station pumps; *second*, possible impeller replacement and motor replacement; and *third*, installation of new pumps. New impellers and an upgraded vertical shaft/bearing system are proposed to satisfy the projected pumping design criteria. The existing pump casings would be retrofitted with a new motor to handle

TABLE 7.13

BACKWASH RECOVERY PUMPING STATION PROJECTED FLOW CONDITIONS

Maximum Daily Average Flow, gpm			
Description	**Existing Conditions**	**Proposed Conditions**	**Possible Future Conditions**
Filter Backwash (1) (26 small and 11 large units)	3,500	3,500	3,500
Thickener Supernatant with Centrate Cycle (2)	N/A	1,880	1,880
Misc. Plant Drain and Waste Flows (3)	2,130	2,130	2,130
Future Additional Filter Backwash (11 large units)	N/A	N/A	1,250
Future Filter to Waste	N/A	N/A	450
Sub-Totals (gpm)	**5,630**	**7,510**	**9,210**
Peak Factor	1.30	1.30	1.30
Required Pump Capacity (gpm)	7,320	9,800	12,000
Design Basis Pump Capacity (gpm)	8,000	10,000	12,000

Notes:

(1) The 3,500 gpm basis (4.04 mgd, 100th percentile + 25% off Table 5.1) is a conservative value, but it is less than the total future backwash flow. Table 5.3 and 5.4 used 4,400 gpm which include the 11.5 off-line filters in the West Gallery (See Section 5.2.4).

(2) 1,880 gpm basis (Thickener With Centrate Recycle Weir Overflow off Table 7.8) is a conservative value. It is based upon the 4 ½ month operation Georgetown 1.0% dredge inflow + 0.5% Sedimentation Basin inflow + centrate recycle using the "Maximum Month" residuals production design criteria. This flow quantity included for recycle treatment Alternative No. 1 and No. 2 only.

(3) 2,130 gpm (Statistical History "Waste Flow" for 100th percentile, Table 5-1) is a conservative value.

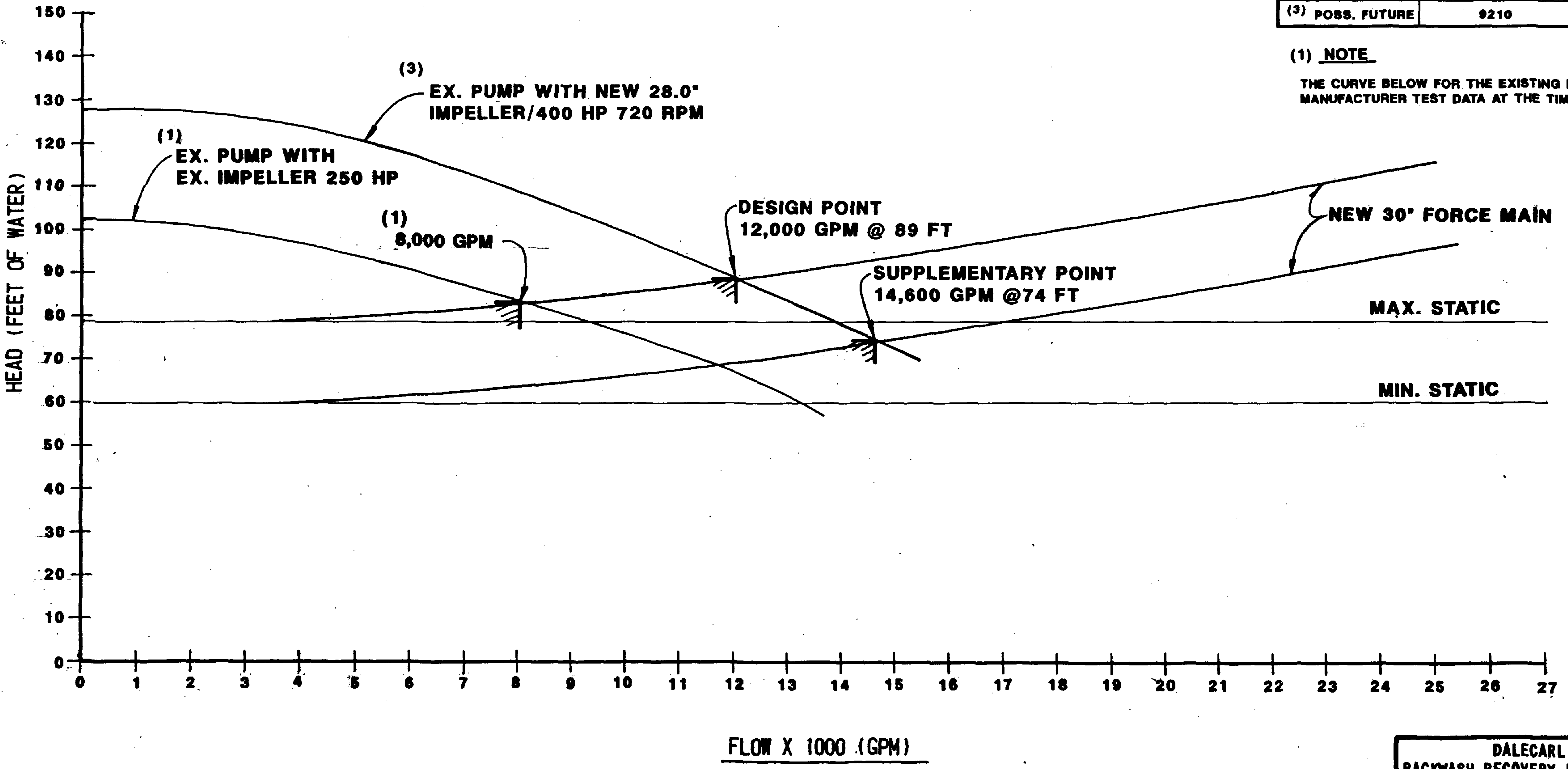
BACKWASH RECOVERY PUMPING STATION

SYSTEM CURVE ANALYSIS

CONDITION	MAXIMUM DAILY AVERAGE FLOW GPM	PUMP DESIGN CAPACITY, GPM
(1) EXISTING	5630	8,000
(2) PROPOSED	7510	10,000
(3) POSS. FUTURE	9210	12,000

(1) NOTE

THE CURVE BELOW FOR THE EXISTING PUMP (1) IS PER MANUFACTURER TEST DATA AT THE TIME OF FABRICATION.



DALECARLIA WTP
BACKWASH RECOVERY PUMPING STATION
MODIFICATION

PUMPING SYSTEM HEAD CURVES

JULY 1996

FIGURE 7.7

WR&A
WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

the higher flow capacity and horsepower demands. The design criteria for the proposed upgrade of the Backwash Recovery Pumping Station is summarized as follows:

Revised Backwash Recovery Pumping Station Design Criteria

Discharge Destination	Dalecarlia Forebay (Treatment Alternative No. 1) Recycle Treatment Facility (Treatment Alternative No. 2 and No. 3)
Capacity	10,000 gpm "proposed"/12,000 gpm "possible future"
Head	89 feet
Motor	Constant rate, w/ Inverter Duty Motor (capable for future Variable Frequency Drive upgrade)
Horsepower	350 Hp for "proposed"/400 Hp under "possible future" criteria
Motor Speed	720 rpm for "proposed"/720 rpm for "possible future"
Wet Well Volume Available	550,000 gal.
Discharge Pipe Size	30 inch
Quantity of Pumps	1 + 1 standby

Applying both the "proposed" and "possible future" criteria, an inverter duty type replacement motor would accommodate either situation and the future installation of a variable frequency drive control. Constant rate motors would be sufficient to handle the design flows shown on TABLE 7.13, but inverter duty motors are proposed to allow for the potential future enhancements. Approximately 30% higher capital cost factor is anticipated by providing an inverter duty motor in lieu of a constant rate type.

These upgrades, once executed, would enable immediate recycling to the Forebay while providing for future recycle treatment options (either inclined settling or micro filtration). The existing ventilation system will be evaluated to confirm adequacy under the increased heat loads generated by the new constant rate motors. The cost of the "possible future" condition has been included in the Design Memorandum Estimate (Book 4 of 5), and would, therefore, suffice for the "proposed", 10,000 gpm condition presented on FIGURE 7.7 and TABLE 7.13.

7.12 Future Recycle Treatment Facilities

Three treatment alternatives were developed for the recycled waste streams generated at the Dalecarlia Water Treatment Plant and were presented in Technical Memorandum No. 10, April 1996. The overall design of the Residuals Dewatering Facility would include provisions for future expansion, including: site space allocation for recycled waste stream treatment. The three treatment alternatives are:

Alternative No. 1 - Recycle Waste Stream to Forebay Without Pretreatment
Alternative No. 2 - Recycle Waste Stream Sedimentation Prior to Forebay
Alternative No. 3 - Filter Backwash and Plant Drainage Microfiltration

Alternative No. 1, "Recycled Waste Stream to Forebay Without Pretreatment", has been described previously under Section 5.6.1. Since that alternative involves no treatment processes other than polymer addition, further detailed description is not required. Due to its ease of implementation, this alternative is anticipated to be incorporated into the final design, until such time as its performance is determined to be unacceptable.

Alternative No. 2, "Recycle Waste Stream Sedimentation Prior to Forebay", has been described previously under Section 5.6.2. this alternative has been determined to be feasible and not *cost prohibitive. Conceptual layouts and preliminary design criteria and considerations follow in this* section.

Alternative No. 3, "Filter Backwash and Plant Drainage Microfiltration", has been described previously under Section 5.6.3. This alternative has been determined to be feasible but not cost effective compared to Alternatives 1 and 2. This alternative was, therefore, not developed beyond the conceptual stage.

The possible future Recycle Treatment Facility is proposed to process supernatant flows from the proposed residuals thickening/dewatering facilities combined with Dalecarlia Water Treatment Plant waste flows. These possible future treatments are to produce an effluent in accordance with regulations pursuant to the following: first, Environmental Protection Agency (EPA) NPDES discharge permit; second, Surface Water Treatment Rule (SWTR); and third, Maryland Department of Environment (MDE) Policy on *Recycle of Waste Streams in Surface Water Treatment Plants.*

7.12.1 Alternative No. 2 (Inclined Settling) Site Considerations

Two site locations have been considered for the possible future Recycle Treatment Facility (Alternative No. 2) and space allocated as part of the overall design presented throughout this Design Memorandum. These two sites are indicated as "Site A" and "Site B", on Sheet C-6. A description of these two alternative sites are as follows:

The ***Option denoted "Site A"*** site is directly adjacent to the Dewatering Facilities. This site location is in a close proximity to the Gravity Thickener Facilities for solids conveyance. This location would require an additional pumping station for conveyance of process supernatant to the Dalecarlia Forebay. This new pumping station, where indictated, would be able to utilize many of the Backwash Recovery Pumping Station force main utilities, with minor rerofitting.

The ***Option denoted "Site B"*** site is directly adjacent to the Dalecarlia Forebay Equalization Basin Pumping Station. This location provides the opportunity for the supernatant of the recycle treatment process to flow by gravity directly into the Forebay. This location would, therefore, not require a new effluent pumping operation. Either alternative of possible future dewatering facility expansions would facilitate modifications to the Backwash Recovery Pumping Station.

7.12.2 Process Operations - Alternative No. 2 (Inclined Settling)

A possible future Recycle Treatment Facility could be configured with either of two types of enhanced settling equipment; inclined plate packs or tube settling packs. The tube settling technology is a more traditional sedimentation basin approach. The overall square footage requirement to apply the tube settling technology could become site prohibitive; therefore, the Inclined Plate Pack Technology is proposed for defining site space allocations. Regardless of the solids settling technology chosen, all processes would require a pre-coagulant addition with first stage rapid mixers followed by flocculation chambers. Inclined Plate Pack manufacturers considered to be satisfactory include:

- Parkson Corporation (Lamella Gravity Settler Model).
- Purac Engineering Incorporated (Chain and Flight Settler Model or Gravity Thickener Model).

The possible future Recycle Recycle Treatment Facility would utilize chemically enhanced gravity settling and thickening residuals collection with inclined plate-pack technology. The facility would probably be configured to include the following process components:

- Rapid Mixers
- Inclined Plate Packs
- Solids Recirculation Pumps
- Chemical Facilities
- Flocculators
- Gravity Thickeners
- Solids Transfer Pumps
- Supernatant Pumps

7.12.3 Possible Future Recycle Treatment Facility - Inclined Plate Design Criteria and Parameters

Site planning of this Design Memorandum proposed space allowances for the future installation of a Recycle Treatment Facility. This section provides the conceptual design criteria utilized to establish the footprint, layout and utility considerations incorporated into the design reflected in the Sheets, Book 2 of 5.

<u>Process Conditions</u>:

• Design Flow	12,000 gpm
• Design Solids	18,100 lbs/day
• Composite Quality	126 NTU
• Flash Mix Duration	10 - 15 seconds
• Flocculation Duration	3 minutes
• Recycle Rate	10 %
• Polymer Dosage	2 mg/l

Anticipated sludge Conc.	0.5-1.0%
Solids Flow @ 0.5% Conc.	302 gpm
Solids Flow @ 1.0% Conc.	151gpm

Process Configuration:

Basin (Quantity)	2
Basin Design Flow	6,000 gpm
Plate Pack (Row Quantity)	4
Plate Pack Efficiency	95%
Effective Basin Plate Area	15,000 ft^2
Hydraulic Plate Loading	0.40 gpm/ft^2
Hydraulic Surface Loading	5.0 gpm/ft^2

Process Components (Per Basin):

Adjustable Influent Weir Gates

Quantity	1
Motor Horsepower (max.)	1/3 Hp.
Gear Type	Worm
Electrical Service	460 volt, 3-phase

Rapid Mixers

Quantity	2
Motor Horsepower (max.)	2 Hp.
Electrical Service	460 volt, 3-phase
Speed	Variable

Flocculators

Quantity	2
Motor Horsepower (max.)	2 Hp.

Electrical Service	460 volt, 3-phase
Speed	Variable

Gravity Thickeners

Quantity	1
Motor Horsepower (max.)	2 Hp
Electrical Service	460 Volts, 3-Phase

Process Pumping Facilities:

TRS Recycle Pumps

Quantity	2+1 Standby
Quantity (max.)	4
Type	Progressive Cavity
Motor Horsepower (max.)	15 Hp
Electrical Service	460 Volts, 3-Phase
Speed	Variable

(2) TRS Transfer Pumps

Quantity	2+1 Standby
Quantity (max.)	4
Type	Progressive Cavity
Motor Horsepower (max.)	15 Hp
Electrical Service	460 Volts, 3-Phase
Speed	Variable

(3) Supernatant Pumps

Quantity	2+1 Standby
Quantity (max.)	4
Type	Vertical Non-Clog Centrifugal Solids Handling

Design Capacity	6,000 gpm
Design Total Head	70 ft.
Motor Horsepower (max.)	200 Hp
Motor Speed (max.)	586 rpm
Speed	Variable
Electrical Service	460 Volts, 3-Phase

Chemical Facilities:

Design Flow	12,000 gpm
Polymer Dosage	2 mg/l
Polymer	288 lbs/day
Polymer Products	Liquid and/or dry
Batched Concentration	0.50%
Applied Chemical Concentration	0.10%
Distribution Device	Diffuser and Rapid Mixer

Anticipated Expansion

Future Flow	18,000 gpm
Future Solids	27,000 lbs./day
Composite Quality	126 NTU
Basin (quantity)	3
Basin Design Flow	6,000 gpm
Effective Basin Plate Area	15,000 ft.^{2}
Hydraulic Plate Loading	0.40 gpm/ft.^{2}
Hydraulic Surface Loading	5.0 gpm/ft.^{2}
Anticipated Sludge Conc.	0.5-1.0%
Solids Flow @ 0.5% Conc.	450 gpm
Solids Flow @ 1.0% Conc.	225 gpm

8.0 CIVIL DESIGN

The following is a presentation of the civil design for the proposed residuals collection and treatment facilities at each of the various sites. Refer to Sheets C-1 through C-13, *Book 2 of 5*, for civil drawings of the sites and corresponding facilities presented herein.

8.1 Standards and Criteria

The following are standards and technical manuals that appear to be applicable to the civil design portion of this project.

8.1.1 US Army Corps of Engineers Standards

Standard	Title	Date
CEMP-E	Architectural and Engineering Instructions	12.9.91
ER 1110-2-1002	Engineering and Design - Maps and Drawings	3.17.66
TM 5-814-2	Sanitary and Industrial Wastewater Collection Pumping Stations and Force Mains	3.15.85
TM 5-800-3	Project Development Brochure	7.15.82
TM 5-813-4	Water Supply, Water Storage	9.20.85
TM 5-803-9	Transportation Planning - Installation Master Plan	4.20.90
TM 5-803-1	Installation Master Planning	6.13.86
TM 5-803-8	Land Use Planning	8.26.88
EM 1110-2-38	Environmental Quality in Design of Civil Works Projects	5.3.71
EM 1110-2-2902, Change 3	Conduits, Culverts and Pipes	11.30.78
TM 5-813-5	Water Supply, Water Distribution	11.3.86
TM 5-813-5	Bituminous Concrete Pavement Design	6.1.92
TM 5-813-2	Classification of Roads for Design	(unknown)

8.1.2 Other Applicable Standards

Standard	Title	Date
WMA-MDE	Stormwater Management Guidelines for State and Federal Projects	7.1.87
WMA-MDE	Design Procedures for Stormwater Management Extended Detention Structures	7.1.87
WMA-MDE	1994 Maryland Standards and Specifications for Soil Erosion and Sediment Control	1994
USDA-SCS	Urban Hydrology for Small Watersheds, TR-55	6.1.86
USDA-SCS	Project Formulation-Hydrology TR-20	5.1.83
Reg. No. 5-90	Montgomery County Regulation on Stormwater Management	8.2.90
Chap. 59, Vol. 4 Montgomery Co. Code	Zoning Ordinance, Montgomery County, Maryland	1994
WSSC	Standard Details	1.1.89
WSSC	General Conditions and Standard Specifications	1.1.89
WSSC	Design Manual, Volume I	1.1.87

8.2 Site Layout and Circulation

8.2.1 Dewatering Facility Site

Most of the facility siting issues and related design effort has been directed to the Dewatering Facility Site which includes the proposed Gravity Thickeners, Thickened Residuals Pumping Station, Dewatering Building and space allocation for possible future facilities. Considerable attention has been given during the course of the conceptual design phase to the possible impacts to the neighboring areas and to the most efficient traffic circulation plan for trucks to be loaded with the dewatered residuals. Although the site is relatively secluded, several residences are nearby and a recreational trail (former railroad) for biking and hiking passes just to the east of the site. A description of the thought process, conclusions and figures related to the dewatering facility site layout are presented in *Site Planning and Architectural Design Concepts-Technical Memo No. 9.*

The proposed dewatering facility site layout is also shown on Sheets C-1 and C-2. Vehicular access to the dewatering facility site from MacArthur Boulevard via existing plant access roads is shown on Sheet C-5 and C-6. A weigh scale station is to be located near the entrance to the facility site for weighing in-coming and outgoing (loaded) trucks. As shown on Sheet C-1, the weigh scale location would not interfere with other vehicular traffic to or from the project site. Approximately 12 parking spaces are provided in proximity to the both the Thickened Residuals Pumping Station and Dewatering Building to suit the anticipated operations and maintenance staffing level for the thickening /dewatering facilities. Paved walkways from the parking area to the facilities are also proposed as shown. A paved Staging Area located to the south of the Dewatering Building is proposed and intended for temporary emergency storage of dewatered residuals such as in the case that truck removal from the site is not possible. The Staging Area has an approximate surface area of 18,000 sf and would be capable of storing approximately 18 working days or 3 ½ weeks of dewatered residuals based on the maximum residuals processing rate of 35.5 wet tons per day.

8.2.2 Georgetown Reservoir Residuals Equalization Basin Site

A site layout of the proposed Residuals Equalization Basin/ Pumping Station at the existing Georgetown Reservoir site is shown on Sheet C-8. As shown, these facilities are proposed to be constructed within a portion of Basin No.1 and will therefore not interfere with the present access road arrangement. This location was suggested due to the lack of sufficient area outside of the existing basins and to minimize the quantity of excavation necessary.

8.2.3 Dalecarlia Sedimentation Basin Residuals Pumping Station Site

The proposed site for the Dalecarlia Sedimentation Basin Residuals Pumping Station was selected based on its central proximity to the existing basins, availability area and avoidance of major buried utility lines. Due to the geometry of the available site, direct vehicular access for loading/unloading of equipment would be from Norton Street, an adjacent residential street. No parking off of the access drive is available due to site constraints nor is it necessary due to the proximity of parking adjacent to the south end of Basin No.1 which is also accessible from Norton Street.

8.2.4 Dalecarlia Forebay Residuals Equalization Basin Site

A site layout of the proposed Residuals Equalization Basin/Pumping Station at the Dalecarlia Reservoir Forebay site is shown on Sheet C-4. As shown, these facilities are proposed to be constructed within an existing open grassy area southeast of and adjacent to the Forebay. Vehicular access to this site is via an existing access road through the Defense Mapping Agency property.

8.3 Site Grading and Erosion Control

The various site grading plans are based upon the incorporation of building designs and street layouts that fit within the prescribed areas and utilize existing topography and desirable natural or man-made surroundings to avoid extreme grade modifications. The plans will minimize the impact of this project on adjacent properties, existing drainage patterns and slope stabilities. To achieve the best possible long-term site stability and minimize the sediment runoff during construction, the following standards will be implemented at all construction sites:

A. Provision will be made to safely conduct surface runoff to storm drains, protected outlets or to stable water courses.

B. Cut and fill slopes will be no steeper than 2:1. Most slopes are 3:1 or flatter for easy maintenance.

C. During construction, surface water will be diverted from the face of all cut and/or fill slopes by the use of earth dikes, ditches and swales. Likewise, subsurface drainage will be provided where necessary to intercept seepage that would otherwise adversely affect slope stability or create excessively wet site conditions.

D. Fill materials will be of the highest quality possible, complying with all required standards, and will be placed and compacted in a manner that also complies with the most stringent requirements.

E. All disturbed areas will be stabilized structurally or vegetatively in compliance with the best industry standards.

8.3.1 Dewatering Facility Site

The Dewatering Facility Site currently drains in a southerly direction on a 3% average slope toward the location of the proposed extended detention basin. For this reason, the basin will be used as a sediment control basin during construction, and all disturbed areas at this site will be easily diverted to the basin. The proposed grades of the dewatering site will preserve this existing drainage pattern of southerly flow toward the basin, but in more of a stepped or terraced configuration. The thickener tanks will sit on the higher terrace, followed by the dewatering building and associated pavement, and finally, by the staging area. Local sumps within these "flat" areas will convey runoff to the basin. The elevations of these terraces were established to make use of the greatest amount possible of excavated material acceptable for structural fill, using the least amount of borrow and maintaining acceptable structure elevations for system hydraulic gradients. Landscape berms will help to make use of structurally unacceptable material. Most proposed slopes will be flat or gently rolling; road grades will be minimized.

8.3.2 Georgetown Reservoir Residuals Equalization Basin Site

Grading will be performed in Basin 1 of the Georgetown Reservoir to backfill around the proposed Equalization Basin and Pumping Station to bring the grade up to a level area at elevation 149. This flat area, framed in by a berm on the north and east and by a short retaining wall on the west, will enable easy access for service and maintenance vehicles to the pumping station. Inlets in three sump areas will collect runoff and convey it to the basin. The ridges and valleys in Basin 2 of the reservoir will be graded to flat, broad slopes to facilitate residuals collection.

The sediment generated by construction in both basins will be contained within the basins themselves, and sediment-laden water pumped from basin bottoms will be discharged only in approved dewatering devices or sediment traps before conveyance to public storm drains or water courses. This practice is typical of sediment control for deep excavations in all of the Dalecarlia construction sites included in this project.

8.3.3 Dalecarlia Sedimentation Basin Residuals Pumping Station Site

The areas surrounding the proposed Sedimentation Basin Residuals Pumping Station will be graded to maintain existing grades along Sedimentation Basins 2 and 3, directing storm runoff away from the Pumping Station and the basins into swales. The swales will drain the runoff to one new and one existing catch basin. The area south of the Pumping Station will be graded to provide easy vehicular access from Norton Street to the equipment hatches of the station. The existing parking lot and yard area south of Basins 1 and 2, respectively, will be regraded to convey all pervious and impervious runoff south of these basins into a broad, grassy swale to an extended detention-type inlet for storm water management purposes.

This site is fairly broad and flat, and sediment generated by construction should be easily contained by conventional sediment control methods which employ silt fence, traps and dewatering devices.

8.3.4 Dalecarlia Forebay Residuals Equalization Basin Site

Grading around the proposed Equalization Basin will be minimal and will consist primarily of backfilling around the basin to convey runoff away from the structure, while maintaining vehicular access roads on the front or forebay side and on the rear side of the structure.

Again, construction generated sediment will be easily contained by the conventional control methods mentioned above, with the addition of a clean water diversion at the rear of the structure at the base of the hill. A coffer dam will be utilized for the placement of the 30-inch backwash recycle discharge pipe into the Forebay. Again, only approved dewatering devices will be used for water pumped during construction from the caisson and the basin excavations.

8.4 Stormwater Management

8.4.1 Dewatering Facility Site

Quantity control storm water management is required by the Maryland Department of the Environment, Water Management Administration, for State and Federal projects to maintain the post-development peak discharges for a 24-hour, 2 and 10 year frequency storm event at a level that is equal to or less than the respective 24-hour, 2 and 10 year pre-development peak discharge rates. Quality control storm water management is also required by the State by means of the best possible method in a hierarchy of preferred practices.

Storm water management, quantity and quality will be implemented at the dewatering site in the form of an extended detention basin. The preferred practice of infiltration, was not considered because of poor soil conditions. The next in the order of prefered practices, flow attenuation and wet ponds, were not considered because there is too little room for swales and insufficient drainage area to sustain a wet pond. The proposed extended detention basin will be designed to detain the one-year frequency storm for 24 hours and pass the larger storms at the required pre-development rates. The basin is currently sized to handle the entire dewatering facility site and the existing paved maintenance area. The area may be expanded to include additional portions or all of the existing shops and storehouse areas in the effort to comply with "Agreement Commitments for the Special Tributary Strategy for Federal Lands in the District of Columbia". This newly implemented policy requires that all federally owned land in the District of Columbia be retrofitted with water quality storm water management for all existing impervious area. To accommodate these larger drainage areas, the basin must expand beyond its present dimensions. The basin will discharge through a 36-inch diameter or larger drop structure into the 102-inch plant drain, and then to an existing rock outfall channel.

8.4.2 Georgetown Reservoir Residuals Equalization Basin Site

All proposed construction performed in the basins will not result in increased future runoff peak flows to any drainage areas, nor will any existing impervious areas increase in size. The portion of Basin 1 that is being backfilled around the proposed Equalization Basin will be graded to drain to catch basins that will discharge runoff into the Equalization Basin. From there, the runoff will be pumped to the gravity thickeners at the proposed dewatering facility site. Since the runoff from any new impervious or semi-impervious areas will ultimately be treated with the collected residuals, there is no further need for storm water management.

8.4.3 Dalecarlia Sedimentation Basin Residuals Pumping Station Site

As explained above under "Grading and Sediment Control", the existing parking lot will be regraded to discharge runoff into a broad, grassy swale for pre-treatment. For additional quality control, the runoff is then detained by passing slowly through an extended detention (limited size) catch basin, into a storm drain system that terminates in the proposed Sedimentation Basin Pumping Station wet well. Runoff from the impervious surfaces of the pumping station and access driveway will also be conveyed via new and existing storm drains into the wet well. All of this runoff will combine with the residuals collected from the sedimentation basins and be pumped to the thickeners at the dewatering facility site with the same result as above with the Georgetown Basin. Again, no additional storm water management will be required.

8.4.4 Dalecarlia Forebay Residuals Equalization Basin Site

All storm runoff from the impervious surfaces of the proposed Equalization Basin and Pumping Station and associated utility appurtenances will spill directly into the Forebay and be treated ultimately as raw water. No other storm water management will be required.

8.4.5 "Stormceptors" - Existing Waste Streams Handling Upgrades

The Dalecarlia WTP Complex drains approximately 10.3 acres to the backwash pumping station via catch basins, yard inlets and roof rain leaders. About 8.1 acres of this total area consist of impervious surfaces, 2.8 acres of which are bituminous concrete surfaces such as roads and parking areas. The pollutant loadings from road and parking areas are typically much heavier than off-road surfaces. Due to the current configuration of the existing Dalecarlia Complex drainage, it roads and parking surfaces runoff and treat a hybrid type via use of oil and grit separator technology. Conventional oil and grit separators are not effective in trapping sediments and petroleum derivations due to the lack of protection against a scouring potential from heavy storms. The proposed "Stormceptor" technology has a patented design that allows heavier flows to bypass the collection chamber, thereby retaining captured sediments and oils from the small flows of average rainfall events and the "first flush" of major storms until scheduled maintenance. The patented "Stormceptor" is not simply an oil and grit separator. An oil and grit separator would not provide the designed water quality benefit that the proposed "Stormceptor" would provide.

The smaller compact size of the "Stormceptor" would enable ready installation in the heavily congested Dalecarlia Facility. The recommended sizes are based on the criteria established for maximum treatment of runoff, and maintenance is estimated to be required only once a year. This frequency may be increased or decreased on a case-by-case basis, depending on such variables as yearly precipitation and sediment loading rates. An additional benefit is that the "Stormceptor" would catch any potential chemical or petroleum spill, preventing a flush through to the plant drain. "Stormceptors" are also less expensive to implement than an extensive re-routing of existing storm drains. A total of five "Stormceptors" are proposed to treat all the impervious road and parking area runoff that enters the plant drains and flows into the backwash pumping station. The respective impervious drainage areas, locations, invert elevations and required sizes are indicated on Sheet C-14 and C-18.

8.5 Outside Piping Systems

8.5.1 General

Design of the various outside piping systems followed general engineering practice and the above referenced standards and criteria as applicable. Design flows for storm water systems were determined by the rational method in which the peak discharge at any point may be determined by the formula:

$$Q = CIA$$

where

Q = the peak discharge in cubic feet per second (cfs)

C = the runoff coefficient

I = the average rainfall intensity in inches per hour (in/hr)

A = the drainage area in acres

Note: in/hr x acres = 1.008 cfs

The storm drain pipe sizes were estimated using approximate values for the above coefficients, based on the 10-year storm event and drainage areas with clay soils.

Pipeline routing was performed as to minimize pipe length and to avoid existing utilities where possible. Existing piping was relocated where necessary to facilitate the proposed construction. Depth of cover exceeded 3.5 feet for all piping systems for protection against freezing. Profiles of the various force main systems were developed to minimize the occurrence of "high spots" or "low spots" in order to minimize the trapping of air or accumulation of solids, respectively. Air release valves have been located were high spots in force mains were unavoidable.

8.5.2 Hydraulics

Hydraulic calculations for pressure piping were performed using the Hazen-Williams formula, as given below, although actual calculations utilized the values provided in *Hydraulic Tables* by Williams and Hazen, which are based on the same formula.

$$V = 1.318\ CR^{0.63}\ S^{0.54}$$

where

V = the mean velocity of the flow, in feet per second (fps)

R = the hydraulic radius of the pipe in feet (cross-sectional area of a flow divided by the wetted perimeter of the pipe). For a circular pipe flowing full, the hydraulic radius is equal to one-fourth the pipe diameter.

S = the friction head loss per unit length of pipe (feet per feet)

C = a roughness coefficient, values of which depend on the type and condition of pipe. The following "C" factors have been utilized for this design:

Type of Pipe	**"C" Factor**
Ductile Iron	120
HDPE	140

Hydraulic calculations for pressure drops at pipe bends, valves, fittings or changes in pipe size referred to as "minor losses" were performed using the following formula:

$$h_L = K_L V^2 / 2g$$

where:

h_L = minor head loss in feet

K_L = head loss coefficient

V = velocity in feet per second

g = acceleration due to gravity (32.2 fps/sec)

The actual "K" coefficients used in the design were selected from various references such as Hydraulic Institute Pipe Friction Manual, 1961.

Hydraulic calculations for gravity piping systems were performed using the Manning formula.

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where

V = the mean velocity of the flow, in feet per second (fps)

R = the hydraulic radius of the pipe in feet (cross-sectional area of a flow divided by the wetted perimeter of the pipe)

S = the slope of the pipe invert

n = the roughness coefficient, values of which depend on the type and condition of the pipe

Type of Pipe	**"N" Factor**
Concrete	0.013

Pipeline diameters for the various piping systems were selected based upon a combination of factors which included the following:

A. Consideration of maximum and minimum design flows

B. Maintaining a velocity greater than 2 fps in residuals transfer lines to prevent deposition of solids in the pipe

C. Maintaining a velocity less than 10 fps to reduce head loss and pumping costs

8.5.3 Pipe Materials

All of the residual, recycle and potable water force mains, with the exception of the high density polyethylene pipe (HDPE) portion of the Georgetown residuals force main, are proposed to be ductile iron pipe. Ductile iron's well documented qualities of strength, resilience, corrosion resistance, joint tightness and ease of tapping for service connections make it a good choice in most applications. It is the best choice for this application, particularly where installation in existing and proposed deep fills may result in pipe deflection. The determination of pipe thickness will be made for each application based on calculated trench loads, internal pressure and laying conditions. Restrained joints and concrete buttresses will be implemented to transmit fluid pressures at joints to the surrounding soil.

High density polyethylene pipe is proposed as a superior choice over ductile iron pipe within the 9-foot Dalecarlia to Georgetown raw water conduit beneath MacArthur Boulevard. It possess the strength and abrasion resisitance required for the job and has an extremely smooth inside surface which will facilitate the pumping of residuals over a long distance. Most importantly, it can be pre-assembled in long lengths and "floated" into the conduit upon final assembly to speed construction within the conduit. The HDPE pipe would be fastened securely to the conduit wall with specially fabricated stainless steel anchors capable of resisting all combinations of forces imposed by wet and dry conditions inside and around the pipe. The pipe would be permitted to expand and contract between fasteners due to seasonal temperature fluctuations, thereby relieving the fasteners of thermally imposed stresses.

Reinforced concrete pipe is proposed to be used for all storm drain construction. Its strength, durability, corrosion resistance, smooth interior and reasonable cost make it an ideal choice. Wall thickness will be determined by external loading and depth of cover.

Sanitary sewer gravity pipe is proposed to be polyvinyl chloride (PVC). It has a very low resistance to flow allowing sewers to be laid on very slight grades. It has the flexibility to deflect under earth or superimposed loadings, does not corrode and is light weight and easy to install.

8.5.4 Valves

Valves were positioned in the various outside piping systems as required for isolation or flow control, as applicable. The type of valve selected depended upon the type of service to be experienced. Mechanical joint plug valves would be the preferred buried valve type for residuals transfer service due to its unobstructed full port design and operational reliability.

8.6 Security /Fencing

8.6.1 Dewatering Facility Site

Chain link fence is proposed to be extended to enclose the northern half of the dewatering site with a vehicle access gate to be installed at the northwest corner as shown on the site plan, Sheet C-1. A portion of fence now dividing the site and running east to west would be permanently removed. Sections of fencing along the east side and further south on both sides of the hike and bike trail will need to be temporarily removed and replaced during construction. All fencing to be added and replaced would be equal in dimensions and in quality to the existing perimeter fence.

8.6.2 Dalecarlia Sedimentation Basin Residuals Pumping Station Site and Forebay Residuals Equalization Basin Site

Chain-link fence along Norton Street is proposed to be removed and replaced during construction and a new gate added for the service driveway heading to the pumping station. Likewise, sections of perimeter chain-link fence surrounding the Forebay area would be removed and replaced during installation of the new force mains. All fencing to be replaced and new gates to be added would be equal in dimension and quality to existing perimeter fence. No additional fencing would be required at these sites.

8.6.3 Georgetown Reservoir Residuals Equalization Basin Site

It does not appear that the existing fence will be disturbed during construction nor are there any changes proposed for the existing perimeter fencing at this site.

8.7 Landscaping

The preliminary landscape planning has been configured for shielding/screening of the public to proposed facilities and to avoid placement over utilities. Minimal screening has been proposed to keep costs to a minimum. The proposed landscaping for each site is described below and accompanied by corresponding figures of preliminary landscaping concepts as referenced hereinafter.

8.7.1 Dewatering Facility Site

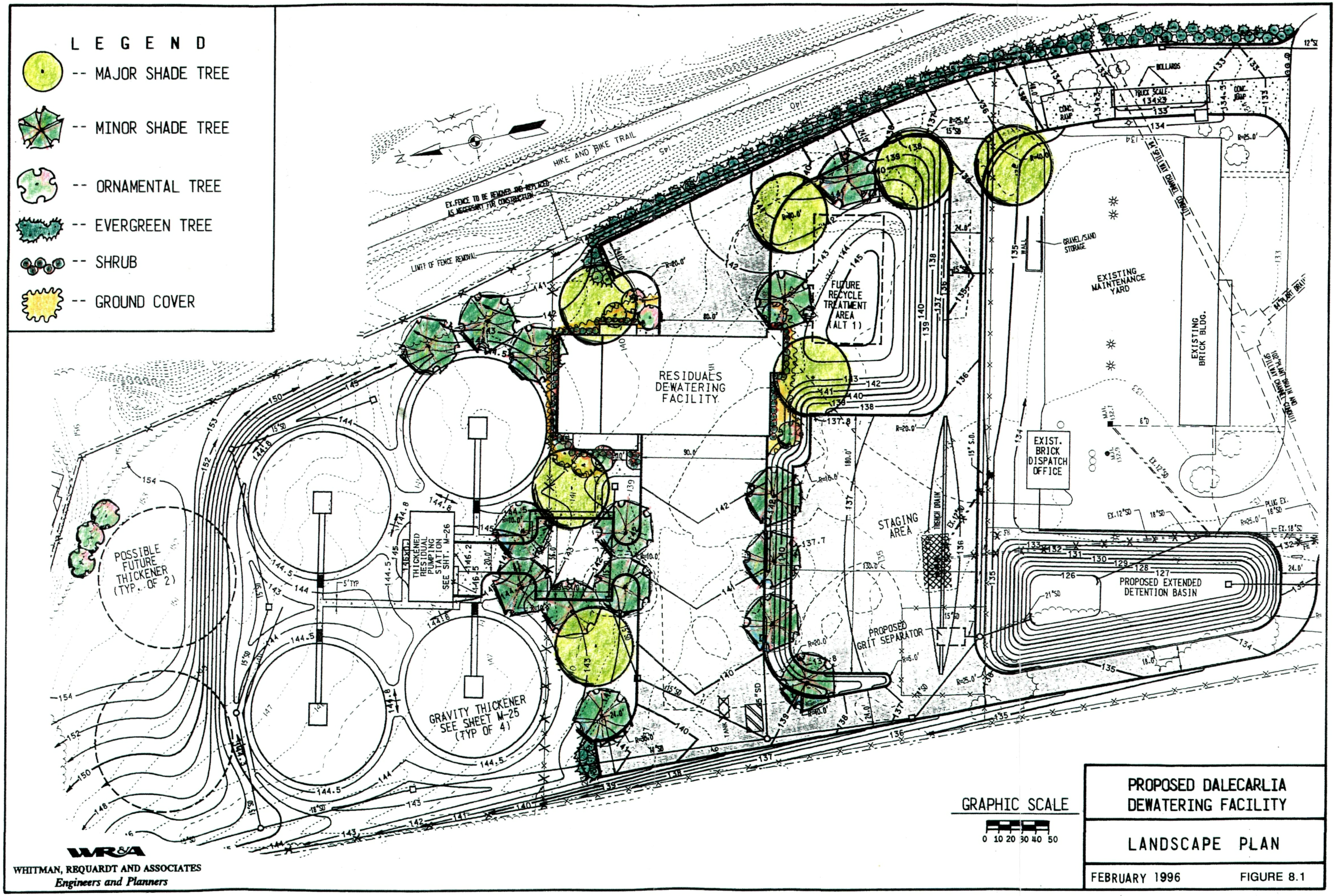
The proposed landscaping at the dewatering facility site was designed to accomplish two goals. The first is to augment the natural woodland screening adjacent to the proposed service road. The second goal is to enhance the architecture of the proposed Dewatering Building. Both of these goals are achieved while respecting the functionality of the Dewatering Building and creating a visual balance between the facility and its surroundings. Augmenting the natural woodland between the hiker/biker trail and the extended service road would be achieved by the use of fast growing evergreens planted next to the eastern property line. This planting would allow views of the building while screening the road and part of the passing truck traffic. The dewatering building which is sixty-six feet tall with a brick facade would be complemented by several large caliper shade trees, large ornamental trees and subordinate landscaping to accommodate the building's large scale. The large caliper trees will also appear more natural than small caliper trees when compared to the surrounding mature woodland.

Shade trees are proposed to be placed no closer than eight feet from the top of major underground utilities and these utilities are no shallower than five to seven feet from the surface. This is to allow for future maintenance without disturbing the trees. Trees will also be placed to shade employees' cars and shade the dewatering building. The choice of plant materials on the site will be limited to those species with well-behaved root systems. This means that trees such as weeping willows will not be specified for this landscape. The landscaping would be watered during the growing season in the absence of adequate rainfall, fertilized, weeded, and monitored for health and vigor for a period of one year.

This landscape visually connects the Dewatering Facility to its surroundings so that the large building does not completely dominate the view of bike trail users and neighboring property owners. The locations of the trees, as depicted on FIGURE 8.1, are carefully chosen to avoid underground utilities, enhance views, and provide shading.

8.7.2 Georgetown Reservoir Residuals Equalization Basin Site

The site for the proposed residuals equalization basin/pumping station at the Georgetown Reservoir is within the existing Basin No. 1 and will therefore be no closer to public view from the adjacent MacArthur Boulevard than the existing facilities. None of the proposed facilities will extend above the existing banks of the basins. However, the presence and operation of the proposed dredge in Basins 1 and 2 may change the character of observations by passers-by and residents along MacArthur Boulevard across from the Georgetown Reservoir site. There is limited opportunity for landscaping between Basin No. 1 and adjacent roads because the space is designated for vehicular access. Landscaping is further limited by an existing seven foot diameter underground utility which parallels the basin, and which would further preclude the planting of trees. The proposed landscaping plan at this site would, therefore, consist of some shrub plantings and turf to soften the hard look



WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

PROPOSED DALECARLIA
DEWATERING FACILITY

LANDSCAPE PLAN

FEBRUARY 1996

FIGURE 8.1

8.7.3 Dalecarlia Sedimentation Basin Residuals Pumping Station Site

The site of the proposed Dalecarlia Sedimentation Basin Residuals Pumping Station is a grassy area adjacent to the existing basins that has limited viewing exposure to passing traffic and nearby residents. The pumping facility is a below grade station with only a small parapet wall and exhaust fans visible. Therefore, there are no plantings proposed for this site. All disturbed areas would be restored by seeding.

8.7.4 Dalecarlia Forebay Residuals Equalization Basin Site

The site for the proposed residuals equalization basin/pumping station at Dalecarlia Reservoir Forebay is remote from passing traffic and view from the public. Therefore, there are no plantings proposed for this site. All disturbed areas would be restored by seeding.

9.0 STRUCTURAL DESIGN

The following is a presentation of the structural design for each of the proposed facilities. Refer to Sheets S-1 through S-23, *Book 2 of 5*, for structural drawings of the facilities presented herein. Site plans indicate physical locations of facilities on site plans, Sheets C-6 through C-9.

9.1 Standards and Criteria

The following are the various engineering and design standards, including U.S. Army Corps of Engineer documents, upon which the design has been based.

EM 1110-2-2104	Strength Design for Reinforced-Concrete Hydraulic Structures
TM 5-809-1	Structural Design Criteria Loads
TM 5-809-2	Structural Design Criteria for Buildings
BOCA	National Building Code 1993
ACI 318-95	Building Code Requirements for Structural Concrete
ACI 350R-89	Environmental Engineering Concrete Structures
ASCE 7-93	Minimum Design Loads for Buildings and Other Structures
TM 5-809-10	Seismic Design for Buildings
AISC	American Institute of Steel Construction "Allowable Stress Design" - Ninth Edition
ACI-530-92/ASCE 5-92	Building Code Requirements for Concrete Masonry Structures
SD1 Publication No. 27	"Design Manual for Composite Decks, Form Decks, Roof Decks and Cellular Metal Floor Deck with Electrical Distribution" 1989

Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders- Steel Joist Institute (Latest Edition)

9.2 Dalecarlia Sedimentation Basins Residuals Pumping Station

The proposed Sedimentation Basins Residuals Pumping Station is to be situated at the south end of existing Sedimentation Basin No. 3. The structure would be located in a very congested site bounded by existing sedimentation basins and existing utility lines. The entire structure would be underground with the top of the structure located at approximately the existing grade elevation. These extremely congested site conditions require the excavation for the pumping station construction to be supported by an excavation support system such as a cofferdam. Further discussion of requirements for excavation support systems may be found in *Geotechnical Evaluation, Book 3 of 5.*

Due to the congested site conditions, the intended area for excavation would be kept to as minimum a size as possible. The structural design, for this reason, has proposed that the pumping station's exterior walls be poured directly against the excavation support members. This would require the excavation support system to be left in place, for most of the 40+ foot vertical depth. The proximity of the proposed structure to the existing sedimentation basins also requires that the design groundwater table elevation be assumed to be at the existing grade elevation. An underdrain piping system is present at the sedimentation basins, but should not be relied upon to maintain a permanently low groundwater level for the structural design. The structure is designed to have a safety factor of 1.1 against flotation when the groundwater table is at the grade elevation. This issue is also discussed in the *Geotechnical Evaluation.*

The exterior walls of the pumping station structure have been designed as panels supporting the lateral earth pressure and the hydrostatic pressure. The south wall panel would be the largest panel thus requiring the maximum thickness. The north wall has the same plan dimensions as the south wall but it would be supported by a vertical cross wall which forms the east wall of the wet well. This allows the north wall to be of a decreased thickness. Similarly, the east and the west walls would be of less width as compared to the south wall panel, and have been designed accordingly. The wall thicknesses would decrease as a function of decreasing depth as the structural loadings would decrease, closer to grade.

The top slab has been designed as one way slab spanning between the support beams, required to frame various openings, and the building walls. The bottom slab of the structure has been designed to resist the uplift pressure due to the potentially high groundwater table. The tops of slabs have been sloped to allow proper drainage. The control room floor would be comprised of a combination of concrete and metal grating. Grating is provided where access to the pumps and other equipment is required. The stairs would be concrete filled metal pan stairs.

9.3 Georgetown Residuals Equalization Basin and Pumping Station

The proposed Residuals Equalization Basin and Pumping Station at Georgetown Reservoir is to be constructed in the northern corner of Basin No. 1. Construction of the structure inside the existing basin would require the extension of the existing 8' x 8' influent conduit that feeds Basin No. 1. The extended conduit is proposed to terminate into an influent distribution channel. Flow into Basin No. 1 from the influent channel would pass through a perforated distribution wall which would consist of a series of 24-inch diameter ports. The wall of the distribution channel would be extended at both ends to tie into the existing berms to form a retaining wall. The area of Basin No. 1 behind this wall and around the equalization tank would be backfilled.

The extension of the 8' x 8' influent conduit has been designed as a buried concrete structure. The influent distribution channel is designed for the maximum hydrostatic loads that it would be subjected to. The ends of the influent distribution channel have been designed as retaining walls, with a section extending into the earthened berm and divide dam.

The equalization tank is designed to resist all the forces imposed on it when it is either completely empty or full. The design groundwater elevation is assumed to be at finished grade level around the tank. The uplift forces would be resisted by friction tension piles.

9.4 Dalecarlia Forebay Residuals Equalization and Pumping Station

The proposed Residuals Equalization Basin and Pumping Station for the Dalecarlia Forebay is to be constructed on the southwest bank of the Dalecarlia Forebay. The top of the structure would be at Elevation 157.0 with the bottom of tank varying from Elevation 139.58 to 137.54. The design ground water is at Elev. 154.00. The existing geology in the vicinity of the tank is such that the use of tension piles for resisting uplift is not practical. For more discussion on the groundwater levels and the foundation conditions refer to the *Geotechnical Evaluation Report, Book 3 of 5.*

The structure is designed to resist all the lateral and vertical forces imposed on it. The bottom of the tank would be a thick mat foundation extending approximately 5 feet beyond the outside of tank walls on all sides. The weight of earth on this mat extension would create sufficient resistant force to anchor against uplift forces on the tank bottom. The tank walls and slabs are designed to resist forces when the tank can be full or empty.

9.5 Gravity Thickeners

The proposed Gravity Thickeners would be circular concrete tanks with bottom slabs that slope toward the center of the tank. The top of the tank walls would be a minimum of 3'- 6" above the surrounding grade elevation which suits hydraulic conditions while eliminating handrail requirements but maintaining accessability. The tanks are designed to resist the forces imposed on them when they are full or completely empty, assuming that the groundwater elevation would be at the grade elevation.

The tanks are to be supported on a pile foundation due to the uncertainty of the subsurface conditions. The uplift pressure on the structure is designed to be resisted by the tension capacity of piles. For further discussion on the existing soil conditions, pile types and capacities, refer to *Geotechnical Evaluation, Book 3 of 5.*

Influent piping to the center well and the solids draw off piping from the center well is to be encased in concrete and supported from the bottom slab of the tank.

9.6 Thickened Residuals Pumping Station

The Thickened Residuals Pumping Station is proposed to be a reinforced concrete structure with its bottom approximately 41 feet below the finished grade. The structure is to be situated in the area between the four proposed gravity thickener tanks.

The station is designed to be constructed on a compacted earth foundation. It is also designed to resist the uplift forces due to a groundwater table elevation at the finished grade. For further discussion on foundation and other geotechnical design criteria, refer to *Geotechnical Evaluation, Book 3 of 5.*

The first floor of the pumping station is to be located at the finished grade elevation. There are to be no intermediate floors between the first floor and the bottom of the pumping station, resulting in unsupported vertical wall height of approximately 41 feet. The exterior walls of the pumping station are to be divided into a series of panels by the introduction of vertical beams which span between the top and bottom slabs. Introduction of vertical beams allows reduction in the thickness of the walls. The horizontal reactions of the vertical beam are designed to be resisted by the framing system of the first floor and the bottom slab.

The first floor slab in the polymer area would be depressed to allow easier loading of polymers and to also allow for containment should an accidental spill occur. The floor would also be depressed in the area of the splitter box to satisfy the mechanical and hydraulic requirements. The splitter box is proposed to be constructed of steel for several reasons:

- The narrow and deep size of the compartments would make the concrete construction difficult;
- Absolute water tightness of concrete can not be guaranteed. The location of the splitter box is such that absolute water tightness is desirable; and
- The splitter box can be fabricated in shop under strict quality control standards.

9.7 Residuals Dewatering Facility and Thickened Residuals Blending Tank

The Thickened Residuals Blending Tank and Residuals Dewatering Facility are proposed to be combined structurally as one structure. The Blending Tank and adjoining Centrifuge Feed Pump Room and Polymer Room are to be below grade and the remaining portion of the Residuals Dewatering Facility would be an above grade structure.

The structure is to be located in the area underlying soil consists of uncontrolled fill of varying depth. Due to the heavy loading criteria demanded by this structure, piles through the fill down to rock are required. For further discussion on the existing soil conditions, pile types and their capacities, refer to *Geotechnical Evaluation, Book 3 of 5.*

The underground portion of the structure is designed to resist the lateral earth pressures and hydrostatic lateral and uplift forces with the groundwater table assumed to be at finished grade elevation.

The blending tank, to be divided into two compartments by a division wall, is designed such that both compartments could be either full or empty at the same time or either of the compartments can be full while the other was empty. The roof slab of the tank is to be located approximately three feet above grade with the slab sloped to provide proper drainage. The common walls between the blending tank and the adjoining below grade portions of the structures such as stair towers and the centrifuge feed pump room would be coated with waterproofing compound coatings.

The above grade portion of the structure is to house the centrifuges, dewatered residuals cake storage hoppers, control room and truck bays for unloading the dewatered residuals. The centrifuges are to be located on the third floor for ease in directing the dewatered residuals to the storage hoppers and thence to trucks. The centrifuges, even though they are mounted on vibration isolators, would produce vibrations in the supporting structure. There are also dynamic forces associated with the operation of the centrifuges. Therefore, the structure has been designed to isolate the vibrations inherent with the operational cycles of the centrifuges.

The structure is to be divided into two structurally independent components by a full height expansion joint system. The part of the structure which houses the centrifuges, storage hoppers and truck bays would be on one side of the expansion joint while the control room, storage rooms, laboratory and electrical room would be on the opposite side of the expansion joint. The provision of expansion joint would prevent the transmission of vibrations to the portion of the structure where the operational personnel are typically to be located.

The structure is designed primarily as a concrete frame for two primary reasons. First, as described above, the centrifuge operation imposes significant dynamic forces upon the supporting structure. This requires that the support structure be designed with a natural frequency that is one and one-half times the natural frequency of the machinery and that the structure has sufficient mass and framing, including large shear walls. Concrete construction readily provides the mass required and the shear walls can be readily incorporated. The second reason is due to the corrosive and damp environment created by the dewatering process and the dewatered solids. Concrete provides a better resistance against such corrosion than would steel construction.

As noted earlier, the building is to be divided in two independent structures by an expansion joint. The portion of the building which houses the centrifuges is designed with shear walls in various bays. In the first floor, in east and west walls where large overhead doors are required for solids removing drive through trucks, wide columns have been designed in place of shear walls. The shear walls would extend all the way to the roof level from the second floor level. Shear walls in the north walls would be provided from the grade level to the roof and on the south side at the expansion joint, the shear wall would extend to the underside of the centrifuge floor. Other key features of the structural design for the Dewatering Facility include:

- The floors are designed to be concrete slab and beam framing. The roof design is to be long span steel joists spanning in the east-west direction, topped by metal deck and concrete slab. The roof system also is designed to act as a diaphragm to increase the stiffness of the structure.

- The stair towers are also designed as concrete frames. Non-load bearing walls are CMU and are addressed in the architectural design.

- The runway beam for the overhead crane is to be supported by concrete haunches provided on columns along the east and west walls. It would also cross the expansion joint.

- The entire structure is designed to be a pile supported structure. The bottom slabs have been designed as structural slabs supported by pile supported grade beams.

- The structure has been analyzed to withstand all the applicable loads including vertical loads, dynamic loads, wind loads and the earthquake loads.

10.0 ARCHITECTURAL DESIGN

The following is a presentation of the architectural design for each of the proposed facilities. Refer to Sheets A-1 through A-15, *Book 2 of 5*, for architectural drawings of the facilities presented herein. Site plans indicate physical locations of facilities on site plans, Sheets C-6 through C-9.

10.1 *Standards and Criteria*

All Architectural Design Conforms to the Following Codes:

1. BOCA - 1993
2. NFPA - 1994
3. ADA
4. OSHA

The following Corps of Engineer documents have been used:

1. TM 5-800-2: Cost Estimate and Military Construction
2. TM 5-805-3: Roof Deck Systems
3. TM 5-805-6: Caulking and Sealing
4. TM 5-805-8: Builders' Hardware
5. TM 5-805-14: Roofing Design
6. TM 5-807-10: Signage
7. TM 5-809-8: Builders' Hardware
8. TM 5-812-2: Firestopping
9. TM 5-853-1: Design for Security
10. MIL-HDBK-1005/7; CHPT 9-Buildings

10.2 Residuals Dewatering Facility

The residuals dewatering facility is proposed to be a four-level building; three levels above-grade and one below-grade. The lower level would be twenty feet below grade and the top of the structure is proposed to be approximately sixty-five feet above-grade. The structure would be reinforced concrete walls, floors, and foundation. The roof system would be longspan steel joists and rigid insulation would be provided for both the roof system and the wall system. Exterior walls would be enclosed with 4" face brick and 12" block backup with anodized aluminum windows and painted steel door frames and doors.

The centrifuges would be located on the upper level of the facility. Also on this level would be a toilet, shower facilities, a control room, and a laboratory. The intermediate level would accommodate storage, and access to the dewatered residuals cake storage hoppers using a metal platform six (6) feet above the floor. The grade level of the building would include an electric room, polymer storage and access driveways for truck loading. In a basement level would be pumps, a machine room, and additional storage. All levels of this facility would have at least two means of egress.

Natural lighting would be provided in the main centrifuge level by a series of roof skylights and perimeter windows. A continuous expansion joint would separate the facility into two (2) structures in an effort to isolate operational vibration from the centrifuge. The building would be enclosed stairways with access to all levels. The main entrance would also be served by an elevator for handicapped access. Handicapped facilities include toilets, showers and "area of refuge" in the stairways. Telephone access would be provided at each "area of refuge".

10.3 *Thickened Residuals Pumping Station*

Below-Grade Pumping Station. The thickened residuals pumping station would extend forty (40) feet below-grade and would be constructed of reinforced concrete. In order to be considered a one-exit building in the BOCA Code, the maximum depth below-grade must be limited to thirty (30) feet. However, Montgomery County has adopted an amendment to 1993 BOCA which allows the pump station to be viewed as a utility building with one exit, provided a vestibule is added to each stair entry point.

It should be noted that within the pumping stations there would be certain maintenance levels that are accessible by catwalks and are reached internally by ladders. These ladders would be provided with the required O.S.H.A. cages for safety. Access by ladder is proposed from the grade level down, and from the bottom level up, to the maintenance platform at elevation 130.

Above-Grade Pumping Station. The overall building height would be approximately twenty-four (24) feet including a parapet around the building. The exterior of the building would consist of 4" of brick and 12" of block masonry concrete behind the brick. All louvers, overhead doors, frames, etc.,would be painted steel and windows, would be anodized finish on Aluminum.

10.4 *Dalecarlia Sedimentation Basin Residuals Pumping Station*

Below-Grade Pumping Station. This structure is proposed to be reinforced concrete and forty-three (43) feet below grade. The structure is proposed to be one-story without intermediate levels, although intermediate platforms do exist for maintenance of equipment that is reached by ladder. There would be no structure above-grade and the pumping station would be entered through stairwell access hatches located at-grade. A single enclosed stairway would be provided for exit from the lowest level of the pumping station because the pumping station is considered a utility building according to BOCA Code. This stairway would be steel pan and concrete construction, and it would be enclosed with masonry walls 12 inches of thickness with automatically closed fire-rated doors. The entire stair enclosure would be a one hour rated enclosure. Entry and exit from the pumping station would be thru an access hatch held open hydraulically for safe use.

10.5 *Materials (General)*

The materials for construction proposed to be used on this building would include extensive use of face brick compatible in color with the existing building campus. The size of the brick may vary to accommodate design intent including both standard and Norman bricks. To assure the long life of the brick enclosure, careful installation of control joints and expansion joints would be provided. The pattern of these joints would be integrated with the design of the buildings, so that they are a natural part of the exterior appearance and the pattern divides the scale of such a large building into human scale components. The walls would be insulated with rigid insulation to meet all energy codes for heat transmission.

The design pays careful attention to the efflorescent of the brick and the specification would be prepared so that only efflorescent free brick would be used. A small amount of pre-cast stone would be integrated with brick surface and color to harmonize with the architectural character of the existing campus and at the same time offer relief from a large expanse of one material. This occurs at window sills, etc.. Where expansion joints are required, attention would be given to providing proper waterstop sealant and other devices to keep the joint watertight.

All metals exposed to moist conditions, interior or exterior, would be steel galvanized where appropriate. Stainless steel or anodized aluminum in all instances would be selected to have the lowest possible maintenance requirements. Where flashing is required, either in the roof systems or for wall systems, it would be stainless steel or cooper for a long life.

The roofing system would be a modified bituminous built-up roof system applied to insulation over a metal deck. Careful attention would be provided for curbs, skylights, or ventilating fans so that flashing cant strips and pitched structure for drainage would insure a long useful life for the roof.

Windows would be provided with thermal break and baked enamel finish on aluminum frames. Glazing would be sun-resistant, double insulated where appropriate for heat transmission, and would be tinted to better harmonize with the environment of the architectural intent of the building.

10.6 Building Surface (All Buildings)

The materials used would be in harmony with the existing campus architecture. They would contribute to the thermal protection of the building as well as sound attenuation. Control joints and water tight mortar joints would be provided as required. Expansion joints where required by structure would have water-stop, flashing, and fiberboard insulation. Only the highest quality masonry workmanship would be allowed, so as to avoid the masonry disintegration that now exists in some Dalecarlia buildings.

10.7 *Exposed Metals (All Buildings)*

The exterior metals proposed for all buildings include materials that are maintenance free. Anodizing of windows offers a wide range of harmonious colors to be integrated with current appearance of the campus. Examples of metals that would be used are:

A. Handrails -- stainless Steel -- 1" nominal diameter. Insert at joints and secure at bottom end with flush stainless sleeves.

B. Louvers -- anodized aluminum: Provide baffled louver blades and bird screen - finish baked on by manufacturer.

C. Window Sash -- anodized aluminum by manufacturers

10.8 *Flashing and Sheet Metal (All Buildings)*

Because of the high moisture content of the all proposed buildings, it is imperative that the components of construction be protected from deterioration by proper flashing. It is recommended that all flashing have the longest possible life, either copper or stainless steel.

10.9 *Roofing (All Buildings)*

The roof surface would have a minimum slope of 1/4" per foot for drainage. It would be selected to be completely watertight especially at points of roof penetration. By proper insulation, it contributes to the energy efficiency of the building. The roof surface selected would withstand the wide temperatures changes with minimum maintenance.

Modified bitumen would be used because it is the correct roof wearing surface for all building roofs. This product, especially the SBS asphaltic application version, carries all of the benefits and ease of repair of single ply roofs and avoids all of the workmanship problems and difficulties of built up roofs. Modified bitumen is very competitive in the marketplace and can be installed by a wide variety of skilled workmen.

10.10 *Coatings (All Buildings)*

All interior finishes have been selected to provide impervious surfaces. This includes ceramic type surfaces on walls and ceramic and quarry tile type surfaces in toilets, labs, and MCC floors. The ceilings would be metal finish, selected for easy cleaning. Concrete floors would be provided with surface hardeners as would the inside surface of all concrete storage hoppers. All metal surfaces associated with doors and hardware would be either coated and painted to resist corrosion or would be galvanized or anodized as is appropriate. Special care would be devoted to all cake storage hoppers for both their resistance to corrosion and the long-term surface maintainability.

Ceramic, for walls and floors in selected rooms, while they add to the initial cost, are more than offset by their extended life, their maintainability, and pleasing restful colors. Most remaining wall surfaces would be painted with epoxy paints two part products (3 mil).

10.11 *Sound Control and Attenuation (Dewatering Facility)*

Design Description

A preliminary noise analysis was performed to predict the impact of the centrifuge dewatering operation on the neighboring residential properties. In situ sound measurements were taken by WR&A personnel at an existing dewatering facility with operating centrifuges of the same capacity and horsepower (SHARPLES DS-706) as required for Dalecarlia. This near field data was assessed in combination with airborne noise shop test data provided by the centrifuge manufacturer. Calculations were then performed using Carrier Corporation's Applied Acoustic Program, Version 1.10.

A simulated far field emission was developed for the nearest residential property line located approximately 85 feet east of the proposed facility. Sound attenuation was considered, using the selected architectural facade with acoustical louvers. Total sources emission was calculated by logarithmically summing the single point sources of six possible operating centrifuges with vibration isolators. The calculated far field noise level was 38 dBA, well within the recommended maximum level of 55 dBA.

Near field sound emission calculations were simulated using five of the six centrifuges in operation. The room was analyzed with no surface adsorption assuming full reverberation with hard surfaces for the walls, ceiling and floor. The calculated noise level at ten feet from an operating centrifuge was 88 dBA. This approaches the 90 dBA allowed by OSHA for an 8-hour period without the use of hearing protection. Exposures above 85 dBA average require the implementation of a hearing monitoring and construction program. Sound reduction measures would be implemented in the building acoustic adsorbers' construction. Acoustic adsorbers' in the form of split face block would be incorporated to limit sound propagation and reverberation.

Pursuant to the preliminary sound analysis and effort to minimize fatigue among workmen, every device for sound control has been utilized. Sound absorption material has been added to block walls on centrifuge floor, isolation for vibrating centrifuge have been added. It is especially desirable to have the benefit of the mass of a concrete building for sound control which is one of the reasons concrete is superior to steel in addition to its longer life. Another important method of sound control has been a complete separation of the Dewatering Facility into two structures. This technique would greatly reduce sound levels.

10.12 *Building Statistics*

A. Dewatering Building

1. Use group: F-2 (low hazard factory)
2. Construction type: 2C
3. Gross building area:
    - a. basement = 5,600 square feet
    - b. Ground floor = 9,200 square feet
    - c. 2nd level floor = 9,200 square feet
    - d. 3rd level floor = 9,200 square feet
    - e. Mezzanine floor = 1,700 square feet
4. Fire Resistance:
    - a. Exteriors
        - 1. Non-bearing - 0
    - b. Interior
        - 1. Non-bearing (stair) - 2 hour
    - c. Floors (includes basement) - 0
    - d. Roof - 0

B. Sedimentation Basin Residuals Pumping Station

1. Use group: utility
2. Construction type: - 2C
3. Gross building area:
    - a. basement = 620 square feet
    - b. control = 730 square feet
4. Fire Resistance:
    - a. Exteriors
        - 1. Non-bearing - 0
    - b. Interior
        - 1. Non-bearing (stair) - 2 hour
    - c. Floors (includes basement) - 0

C. Thickened Residuals Pumping Station

1. Use group: utility
2. Construction type: 2C
3. Gross building area:
   a. basement = 1,711 square feet
   b. grade = 1,800 square feet
   c. splitter room = 443 square feet
4. Fire Resistance:
   a. Interior
      1. Non-bearing (stair) - 1 hour
   b. Floors - 0
   c. Roof - 0

11.0 HVAC DESIGN

The following is a presentation of the HVAC design for those proposed facilities which contain heating and ventilation requirements. Only the Dewatering Facility building is proposed to contain air conditioning equipment. The three major facilities requiring heating and ventilation provisions include: the Dewatering Facility, the Thickened Residuals Pumping Station, and the Sedimentation Basin Residuals Pumping Station. Reference sheets M-20 through M-34, *Book 2 of 5*, for the HVAC configurations as presented herein. M-34 provides an HVAC schematic for the Dewatering Facility.

11.1 Standards and Criteria

The following are the various engineering and design standards, including U.S. Army Corps of Engineer documents, upon which the HVAC design has been based upon.

ASHRAE Fundamentals	1993
NFPA 54 (Piping and Venting System)	1992
American Gas Association	1992
Industrial Risk Insurance	1993
Joint Services Manual (Weather Data)	1994
AEI-Architect/Engineer's Instructions	July 1994
TM 5-815-3	July 1991
EM 1110-2-3105	March 1994
TM 5-810-1	June 1991
TM 5-805-4	December 1983
TM5-785, Engineer's Weather Data	July 1978

11.1.1 Ventilation Criteria Summary

The following listing reflects the general ventilation criteria utilized for the Dewatering Facility, the Thickened Residuals Pumping Station, and the Sedimentation Basin Residuals Pumping Station. General ventilation criteria includes:

a. Gravity ventilation for non-explosive wet well conditions.

b. Gravity ventilation for non-operative type structures, i.e., vaults.

c. Generally segregate ventilation of pump sumps (wet and/or dry) from control areas.

d. Hazardous/Explosive atmospheres require 14 air-changes/hr. ventilation.

e. Minimum ventilation requirements will be 6 air changes (A.C.)/hr for non-operational periods (continuous), or 12 air changes intermittently, or BTUH loading ventilation periods. Of these three, the most stringent air exchange requirement would be applied.

f. Provide ventilation to maintain a maximum design temperature of 40°C (104°F) considering all BTUH loads and (1% Ashrae Temperature Data).

g. General control will be thermostatic with Repeat Cycle Timers (RCT).

h. Intake louver velocity at 500 to 700 fpm.

i. Exhaust louver velocity at 1000 to 1200 fpm.

j. Standard louvers will provide 50 percent free area.

k. Acoustical louvers will provide 28 percent free area.

l. Evaluate allowable emitted sound level (DB) range.

11.1.2 Heating Criteria Summary

The following listing reflects the general heating criteria utilized for the Dewatering Facility, the Thickened Residuals Pumping Station, and the Sedimentation Basin Residuals Pumping Station. General heating criteria includes:

a. Temperature ranges:

Low Activity	68°F
High Activity	55°F
Freeze Protection	40°F

b. An evaluation of economics: whether gas or electric heating systems should be utilized.

c. Infrared heat will be acceptable for spot heating.

d. Use of automatic temperature set back to 50°F during unoccupied periods for occupancy levels less than 168 hours/week.

e. Electrical heating when load is below 15,000 BTUH and gas not reasonably available; all energy consumption would be below 60,000 BTU/ft^2 per year with nominal 40 hours/week, or less than 118,000 BTU/ft^2/yr. for 24 hours/day, 7 days/week with outside temperature control.

f. ASHRAE median of annual extremes.

11.2 Dalecarlia Sedimentation Basin Residuals Pumping Station

The Sedimentation Basin Residuals Pumping Station is proposed to have individual thermostatically controlled electric unit heaters of appropriate BTUH capacities. Ventilation would be achieved via a negative air pressure system. The Pump Room and Control Level would be designed as a combined space with air supplied and exhausted as required. The single access and egress stairwell would be treated as a non-ventilated space, separated by a 2-hour (fire protection) rated CMU wall. An adjacent negative air pressure ventilation system would handle any potential smoke control. An analysis summary of the proposed heating and ventilation for this facility is presented on TABLE 11.1.

11.3 Thickened Residuals Pumping Station

The Thickened Residuals Pumping Station is proposed to have individual thermostatically controlled natural gas-fired unit heaters of appropriate BTUH capacities. A negative air pressure

TABLE 11.1

Heading and Ventilation Analysis: Sedimentation Basin Res. P.S. - Pump / Control Room	
A. Ventilation:	
• Number of Occupants	0
• BTUH Loading	60,485
• Cooling cfm	5,499
• 6 A.C. cfm (Minimum/Constant)	1,914
• 12 A.C. cfm (Maximum/Intermed.)	3,828
• System cfm	5,500
• System Type (Positive/Negative)	Neg.
• Supply Fan Quantity (% cfm)	1 (100%)
• Exhaust Fan Quantity (% cfm)	1 (110%)
• Inside Design Condition	104°F DB
• Outside Design Condition	94°F DB
• Control (Constant/Thermostatic)	Therm.
B. Heating:	
• Number of Occupants	0
• Estimated BTUH Load	102,390
• Estimated (kw) Load	30
• Duct Heater Type	-
• Wall Radiator Type	-
• Unit Heater Type	Elect.
• Baseboard Heater Type	-
• Inside Design Condition	55°F
• Outside Design Condition	12°F
• Control (Integral/Remote Therm.)	Integral

ventilation system would be utilized. The HVAC provisions would include zones, or separate systems for each of the following:

- *The Pump Room and Control Rooms.* These two spaces are proposed to serviced by a single HVAC system. Combined equipment has been sized pursuant to a Heating and Ventilation Analysis whereby each room was evaluated individually to calculate total load. Refer to TABLE 11.2 and TABLE 11.3.

- *The Splitter Box Room.* This area would require both ventilation and heating provisions. The results of a heating and ventilation analysis is presented on TABLE 11.4.

- *The Stairwell.* The single egress stair would have no mechanical means of heating or air conditioning. The stair is separated by fire doors and rated walls (refer to Section 10, *Architectural Design*, for further discussion). Natural convection and gravity flow would accomplish ventilation. Adjacent spaces are provided with air negative pressure ventilation provisions for smoke control.

11.4 Dewatering Facility

The Dewatering Facility HVAC design is proposed to consist of several separate heating and/or ventilation zones, with air-conditioning limited to the operator occupied areas (Lab and Control Rooms on the upper level) only. Each zone will be thermostatically controlled, employ indirect gas-fired units of required capacity, and utilize air-handling units to supply heat and ventilation. Each of the area zones, or systems, proposed for the Dewatering Facility are presented below. Section 11.2, 11.3 and 11.4 provide the HVAC design criteria for Heating, Ventilation, and Air-Conditioning, respectively.

11.4.1 HVAC Systems (Area Zones).

The systems (or area zones), to be included in the Dewatering Facility would include the following:

TABLE 11.2

Heating and Ventilation Analysis: Thickened Residuals P.S. - Pump Room	
A. Ventilation:	
• Number of Occupants	0
• BTUH Loading	22,140
• Cooling cfm	2,500
• 6 A.C. cfm (Minimum/Constant)	6,646
• 12 A.C. cfm (Maximum/Intermed.)	13,292
• System cfm	13,500
• System Type (Positive/Negative)	Neg.
• Supply Fan Quantity (% cfm)	1 (100%)
• Exhaust Fan Quantity (% cfm)	(1)
• Inside Design Condition	104°F DB
• Outside Design Condition	94°F DB
• Control (Constant/Thermostatic)	Therm.
B. Heating:	
• Number of Occupants	0
• Estimated BTUH Load	68,260
• Estimated (kw) Load	20
• Duct Heater Type	-
• Wall Radiator Type	-
• Unit Heater Type	Gas
• Baseboard Heater Type	-
• Inside Design Condition	55°F
• Outside Design Condition	12°F
• Control (Integral/Remote Therm.)	Integral

Notes: (1) Exhaust is combined Pump and Control Room areas.
cfm (total) = (5,000 + 13,500) 110%

TABLE 11.3

Heating and Ventilation Analysis: Thickened Residuals P.S. - Control Room	
A. Ventilation:	
• Number of Occupants	0
• BTUH Loading	47,511
• Cooling cfm	4,500
• 6 A.C. cfm (Minimum/Constant)	2,381
• 12 A.C. cfm (Maximum/Intermed.)	7,762
• System cfm	5,000
• System Type (Positive/Negative)	Neg.
• Supply Fan Quantity (% cfm)	2 (50%)
• Exhaust Fan Quantity (% cfm)	(1)
• Inside Design Condition	104°F DB
• Outside Design Condition	94°F DB
• Control (Constant/Thermostatic)	Therm.
B. Heating:	
• Number of Occupants	0
• Estimated BTUH Load	68,260
• Estimated (kw) Load	20
• Duct Heater Type	-
• Wall Radiator Type	-
• Unit Heater Type	Gas
• Baseboard Heater Type	-
• Inside Design Condition	55°F
• Outside Design Condition	12°F
• Control (Integral/Remote Therm.)	Integral

Notes: (1) Exhaust is combined Pump and Control Room areas.
cfm (total) = (5,000 + 13,500) 110%

TABLE 11.4

Heating and Ventilation Analysis: Thickened Residuals P.S. - Splitter Box Room	
A. Ventilation:	
• Number of Occupants	0
• BTUH Loading	7,856
• Cooling cfm	714
• 6 A.C. cfm (Minimum/Constant)	552
• 12 A.C. cfm (Maximum/Intermed.)	1,104
• System cfm	1,200
• System Type (Positive/Negative)	Neg.
• Supply Fan Quantity (% cfm)	-
• Exhaust Fan Quantity (% cfm)	1 (100%)
• Inside Design Condition	104°F DB
• Outside Design Condition	94°F DB
• Control (Constant/Thermostatic)	Therm.
B. Heating:	
• Number of Occupants	0
• Estimated BTUH Load	34,130
• Estimated (kw) Load	10
• Duct Heater Type	-
• Wall Radiator Type	-
• Unit Heater Type	Gas
• Baseboard Heater Type	-
• Inside Design Condition	55°F
• Outside Design Condition	12°F
• Control (Integral/Remote Therm.)	Integral

- *Third Floor (Centrifuge Operating Area).* Heat would be provided by a series of indirect gas-fired, separate combustion propeller fan unit heaters. A negative air pressure ventilation system would be utilized via separate roof exhaust fans. The results of a heating and ventilation analysis is presented on TABLE 11.5.

- *Third Floor (Control Room, Laboratory and Locker Room).* Heat would be provided by a single indirect gas-fired air-handling unit. Positive ventilation would be provided by a common air-handling unit. This zone would be the only area of the facility with air-conditioning. Room, or area, variable temperature control would be achieved via thermostat and variable volume flow control of the air-handling unit responsible for providing heat and/or ventilation to these rooms. The results of a heating and ventilation analysis is presented on TABLE 11.6.

- *Second Floor, First Floor (Dry Polymer Area) and Lower Level.* Heat would be provided by a single indirect gas-fired air-handling unit. Positive ventilation would be provided by the same, common air-handling unit. The results of a heating and ventilation analysis is presented on TABLE 11.7, TABLE 11.8, and TABLE 11.9, respectively.

- *Grade Level - Electrical Room.* A positive ventilation system would be maintained by a combination of supply and exhaust duct fans. The results of a heating and ventilation analysis is presented on TABLE 11.10.

- *Grade Level Truck-Bay.* Freeze protection would be provided by a single indirect gas-fired air-handling unit. Negative air pressure ventilation would be maintained by exhaust duct fans. Insulation would be required on the under slab of second level, overhead of the truck bay. Refer to the discussion of the ASHRAE analysis (Section 11.5) below.

- *The two main stairs.* These two areas, with access to all levels, would have no mechanical means of heating or air conditioning. Since these locations are separated by fire doors and

TABLE 11.5

Heating and Ventilation Analysis: Dewatering Facility - 3rd Floor Centrifuge Area	
A. Ventilation:	
• Number of Occupants	3
• BTUH Loading	371,000
• Cooling cfm	38,200
• 6 A.C. cfm (Minimum/Constant)	17,875
• 12 A.C. cfm (Maximum/Intermed.)	NA
• System cfm	38,200
• System Type (Positive/Negative)	Neg.
• Supply Fan Quantity (% cfm)	NA
• Exhaust Fan Quantity (% cfm)	3 (33%)
• Inside Design Condition	104°F
• Outside Design Condition	94°F
• Control (Constant/Thermostatic)	Therm.
B. Heating:	
• Number of Occupants	3
• Estimated BTUH Load	325,556
• Estimated (kw) Load	NA
• Duct Heater Type	NA
• Wall Radiator Type	NA
• Unit Heater Type	(2) Gas Fired
• Baseboard Heater Type	NA
• Inside Design Condition	55°F
• Outside Design Condition	0°F
• Control (Integral/Remote Therm.)	Integral

TABLE 11.6

Heating and Ventilation Analysis: Dewatering Facility - 3rd Floor Laboratory/Control Room/Locker Room	
A. Ventilation:	
- Number of Occupants	4
- BTUH Loading	
- Cooling cfm	
- 6 A.C. cfm (Minimum/Constant)	
- 12 A.C. cfm (Maximum/Intermed.)	NA
- System cfm	
- System Type (Positive/Negative)	Positive
- Supply Fan Quantity (% cfm)	
- Exhaust Fan Quantity (% cfm)	NA
- Inside Design Condition	
- Outside Design Condition	
- Control (Constant/Thermostatic)	Therm.
B. Heating:	
- Number of Occupants	4
- Estimated BTUH Load	110,000
- Estimated (kw) Load	NA
- Duct Heater Type	AHU-3
- Wall Radiator Type	NA
- Unit Heater Type	NA
- Baseboard Heater Type	-
- Inside Design Condition	68°F
- Outside Design Condition	0°F
- Control (Integral/Remote Therm.)	Remote Therm.
C. Air Conditioning:	
- Number of Occupants	4
- Inside Design Condition	60°F
- Outside Design Condition	100°F

TABLE 11.7

Heating and Ventilation Analysis: Dewatering Facility - 2nd Floor Hopper Area	
A. Ventilation:	
• Number of Occupants	0
• BTUH Loading	38,000
• Cooling cfm	7,000
• 6 A.C. cfm (Minimum/Constant)	13,000
• 12 A.C. cfm (Maximum/Intermed.)	NA
• System cfm	13,000
• System Type (Positive/Negative)	Positive
• Supply Fan Quantity (% cfm)	100%
• Exhaust Fan Quantity (% cfm)	NA
• Inside Design Condition	104°F
• Outside Design Condition	94°F
• Control (Constant/Thermostatic)	Therm.
B. Heating:	
• Number of Occupants	0
• Estimated BTUH Load	247,805
• Estimated (kw) Load	NA
• Duct Heater Type	AHU
• Wall Radiator Type	NA
• Unit Heater Type	NA
• Baseboard Heater Type	NA
• Inside Design Condition	55°F
• Outside Design Condition	0°F
• Control (Integral/Remote Therm.)	Remote Therm.

TABLE 11.8

Heating and Ventilation Analysis: Dewatering Facility - 1st Floor Polymer Storage Area	
A. Ventilation:	
• Number of Occupants	0
• BTUH Loading	11,700
• Cooling cfm	2,700
• 6 A.C. cfm (Minimum/Constant)	3,825
• 12 A.C. cfm (Maximum/Intermed.)	NA
• System cfm	3,825
• System Type (Positive/Negative)	Positive
• Supply Fan Quantity (% cfm)	100%
• Exhaust Fan Quantity (% cfm)	NA
• Inside Design Condition	104°F
• Outside Design Condition	100°F
• Control (Constant/Thermostatic)	Therm.
B. Heating:	
• Number of Occupants	2
• Estimated BTUH Load	62,000
• Estimated (kw) Load	NA
• Duct Heater Type	NA
• Wall Radiator Type	AHU
• Unit Heater Type	Gas
• Baseboard Heater Type	NA
• Inside Design Condition	68°F
• Outside Design Condition	0°F
• Control (Integral/Remote Therm.)	Remote Therm.

TABLE 11.9

Heating and Ventilation Analysis: Dewatering Facility - Lower Level	
A. Ventilation:	
• Number of Occupants	0
• BTUH Loading	53,150
• Cooling cfm	12,300
• 6 A.C. cfm (Minimum/Constant)	NA
• 12 A.C. cfm (Maximum/Intermed.)	13,000
• System cfm	13,000
• System Type (Positive/Negative)	Positive
• Supply Fan Quantity (% cfm)	100%
• Exhaust Fan Quantity (% cfm)	NA
• Inside Design Condition	104°F
• Outside Design Condition	94°F
• Control (Constant/Thermostatic)	Constant
B. Heating:	
• Number of Occupants	0
• Estimated BTUH Load	82,000
• Estimated (kw) Load	NA
• Duct Heater Type	AHU
• Wall Radiator Type	NA
• Unit Heater Type	NA
• Baseboard Heater Type	NA
• Inside Design Condition	55°F
• Outside Design Condition	40°F
• Control (Integral/Remote Therm.)	Remote Therm.

TABLE 11.10

Heading and Ventilation Analysis: Dewatering Facility - 1st Floor Electrical Room	
A. Ventilation:	
• Number of Occupants	0
• BTUH Loading	220,440
• Cooling cfm	13,600
• 6 A.C. cfm (Minimum/Constant)	2,900
• 12 A.C. cfm (Maximum/Intermed.)	NA
• System cfm	13,600
• System Type (Positive/Negative)	Positive
• Supply Fan Quantity (% cfm)	100 %
• Exhaust Fan Quantity (% cfm)	100 %
• Inside Design Condition	104°F
• Outside Design Condition	94°F
• Control (Constant/Thermostatic)	Therm.
B. Heating:	No heating supplied to Electrical Room
• Number of Occupants	
• Estimated BTUH Load	
• Estimated (kw) Load	
• Duct Heater Type	
• Wall Radiator Type	
• Unit Heater Type	
• Baseboard Heater Type	
• Inside Design Condition	
• Outside Design Condition	
• Control (Integral/Remote Therm.)	

rated walls (refer to Section 10, *Architectural Design*, for further discussion). Natural convection and gravity flow would accomplish ventilation. This would prevent any "chimney effect" and adjacent spaces would be provided with negative air pressure ventilation provisions for smoke control.

11.4.2 Heating Design Criteria

Each system/zone which is proposed to include heating would be designed with the following provisions.

- Fire protected gas service
- Indirect gas-fired air-handling units and separate combustion unit heaters
- Combustion gas flues to penetrate roof
- Gas main provided to Dewatering Facility by Washington Gas Company
- Thermostatic control

11.4.3 Ventilation Design Criteria

Each system/zone which is proposed to include ventilation would be designed with the following provisions.

- Roof fans, in-line centrifugal duct fans, air-handling units, intake louvers with motor operated dampers, exhaust louvers, acoustical louvers where shown.
- Thermostatic control (Timer control where required)
- Automatic differential control (Electrical Room system)

11.4.4 Air-Conditioning Design Criteria

The Control room, Laboratory and Locker Room are the only areas proposed to include air-conditioning. These areas (one zone) would be designed with the following provisions.

- Direct expansion cooling
- Roof mounted condenser unit
- Three-zone differential control
- Variable volume/variable temperature control system

11.5 ASHRAE Energy Conservation Analysis - Dewatering Facility

An energy conservation analysis was conducted for the Dewatering Facility pursuant to the ASHRAE Standard 90.1. The evaluation was conducted to confirm the adequacy of the proposed insulation requirements. Additionally, this evaluation was conducted to validate these insulation requirements considering the nine percent skylighting proposed in the facility's roof. The results of this evaluation stipulate the following:

- *Exterior Walls.* The building would be comprised of a brick and window exterior. The brick would be backed by either concrete or CMU walls. Double pane hermetically sealed glass is located as indicated on the elevations, Sheets A-10 through A-13. The evaluation was conducted with a composite wall U-value rating, proportioning each elevation by its corresponding percentage of glass. The analysis evaluated whether or not a CMU cavity fill insulation would be adequate, but failed to meet the standard. The cavity between the brick and bearing surface (concrete or block) provides an opportunity to install insulation material. The analysis of this option satisfies SAHRAE 90.1 requirements and stipulates that the wall insulation U-value be less than 0.15 BTU per °F per square foot per hour (U-value $\leq$ 0.15 BTU / °F· ft^2 hr).

- *2nd Floor Understab (Truck Bay Area).* This area requires heating and was treated as an exterior concrete wall requiring insulation similar to the brick wall systems. ASHRAE 90.1 is satisfied with wall insulation U-value $\leq$ 0.15 BTU / °F· ft^2· hr.

- *Louver/Duct Openings.* The louver and duct openings were evaluated utilizing a U-value equivalent to a blank metal cover without insulation. The standard is meet with exterior walls containing an insulation material in the brick cavity, and therefore would need no further treatment at the louvers. However, it is recommended that the design include insulated motorized dampers at all louver locations.

- *Roof System.* It is proposed that up to ten percent of the roof system's total surface area be occupied by skylights. The roof system's insulating value is calculated as a composite of concrete deck (90 percent) with roofing and skylight glass (10 percent). Each component contains a unique U-value for insulation. The ASHRAE Standards would be met provided that the composite roof system complies with the following insulation formula for its total U-value:

$$U_{SYSTEM} = 0.057 \text{ BTU / °F} \cdot \text{ft}^2 \cdot \text{hr} \leq 0.1(\text{U-value})_{SKYLIGHT} + 0.9\,(\text{U-Value})_{ROOF}$$

12.0 ELECTRICAL DESIGN

The following is a presentation of the electrical design for each of the proposed facilities. Refer to Sheets E-1 through E-7, *Book 2 of 5*, for electrical drawings related to the discussions presented herein. Site plans indicate physical locations of facilities, see Sheets C-6 through C-9 (*Book 2).*

12.1 Standards and Criteria

The following subsections offer the standards and criteria upon which the design has been based. The corresponding requirements are to be incorporated into the design for lighting (subsection 12.1.1), power (subsection 12.1.2), and special systems (subsection 12.1.3).

12.1.1 Lighting

Lighting design is to incorporate energy saving technology in compliance with the following standards:

IES Lighting Handbook - latest edition
ASHRAE/IES 90.1 - Energy Efficient Design of New Buildings except Low Rise Residential Buildings - latest edition
NFPA 70 - National Electrical Code - latest edition.
NFPA 101 - Life Safety Code - latest edition

Lighting levels in locker rooms, stairwells, corridors, elevators, and toilet rooms are to be in compliance with the IES Lighting Handbook (IES), FIGURE 12-1, III - Industrial Group. Lighting levels in the Control Room are to conform to the requirements of Chapter 15 for VDT Office Areas. Lighting would be designed to reduce glare and would be coordinated with the interior design to maintain the recommended luminance contrasts between task and VDT or adjacent surfaces. IES has no specific recommendations for lighting levels for Water Treatment Plant Facilities. Instead, lighting levels for similar type industrial spaces were reviewed to develop lighting levels for the remaining areas. Lighting would be designed to the following levels:

Area Name	Foot Candles
Locker Rooms, Toilet Rooms	20
Stairwells, Corridors, Elevators	10
Control Room (VDT Area)	30 - 50
Pump Rooms, Drywells, Centrifuge Room	30
Electrical Rooms	20
Laboratory	50 - 70
Mechanical Rooms (non-process equipment)	15
Chemical Feed Equipment Areas/Rooms	30
Storage Areas/Rooms	15
Loading/Unloading Areas	20

Indirect fluorescent lighting luminaries are proposed to be used in the Control Room and Laboratory to minimize glare. Three levels of lighting would be achieved by using two switches for each space - one controlling 1/3 of the luminaries and the other controlling 2/3. Electrical Rooms would be provided with industrial fluorescent luminaries with porcelain reflectors. Stairwells and toilet rooms would be provided with wall mounted fluorescent luminaries with uplight and downlight. Except for the Centrifuge Room, the remaining areas would be provided with fluorescent non-metallic enclosed and gasketed luminaries. The Centrifuge Room would be provided with high pressure sodium high bay luminaries with quartz restrike feature and glass reflector.

Exterior wall mounted decorative high pressure sodium fixtures with cut-off optics are proposed to be provided around the perimeter of the Dewatering Facility and above the doors on the MCC enclosure at the Dalecarlia Forebay. No additional site lighting would be provided in order to minimize the visual impact of the facilities on the surrounding neighborhood.

Fluorescent lamps would be FO32T8, 3500°K with a CRI of 85 and provided with electronic ballasts. Fluorescent ballasts would have a power factor greater than 90 and a THD of less than 15%. High pressure sodium lamps would have a CRI of 22 and would be provided with high power factor ballasts.

During a power failure, emergency lighting would provide 2 Foot Candles of illumination along the paths of egress. Emergency lighting would be provided using integral emergency ballasts in selected fluorescent fixtures, except in the Centrifuge Room where unit emergency lighting equipment with NEMA 4X non-metallic housings would be provided. Exit signs would be LED type provided with integral battery back-up in the event of loss of power. Exit sign in areas provided with enclosed and gasketed fixtures and in the Centrifuge Room would be of NEMA 4X construction.

12.1.2 Power

The existing electric services at the Dalecarlia Water Treatment Plant and the Georgetown Reservoir are inadequate to handle the additional electric loads required by the residuals conveyance and treatment facilities. New electric services would be provided at both locations. Since the residuals operations to be conducted at these facilities are interruptible and not required for the continuation of water service, standby electric service is not proposed to be provided. The details of the service is discussed under the design details for each specific facility. The discussion order follows the electrical flow which is not necessarily the process flow.

Electrical power distribution would conform to the following standards:

ANSI C2 - National Electrical Safety Code - latest edition.

COE - Baltimore District - Instructions and Guidance to Architect-Engineers for Military Construction - Electrical - 18 February 1993.

COE - Architectural and Engineering Instructions, Design Criteria - 3 July 1994.

COE - ER 1110-2-3101 - Pumping Station, Local Cooperation and General Considerations - 3 December 1962.

COE - ER 1110-2-3105 - Mechanical and Electrical Design of Pumping Stations - 30 April 1994.

NFPA 70 - National Electrical Code - latest edition.

NFPA 780 - Installation of Lightning Protection Systems - latest edition.

Conductors would be copper with type THWN insulation. Medium voltage conductors would be type EPR with 133% insulation. All conductors would be run in raceway. Exterior raceway run below grade would be schedule 40 PVC encased in concrete with schedule 80 turnups. Where multiple raceways are run together they would be encased in a reinforced concrete ductbank. Electrical manholes would be provided with a sump pit, pull iron and non-metallic cable racks. Electrical manholes greater than seven feet in depth would be provided with non-metallic ladders. Handholes would be provided in conduit/duct runs where only branch circuits or instrumentation wiring would be pulled. Interior raceways would be schedule 40 PVC except areas subject to excessive abuse which would be schedule 80.

Junction boxes, pull boxes, separately mounted motor starter enclosures, control panels, disconnect enclosures and similar items would be NEMA 4X non-metallic, except as indicated. In the Control Room, Electrical Room, Laboratory and similar spaces in the Dewatering Facility and the existing Substation Building where equipment would not be exposed to moisture, dirt and other contaminants, these items would be NEMA 1. On the motor control center level of below grade pumping stations, these items would be NEMA 12. All indicating lights, selector switches, and pushbuttons would be heavy duty oil-tight NEMA 30.5mm or IEC 22mm. Indicating lights would be push to test, neon or transformer type for long life. Separately mounted starters would be NEMA rated. Safety switches would be heavy duty.

Motor Control Centers would be provided with Class I, Type CT wiring. Motor Control Centers in separate electrical rooms would be NEMA 1 construction; on separate floors in Pumping Stations would be NEMA 12 construction; and in weatherproof enclosures would be NEMA 3R walk-in construction. Motor starters would be NEMA rated. All motors not in sight of the motor control center would be provided with emergency lockout pushbuttons within sight of the motor. All motor control centers except in the Dewatering Facility would be provided with service entrance Category.C3 Transient Voltage Surge Suppressors (TVSS). All induction motors over 10 HP not provided with Variable Frequency Drives (VFD's)would be provided with low voltage capacitors for power factor correction.

Motor starters would be provided with motor circuit protectors, red "run" and green "stopped/power available" lights, and non-resettable elapsed time meters. Selector switches, pushbuttons and similar items would be located at a local control panel located near the motor or the motor control center would be used as the local control panel. Additional local motor information would be available at the Display Unit associated with the local Programmable Logic Controller (PLC) and at the Man Machine Interface computers located in the Control Room in the Dewatering Facility and in the Control Room in the existing Filter Building.

VFD's would be mounted in motor control centers where possible. VFD's would be Pulse Width Modulation (PWM) type and would be provided with output line reactors where motor feeders are greater than 100 feet in length. Output isolation contactors would be provided for all VFD's to disconnect the motor from the VFD when not operating. VFD applications would meet the requirements for Harmonic Noise Guidelines specified in IEEE Standard 519. Maximum voltage and current harmonics would be 5% at point of common coupling.

A ground grid consisting of #4/0 tinned copper wire and copper clad steel rods would be provided around each proposed facility. Ground grids around adjacent facilities would be interconnected. Electrical manholes would have a ground rod and all metal components would be grounded.

12.1.3 Special Systems

Special systems to be provided include a Fire Detection and Alarm System and a Telephone Distribution System. No additional special systems such as video monitoring, card access, or building access monitoring are proposed to be provided. The sites of the proposed facilities are secure and no existing adjacent facilities presently have these items.

A multi-plexed addressable Fire Detection and Alarm System would be provided for all proposed facilities. A main control panel would be provided in the Control Room in the Dewatering Facility to monitor all facilities. Sub-control panels would be located in the MCC3 Enclosure at the Dalecarlia Forebay, in the Thickened Residuals Pumping Station, and in the Sedimentation Basin Residuals Pumping Station connected to the main control panel via fiber optic communication. A sub-control panel would be located in the Influent Gate House at the Georgetown Reservoir with dial-up telephone connection to the main control panel. The system would be Class A provided with Style E Initiating Device circuits, Style 5 Signaling Line circuits and Style Z Notification Appliance circuits. All initiating devices would be provided with separate addresses. Alarm and Trouble indication by facility would be sent to the Dewatering Facilities SCADA System and to the Fire Detection and Alarm System Control Panel located at the existing Dalecarlia Filter Building. The Fire Detection and Alarm system would be designed to the following standards:

NFPA 70 - National Electrical Code - latest edition.

NFPA 72 - Standard for the Installation, Maintenance and use of Protective Signaling Systems - latest edition.

NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems - latest edition.

A telephone distribution system would be provided for the Dewatering Facility and connected to the existing plant wide telephone system. No telephone distribution is proposed to be provided at any other facility. The telephone distribution system would be Level 3. The Telephone Distribution System would be designed to the following standards:

NFPA 70 - National Electrical Code - latest edition.

BICSI (Building Industry Consulting Services International - Telecommunications Distribution Methods Manual - latest edition.

EIA (Electronic Industries Association) TR-41.8.1 - Standard for Premises Wiring.

EIA TR-41.8.3 - Standard for Building Architecture

IEEE 802.3 - 10BASE-T
AT&T - Systimax Structured Cabling Systems (SCS) Guidelines

12.2 *Dalecarlia Sedimentation Basins Residuals Pumping Station*

The electrical facilities at the proposed Dalecarlia Sedimentation Basins Residuals Pumping Station would be fed from the secondary side of an existing transformer located in the existing Substation Building located at the southern end of Sedimentation Basin No. 1. The existing substation transformer is fed by two 4160 volt feeders (primary selective) from the existing 4160 substation in the existing Finished Water Pumping Station. The estimated maximum demand load of the additional facilities is 395 kVA, including all possible future loads. The existing transformer is 500 kVA, and according to Washington Aqueduct engineering staff, it presently has a 50 kVA demand load.

A 480 volt distribution panelboard is proposed to be provided on the secondary side of the existing transformer. It would feed the existing motor control center and all new loads associated with the Sedimentation Basins Residuals Pumping Station and Traveling Submerged Residuals Collection Systems to be provided for the four existing sedimentation basins. A motor control center would be provided in the upper level of the Residuals Pumping Station to serve the pumping station loads and Sedimentation Basins No. 3 and 4 Residuals Collection System.

Sedimentation Basins No. 1 and 2 Residuals Collection System would be fed from the existing Substation Building. The DC drives for the Residuals Collection Systems would be fed at 120 volts. Three drives operated from a single controller for Sedimentation Basins No. 1 and 2 would run simultaneously. Four drives operated from a single controller for Sedimentation Basins Nos. 3 and 4 would run simultaneously. All residual collection system controllers for Sedimentation Basins No. 1 and 2 would be fed from a single 120 volt circuit out of the existing Substation Building. All residuals collection system controllers for Sedimentation Basins No. 3 and 4 would be fed a single 120 volt circuit out of the Sedimentation Basins Residuals Pumping Station.

12.3 *Georgetown Reservoir Residuals Equalization Basin and Pumping Station*

There is an existing 100 ampere, 120/240 volt single phase service at the Influent Gate House that provides power for lighting and receptacles at Georgetown Reservoir. This service is inadequate for the 350kVA demand load proposed to be added at this location. A 800 ampere, 480 volt three phase service is proposed to be provided to serve the facilities to be provided at this location. A 480 volt distribution panelboard, cast coil transformer, 208Y/120 volt appliance panelboard, separately mounted motor starters, and separately mounted VFD's would be provided in the Influent Gate House. This existing facility is above the aqueduct serving the Georgetown Reservoir, and excessive levels of moisture are, therefore, often present there. All enclosures for motor starters, panelboards and other electrical equipment would be rated NEMA 4X.

Five 200 ampere receptacles with separately mounted disconnect would be provided to serve the proposed Residuals Collection Dredge. There is only one dredge that is to be moved around the basin as required. Therefore, all five receptacles would be served from a single circuit.

12.4 *Backwash Recovery Pumping Station Improvements*

The existing substation transformer is presently served by a single 2400 volt feeder from the existing 2400 volt substation located in the existing Finished Water Pumping Station. The existing transformer is 500 kVA, and presently feeds a 600A motor control center. The existing 2400 volt feeder is 350 kcmil and the transformer has primarily fused overcurrent/short circuit protection.

The existing transformer is adequate as long as only one new 400 Hp backwash pump is operated at any time along with the miscellaneous facility loads. The transformer fusing and ventilation should be evaluated for possible modification. The estimated demand load after the improvements is 443 kVA.

A 480 volt distribution panelboard is proposed to be provided on the secondary side of the existing transformer. It would feed the existing motor control center and two new VFD's for the new 400 Hp Backwash Pumping Units. The starters and controls for the existing Backwash Pumping Units will be removed. New separately mounted VFD's would be provided with NEMA 12 enclosures.

12.5 *Dewatering Facility*

A PEPCO 600 ampere, 13.8 kV, three phase service is proposed to be provided to serve the Dewatering Facility. A ductbank would be provided from MacArthur Boulevard to the Dewatering Facility and would be constructed to PEPCO standards. This feeder would have primary metering and would serve a 15kV switchgear lineup to be located in the Electrical Room. The switchgear would have vacuum breakers with solid state relaying and solid state metering. The metering system would be provided with a PLC to communicate with the SCADA system via a Modbus link.

One 15kV feeder breaker would feed a 3000 kVA dry type substation transformer with 480 volt switchgear located in the Dewatering Facility. The switchgear would provide 480 volt power for the Dewatering Facility and the Thickened Residuals Pumping Station. The substation would be provided with fans for a capacity of 3325 kVA. The estimated normal demand (5 centrifuges running) with the addition of all future facilities is approximately 2800 kVA. The estimated peak emergency condition demand (6 centrifuges running) with the addition of all future facilities would be approximately 3100 kVA.

The 480 volt switchgear would feed a motor control center in the Dewatering Facility, a motor control center in the Thickened Residuals Pumping Station, six centrifuge controllers, and a Dewatering Facility distribution switchboard. The switchgear would be provided with air circuit breakers with solid state trip and solid state metering. The metering system would be provided with a PLC to communicate with the SCADA system via a Modbus link. The 480 volt switchgear would be provided with service entrance Category C3 Transient Voltage Surge Suppressors (TVSS). The motor control center would feed all motor loads that require a starter or VFD. Items such as motor operated valves with integral controls would be fed from distribution panelboards.

A lightning protection risk assessment of the Dewatering Facility indicates a moderate to severe risk. This facility would contain numerous VFD's and the operator interface computer for all the solids handling facilities; therefore this facility would be provided with a lightning protection system connected to the ground grid. Air terminals and downlead conductors would be aluminum. The lightning protection system would be connected to the ground grid with aluminum to copper connectors. Lightning protection system would be provided with a UL Master Label (Label C).

12.6 *Dalecarlia Forebay Residuals Equalization Basin and Pumping Station*

The demand load for the proposed facilities at the Dalecarlia Forebay is approximately 230 kVA. There is an existing 2400 volt double ended switchgear lineup in the existing Substation Building for the Dalecarlia Booster Pumping Station adjacent to the proposed facility. The existing load is at the limit of the capacity for these feeders. Therefore, a second feeder breaker is proposed to be provided in the 15kV switchgear lineup at the Dewatering Facility to feed the additional loads.

A 300 kVA padmounted cast coil resin transformer is proposed to be located at the Dalecarlia Reservoir Forebay to provide 480 volt power for the motor control center serving the proposed Dalecarlia Forebay Equalization Basin Pumping Station. The motor control center would be provided with a NEMA 3R walk-in enclosure. The motor control center would incorporate a transformer and panelboard for 120 volt loads. The motor control center would be provided with luminaries, receptacles and heaters (sized to control condensation).

Three 200 ampere receptacles with separately mounted disconnect would be provided to serve the Residuals Collection Dredge to be operated at the Dalecarlia Forebay site plus one receptacle to serve the Dalecarlia Reservoir. There is only one dredge that is to be moved around the Forebay as required and initial portion of the Dalecarlia Reservoir. Therefore, all four receptacles would be served from a single circuit.

12.7 *Thickened Residuals Pumping Station*

A motor control center would be located in the upper level of the proposed Thickened Residuals Pumping Station fed from the 480 volt secondary switchboard in the Electrical Room of the Dewatering Facility. This would feed all motors in the pumping station and at the thickeners.

12.8 *Possible Future Facilities*

The proposed transformer to be located at the Dalecarlia Forebay would be provided with a loop feed switch in the primary section. Should the possible future Recycle Treatment Facility be located at the Dalecarlia Forebay, the 13.8 kV feeder could then be extended from this location. The feeder to this location from the Dewatering Facility would be sized to accommodate this future load. The relay settings on the feeder breaker would be set for the initial load and would need to be adjusted should the facility be added. Should the Recycle Treatment Facility be located near the Dewatering Facility, space would be provided adjacent to the primary switchgear in the Dewatering Facility to add an additional feeder section and breaker to the lineup.

13.0 INSTRUMENTATION AND CONTROLS DESIGN

The operations of the dewatering process presented in Section 7 (*Process and Mechanical Systems Design*) and Section 8 (*Civil Design*) are intended to be controlled by the instrumentation methods described in this section. Section 13.2 is divided into three major subsections, outlining the instrumentation and control design philosophy and standards applied, covering: PLC Network, Operator Interface (Hardware), and Operator Interface Software. Subsequent sections 13.3 through 13.8 provide specific operational design control processing of interface points. The following is a presentation of the instrumentation and control design for the proposed facilities. Refer to Sheet I-1, Book 2 of 5 for instrumentation drawing related to the discussions presented herein.

13.1 Standards and Criteria

The following are the various engineering and design standards (including U.S. Army Corps of Engineer documents) upon which the design has been based:

NFPA 70 - National Electric Code - latest edition

13.2 Instrumentation and Control Design Philosophy

The proposed Supervisory Control and Data Acquisition (SCADA) System would consist of distributed intelligence programmable logic controller (PLC) system linked by a fiber optic or dial up network to central supervisory PLCs and operator interface computers. The operator interface computers would consist of a IBM compatible computer linked to the PLC data highway through a serial link interface. The operator interface would include a software package which is standard for use in water and wastewater applications.

The various proposed facilities are, for the purpose of this presentation, divided into two groups: “Liquid Elements” and “Solids Processing Elements”. The Liquid Elements would include the flows from the two reservoirs and the Sedimentation Basin up to the Thickener Splitter. All Liquid Element equipment are proposed to be controlled by the existing SCADA system within the Chemical Building WTP Control Room. All other Solids Processing Elements are proposed to be controlled by the new SCADA system to be located within the proposed Dewatering Facility Control Room.

13.2.1 PLC Network

The PLC system would monitor and continually update on the network the status or values of remote instrument signals equipment for equipment control and for use by the operator interface. It would monitor, generate and continually update on the network alarms or events, with date and time for use by the operator interface. All PLCs would initiate execution of stored programming upon reset or power up. They would require no external command to run so long as the PLC memory contains an executable memory. The PLCs at a facility main control panel would be provided with a hot standby processor. The PLC would include all necessary hardware to allow all required serial data communications to be switched automatically to the active on-line processor at all times. Memory would be battery or EPROM backed so that power loss would not cause a loss of program logic.

The PLCs would be of modular design, with the input/output modules separate from the logic processor and memory, with all modules connected to a common back plane. It would be possible to remove any of the modules without disturbing the associated external wiring. The PLCs would contain Modbus and Modbus Plus communication ports. This would provide a system of open architecture. Future additions could be made to the system without being required to utilize the same manufacturer. The PLCs would contain input/output devices as follows: Discrete Inputs, Discrete Outputs, Analog Inputs (4-20 mA, 1-5VDC, 0-10 VDC), and Analog Outputs (4-20 mA, 1-5VDC, 0-10 VDC).

Each facility main control panel would be provided with a ASCII Operator Keypad and Display Unit to communicate with the on-line PLC. The Keypad and Display Unit would be panel mounted and would include two display lines each supporting 40 characters and 16 programmable function keys with associated indicator lights. The unit would be capable of displaying various program data and transferring operator entered commands to the PLC.

Each facility main control panel PLC would be provided with an Uninterruptible Power Supply (UPS). The UPS would have an emergency output runtime of 6.5 minutes at full load and 18 minutes at half load.

The PLCs for the switchgear, switchboards and equipment control panels would be similar to those at a facility main control panel except they would not be provided with a hot standby processor.

13.2.2 Operator Interface

The proposed operator interface computer (PC) would consist of IBM compatible processor of the latest technology at the time of final design. It would include RAM memory, 2 floppy disk drives, 1CD ROM drive, integral backup tape drive, 3 button trackball and hard disk storage. Color graphics "flat screen" monitors with at least 1280 x 1024 pixel resolution would be provided. The PC would be provided with a standard IBM keyboard. PCs, modems, monitors and alarm printers would be provided with emergency UPS backup.

The operator interface would provide the means of operator interaction with the processes of the programmable controller system. The operator interface would provide to the facility operator an organized, comprehensive display of data relating to the specified processes. It would allow the operator to enter various data pertaining to facility operation for use by the PLC system. It would display and retain alarm occurrences and acknowledgments. It would allow the operator to initiate manual override controls of the programmable controller automatic control system.

The operator interface would display alarm messages and acknowledgments. The five most recent alarms or acknowledgments would be displayed regardless of the current video page display, in a separate 'window' except for on the alarm page. The operator interface would retain the most recent 200 alarm messages, with time/date labels. The alarm page would allow the operator to list the previous 200 alarm messages on the screen. Alarm messages and acknowledgments would be printed on the alarm printer as they occur.

The operator interface computer would include as a minimum the following display screens:

- 2-Screens for Solids Handling Process Overview
- 3-Screens for Dalecarlia Forebay Residuals Equalization Basin Pumping Station

- 3-Screens for Georgetown Reservoir Residuals Equalization Basin Pumping Station
- 7-Screens for Sedimentation Basin Residuals Pumping Station
- 12-Screens for Dewatering Facility
- 5-Screens for Thickened Residuals Pumping Station
- 4-Screens for Existing Backwash Recovery Pumping Station

The SCADA system would be configured to allow the facilities to be controlled and monitored from a remote location via a remote laptop computer. The remote computer would communicate with an operator interface computer through a dial-up modem. The remote laptop would be loaded with the same database and displays as the operator interface computers. The remote laptop would be capable of accessing historical data from the operator interface computer as well as real time data. The remote laptop computer would also be capable of displaying historical trends and dynamic graphical displays similar to the operator interface computers.

Alarm printers would be 24 pin letter quality 12 inch wide dot matrix printer. The printing would be near letter quality at 240 cps at 12 cpi and letter quality at 80 cps at 12 cpi. Report printers would be laser jet type with at least 600 x 600 dpi, at 16 pages per minute. The report printer would be capable of handling paper sizes up to 12"x17"as well as standard letter and legal paper sizes.

13.2.3 Operator Interface Software

The proposed operator interface computer's operating system would utilize the latest version of Microsoft Windows. It would be able to concurrently run the Scan, Alarm and Control package in the background and open and close files, for example for the following packages: Historical Trending, Alarm Logging (log files on disk/diskettes) and Report Scheduler. The operating system would be designed specifically to take advantage of the multitasking capability of the microprocessor. In addition, it would be capable of supporting up to 32 MB of RAM memory. The operating system would support commercially available DOS programs such as the latest version of Lotus 1-2-3, Microsoft EXCEL, DBASE, or similar product. These programs would be able to run concurrently with other system programs. The operating system would also provide lockout of keyboard re-boot commands and a user configurable master menu.

The software of the operator interface would include a database which supports as a minimum of 32,000 points. The database would contain all I/O point information and the logical interconnections of the display and control would be resident within the computer. The database would contain the PLC addresses, I/O type structure, interrogation schedules and basic communication parameters. The database would be user configurable and menu driven for ease of use. An interactive "fill in the blanks" procedure would be provided with full screen editing capabilities. All fields would have default values. The only fields that the system designer would need to enter in order to get a basic operational system would be PLC and I/O point names and addresses. It would be possible to copy a point definition to other points in order to save tedious work. Specific help topics would be available at all levels of editing. It would be possible to create and save several databases and load a new one. The software of the operator interface would include color graphic display capability in order to provide the operator with dynamic operation of the system. Graphics support would be provided to enable the designer or the user to create on screen pictures for a particular application. All analog inputs received by the operator interface would be converted to true engineering units for display and calculation purposes.

The software of the operator interface would include a standard software package for use in on-line trending and historical trending. On line trends would provide the ability to show on-line trends of analog or calculated values. At least 60 stored values would be displayed. Each stored value would be the instantaneous or average value of a number of samples, depending on the desired resolution. The trend would therefore span a fixed time period of 1 minute to approximately 60 hours depending on the averaging chosen. Historical trending would be similar to one-line trends except that it would be possible to define each I/O or calculated value to be saved on historical files. The values would be collected from the process database and would be stored on the system disk. Each value would be designated by its tag name and stored in the file with its tag name, value and time. It would be possible to define each value to be stored in the historical files. The definition would be done by entering data in a menu-driven format. It would be possible to monitor and edit the data on line.

The proposed Operator Interface would be provided with standard software packages which provide alarm handling and permanent records of system events. When an alarm occurs on the system an audible buzzer would sound and the event would be logged to a printer or the disk. The operator would be able to select one of three alarm priorities, low, medium and high, to be displayed for all I/O points. Each I/O point would have an assignable alarm priority during database building. For example, selecting medium alarm priority would suppress low alarms from being displayed and printed. For each I/O point it would be possible to assign the alarm media one, or any combination of, Printer, Log file, and Historical (Alarm Summary) Buffer and audible buzzer. In addition, all alarms would be displayed on the operator's screen as blinking fields and all recent alarms would be displayed in an Alarm Summary screen. For analog inputs, it would be possible to define four absolute value alarms in engineering units: Hi Hi, Hi, Lo, and Lo Lo. It would be possible to define the same I/O addressed twice in cases which require more than four alarms. For analog inputs, it would be possible to define a rate-of-change (ROC) alarm. It would also be possible to define two ROC alarms for the same I/O address, one in percent and one in actual engineering units. The most recent 23 alarms would be stored in an Alarm Summary Buffer and it would be possible to display them on an Alarm Summary screen or in a most recent Alarms Window or any operator screen. The number of alarms in the window would be user definable. Individual unacknowledged (flashing) alarms would be acknowledged by positioning the cursor on the flashing alarm field on the operator screen and pressing a key. It would be possible to acknowledge all alarms on a screen simultaneously by pressing two keys. If several alarms are detected for an I/O point, the highest priority alarm status would be latched and displayed as an unacknowledged flashing alarm. Once the alarm is acknowledged, the current alarm status would be displayed.

Passwork protection would be provided. The operator interface would be provided with a standard Report Generator software package. This would allow the user to create his own report forms. Building a report would be menu-driven. Each menu would let the user specify what information is to be printed based on the time of day, day of the week or event. The data for the report would come from either the current database or from historical trending data files. The data for the report would appear only on the parallel-connected printer. The operator interface would be capable of providing hard copies of line display screens to a printer by pressing a key. A Graphics Display Print program would be available in order to correctly print graphic displays. This program would print graphic representation of any display.

It would be possible to assign different passwords to different operators by assigning a password to each operator screen. If the password is not entered, the operator would not be able to change values or send controls. The operator interface would be provided with the means to limit the configuration capability to selected users. The operator interface configuration would be such that the operator may not, through random or accidental keyboard inputs, be able to alter the configuration of or interrupt the operation of the operator interface.

On-line help would be available at two levels throughout all screens: general page help and specific topic help. Help would be of ASCII files and user-editable. General help would be available by pressing a function key. Specific topic help would be available for the currently selected field.

13.3 *Dalecarlia Sedimentation Basins Residuals Pumping Station*

The main control panel for the Dalecarlia Sedimentation Basins Residuals Pumping Station is proposed to be provided with PLC-3/3A that would be housed in a NEMA 12 enclosure in the upper level of the station. The Residuals Collection Control Panels for Sedimentation Basins 1 through 4 PLCs (16 total) and the Main Distribution Panel (MDP3) PLC would be connected to PLC-3/3A via a Modbus link. MDP3 PLC is located in the existing Sedimentation Basins Substation Building in a NEMA 1 enclosure adjacent to MDP3. PLC-3/3A would be linked by a Modbus Plus fiber optic link to the Central Supervisory PLC-6/6A located in the Control Room of the Dewatering Facility. Using a fiber optic modem PLC-6/6A would be connected to Central Supervisory PLC-7/7A located in the Existing Filter Building Control Room. The PLC-7/7A would monitor and control the facilities. PLC-6/6A would monitor the facilities. Emergency shutdown of the motors would be available at the motor using an emergency lockout pushbutton.

MCC4 to be located in the upper level of the Sedimentation Basins Residuals Pumping Station would be used as a local control panel for pumps, supply fan and exhaust fans and would contain all manual controls. The PLC would control the submersible pumps, supply fan, exhaust fans and plug valves. The PLC would only provide monitoring functions for the sump pump and air compressors. The sequencing of the residuals collection drives would be performed by PLC-3/3A. The automatic control functions would be performed by the PLCs in the residuals collection control panel (SCCP).

Control or interlocks at SBPSCP would be either through KEYPAD or automatic in response to other inputs. Refer to TABLE 13-1 for proposed control specifications.

13.4 *Georgetown Reservoir Residuals Equalization Basin and Pumping Station*

The main control panel for the residuals collection and conveyance facilities to be provided at the Georgetown Reservoir site, would be provided with PLC-2/2A that would be housed in a NEMA 4X enclosure in the existing Influent Gate House. A solid state circuit monitor would be connected directly to PLC 2/2A and appropriate software included to monitor the incoming electrical service at this facility. The PLC would be linked by a dedicated leased line to the Central Supervisory PLC-6/6A located in the Control Room of the Dewatering Facility. Using a fiber optic modem, PLC-6/6A would be connected to Central Supervisory PLC-7/7A located in the Existing Filter Building Control Room. PLC-7/7A would monitor and control the facilities. PLC 6/6A would monitor the facilities. Emergency shutdown of the motors would be available at the motor using an emergency lockout pushbutton.

The separately mounted VFDs and motor starters to be located in the Influent Gate House would be used as local control panels and would contain manual controls. The PLC would control the submersible pumps, comminutor, and submersible mixers. The residuals collection dredge would be controlled locally only by an operator from the barge mounted control panel. Control or interlocks at GRPSCP would be either through KEYPAD or automatic in response to other inputs. Refer to TABLE 13-2 for proposed control specifications.

13.5 *Dalecarlia Forebay Residuals Equalization Basin and Pumping Station*

The main control panel for the proposed residuals collection and conveyance facilities to be provided at the Dalecarlia Forebay site, would be provided with PLC-1/1A that would be incorporated in MCC3 which is housed in a free standing NEMA 3R walk-in enclosure. The PLC would be linked by a Modbus Plus fiber optic link to the Central Supervisory PLC-6/6A located in the Control Room of the Dewatering Facility. Using a fiber optic modem, PLC-6/6A would be connected to Central Supervisory PLC-7/7A located in the Existing Filter Building Control Room. PLC-7/7A would monitor and control the facilities. PLC 6/6A would monitor the facilities.

TABLE 13-1
Dalecarlia Sedimentation Basins Residuals Pumping Station

INSTRUMENT CONTROLLERS	MCC4 or LCP	PLC-3/3A SBPSCP	PLC-7/7A DFMCP MMI	PLC-6/6A FBCP MMI
WET WELL				
Level Indication		XX	XX	XX
Low Level Alarm		XX	XX	XX
High Level Alarm		XX	XX	XX
RS PUMPS	**VFD**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
H-O-A Select		XX	XX	
H-O-A Status		XX	XX	XX
Start-Stop	XX	XX	XX	
Flow Rate Adjust	XX	XX	XX	
Flow Rate		XX	XX	XX
Run Status	XX	XX	XX	XX
Motor/VFD Failure Alarms		XX	XX	XX
Prefailure Trouble		XX	XX	XX
Discharge Pressure		XX	XX	XX
Discharge Pressure Alarms		XX	XX	XX
Discharge Pressure Trouble		XX	XX	XX
FANS	**Starter**			
H-O-A Select	XX			
H-O-A Status		XX	XX	XX

TABLE 13-1
Dalecarlia Sedimentation Basins Residuals Pumping Station

INSTRUMENT CONTROLLERS	**MCC4 or LCP**	**PLC-3/3A SBPSCP**	**PLC-7/7A DFMCP MMI**	**PLC-6/6A FBCP MMI**
Start-Stop	XX	XX		
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
SUMP PUMP	**LCP**			
H-O-A Select	XX			
H-O-A Status	XX	XX	XX	XX
Control	XX			
Run Status	XX	XX	XX	XX
Failure Alarms		XX	XX	XX
High High Level Alarm		XX	XX	XX
AIR COMPRESSORS	**LCP**			
H-O-A Select	XX			
H-O-A Status	XX	XX	XX	XX
Control	XX			
Run Status	XX	XX	XX	XX
Prefailure Trouble		XX	XX	XX
Failure Alarms		XX	XX	XX
RESIDUALS COLLECTORS	**RCCP**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
H-O-A Select		XX	XX	

TABLE 13-1 Dalecarlia Sedimentation Basins Residuals Pumping Station				
INSTRUMENT CONTROLLERS	**MCC4 or LCP**	**PLC-3/3A SBPSCP**	**PLC-7/7A DFMCP MMI**	**PLC-6/6A FBCP MMI**
H-O-A Status		XX	XX	XX
Start-Stop	XX	XX	XX	
Travel Rate Adjust	XX	XX	XX	
Travel Rate	XX	XX	XX	XX
Flow Rate per Basin		XX	XX	XX
Solids Density per Basin		XX	XX	XX
Sequencing		XX	XX	
Cycles per Week		XX	XX	
Failure Alarms	XX	XX	XX	XX
Prefailure Trouble	XX	XX	XX	XX
PLUG VALVE	**LCPP**			
Open-Close	XX			
Open-Closed Status	XX	XX	XX	XX
VALVES				
Open-Closed Status	XX	XX	XX	XX

TABLE 13-2 Georgetown Residuals Equalization Basin and Pumping Station				
INSTRUMENT CONTROLLERS	**VFD/ Starter LCP**	**PLC-2/2A GRPSCP**	**PLC-7/7A DFMCP MMI**	**PLC-6/6A FBCP MMI**
EQUALIZATION BASIN				
Level Indication		XX	XX	XX
Low Level Alarm		XX	XX	XX
High Level Alarm		XX	XX	XX
PUMPS	**VFD**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Start-Stop	XX	XX	XX	
Flow Rate Adjust	XX	XX	XX	
Discharge Flow Rate		XX	XX	XX
Run Status	XX	XX	XX	XX
Motor/VFD Failure Alarms		XX	XX	XX
Prefailure Trouble		XX	XX	XX
Discharge Pressure		XX	XX	XX
Discharge Pressure Alarms		XX	XX	XX
Discharge Pressure Trouble		XX	XX	XX
COMMINUTOR	**Starter**			
Start-Stop	XX			
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX

TABLE 13-2
Georgetown Residuals Equalization Basin and Pumping Station

INSTRUMENT CONTROLLERS	**VFD/ Starter LCP**	**PLC-2/2A GRPSCP**	**PLC-7/7A DFMCP MMI**	**PLC-6/6A FBCP MMI**
Prefailure Trouble		XX	XX	XX
Dredge Interlock		XX		
SUBMERSIBLE MIXER	**Starter**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Start-Stop	XX	XX	XX	
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
Prefailure Trouble		XX	XX	XX
Low Level Cut-Off		XX		
Low Level Alarm		XX	XX	XX
DREDGE	**LCP**			
Run Status	XX	XX	XX	XX
Control	XX			
Failure Alarms	XX			
Prefailure Trouble	XX			
VALVES				
Open-Closed Status		XX	XX	XX

Emergency shutdown of the motors would be available at the motor using an emergency lockout pushbutton.

MCC3 would be used as a local control panel and would contain all manual controls. The PLC would control the submersible pumps, comminutor, and submersible mixers. The residuals collection dredge would be controlled locally only by an operator from the barge mounted control panel. Control or interlocks at DFPSCP would be ~~either~~ through KEYPAD or automatic in response to other inputs. Refer to TABLE 13-3 for proposed control specifications.

13.6 *Backwash Recovery Facility Improvements*

The control panel to be added within the existing Backwash Recovery Facility, would be provided with PLC-8/8A that would be housed in a NEMA 12 enclosuure on the same level as the existing motor control center. The PLC would be linked by a Modbus Plus fiber optic link to the Central Supervisory PLC-7/7A located in the Control Room of the existing Filter Building. Using a fiber optic modem PLC-7/7A would be connected to Central Supervisory PLC-6/6A located in the Dewatering Facility Control Room. PLC 7/7A would monitor and control the facilities. PLC-6/6A would monitor the facilities. Emergency shutdown of the motors would be available at the motor using an emergency lockout pushbutton.

The existing motor control center would be used as a local control panel and would contain all manual controls. The PLC would control the backwash pumps. All equipment associated the backwash process would be controlled and/or monitored by the PLC. Control at BRPSCP would be through KEYPAD inputs. Refer to TABLE 13-4 for proposed control specifications.

13.7 *Dewatering Facility*

The control panel for the Dewatering Facility would be provided with PLC-5/5A that would be housed in a NEMA 1 enclosure in the Electrical Room on the ground floor of the Dewatering Facility. The Centrifuge Control Panels for Centrifuges 1 through 6 PLCs (6 total), the primary switchgear PLC, and the secondary switchgear PLC would be connected to PLC-5/5A via a Modbus link. The Centrifuge Control Panels, housed in NEMA 4X enclosures, would be located on the floor of the Control Room in the Dewatering Facility. The switchgear PLCs would be located within their associated switchgear in the Electrical Room. PLC-5/5A would be linked by a Modbus Plus fiber

TABLE 13-3
Dalecarlia Forebay Residuals Equalization Basin and Pumping Station

INSTRUMENT CONTROLLERS	MCC5 or LCP	PLC-1/1A DFPSCP	PLC-7/7A DFMCP MMI	PLC-6/6A FBCP MMI
EQUALIZATION BASIN				
Level Indication		XX	XX	XX
Low Level Alarm		XX	XX	XX
High Level Alarm		XX	XX	XX
PUMPS	**VFD**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Start-Stop	XX	XX	XX	
Flow Rate Adjust	XX	XX	XX	
Discharge Flow Rate		XX	XX	XX
Run Status	XX	XX	XX	XX
Motor/VFD Failure Alarms		XX	XX	XX
Prefailure Trouble		XX	XX	XX
Discharge Pressure		XX	XX	XX
Discharge Pressure Alarms		XX	XX	XX
Discharge Pressure Trouble		XX	XX	XX
COMMINUTOR	**Starter**			
Start-Stop	XX			
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX

TABLE 13-3
Dalecarlia Forebay Residuals Equalization Basin and Pumping Station

INSTRUMENT CONTROLLERS	**MCC5 or LCP**	**PLC-1/1A DFPSCP**	**PLC-7/7A DFMCP MMI**	**PLC-6/6A FBCP MMI**
Prefailure Trouble		XX	XX	XX
SUBMERSIBLE MIXER	**Starter**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Start-Stop	XX	XX	XX	
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
Prefailure Trouble		XX	XX	XX
Low Level Cut-Off		XX		
Low Level Alarm		XX	XX	XX
DREDGE	**LCP**			
Run Status	XX	XX	XX	XX
Control	XX			
Failure Alarms	XX			
Prefailure Trouble	XX			
VALVES				
Open-Closed Status		XX	XX	XX

TABLE 13-4
Backwash Recovery Facility Improvements

INSTRUMENT CONTROLLERS	ex MCC or LCP	PLC-8/8A BRPSCP	PLC-7/7A DFMCP MMI	PLC-6/6A FBCP MMI
WET WELL				
Level Indication		XX	XX	XX
Low Level Alarm		XX	XX	XX
High Level Alarm		XX	XX	XX
BACKWASH PUMPS	**VFD**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Start-Stop	XX	XX		XX
Flow Rate Adjust	XX	XX		XX
Flow Rate		XX	XX	XX
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
Prefailure Trouble		XX	XX	XX
Discharge Pressure		XX	XX	XX
Discharge Pressure Alarms		XX	XX	XX
Discharge Pressure Trouble		XX	XX	XX
CLEARWELL DECANT PUMP	**LCP**			
Start-Stop	XX	XX	XX	
Run Status	XX	XX	XX	XX

TABLE 13-4
Backwash Recovery Facility Improvements

INSTRUMENT CONTROLLERS	**ex MCC or LCP**	**PLC-8/8A BRPSCP**	**PLC-7/7A DFMCP MMI**	**PLC-6/6A FBCP MMI**
Motor/Starter Failure Alarms		XX	XX	XX
Prefailure Trouble		XX	XX	XX
Low Level Cut-Off		XX		
Low Level Alarm		XX	XX	XX
84" PLANT DRAIN PUMP	**LCP**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
H-O-A Select		XX	XX	
H-O-A Status		XX	XX	XX
Start-Stop	XX	XX	XX	
Run Status	XX	XX	XX	XX
Motor Start Failure Alarms		XX	XX	XX
High Level Alarm		XX	XX	XX
Level Start/Cut-Off		XX		
Low Level Alarm		XX	XX	XX
VALVES				
Open-Closed Status		XX	XX	XX

optic link to the Central Supervisory PLC-6/6A located in the Control Room of the Dewatering Facility. Using a fiber optic modem, PLC-6/6A would be connected to Central Supervisory PLC-7/7A located in the Existing Filter Building Control Room. PLC 6/6A would monitor and control the facilities. PLC-7/7A would monitor the facilities when the Dewatering Facility is not in operation. Emergency shutdown of the motors would be available at the motor using an emergency lockout pushbutton and at PLC-7/7A during out of hours operation.

MCC1 would be used as a local control panel and would contain manual controls. The PLC would control pumps, fans, air handling units, conveyors, and mixers. The PLC would provide monitoring functions for sump pumps, air compressors and similar systems. The sequencing of the centrifuge drives would be performed by PLC-5/5A. The centrifuge's automatic control functions would be performed by the PLC in the centrifuge control panel (COP). HVAC system for the Control Room and Laboratory would be through ATC but motor failure would be monitored by PLC-5/5A. Control or interlocks at DFCP would be either through KEYPAD or automatic in response to other inputs. Refer to TABLE 13-5 for proposed control specifications.

13.8 *Thickened Residuals Pumping Station*

The main control panel for the Thickened Residuals Pumping Station would be provided with PLC-4/4A that would be housed in a NEMA 12 enclosure in upper level of the pumping station. PLC-4/4A would be linked by a Modbus Plus fiber optic link to the Central Supervisory PLC-6/6A to be located in the Control Room of the Dewatering Facility. Using a fiber optic modem, PLC-6/6A would be connected to Central Supervisory PLC-7/7A located in the Existing Filter Building Control Room. PLC 6/6A would monitor and control the facilities. PLC-7/7A would monitor the facilities. Emergency shutdown of the motors would be available at the motor using an emergency lockout pushbutton and at PLC-7/7A during out of hours operation.

MCC2 would be used as a local control panel and would contain manual controls. The PLC would control pumps, fans, drives, and mixers. The PLC would provide monitoring functions for sump pumps, hydropneumatic pumps and similar systems. Control or interlocks at TRPSCP would be either through KEYPAD or automatic in response to other inputs. Refer to TABLE 13-6 for proposed control specifications.

TABLE 13-5 Dewatering Facility				
INSTRUMENT CONTROLLERS	**MCC1 or LCP**	**PLC-5/5A DFCP**	**PLC-6/6A DFMCP MMI**	**PLC-7/7A FBCP MMI**
STORAGE/BLENDING TANK				
Level Indication		XX	XX	XX
Low Level Alarm		XX	XX	XX
High Level Alarm		XX	XX	XX
MIXER	**Starter**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Start-Stop	XX	XX	XX	
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
CENTRIFUGE PUMPS	**COP**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
H-O-A Select	XX			
H-O-A Status	XX	XX	XX	XX
Start-Stop	XX		XX	
Flow Rate Adjust	XX		XX	
Flow Rate	XX	XX	XX	XX
Flow Totalization		XX	XX	XX
Backdrive Speed	XX	XX	XX	XX

TABLE 13-5
Dewatering Facility

INSTRUMENT CONTROLLERS	MCC1 or LCP	PLC-5/5A DFCP	PLC-6/6A DFMCP MMI	PLC-7/7A FBCP MMI
Run Status	XX	XX	XX	XX
Failure Alarms	XX	XX	XX	XX
Prefailure Troubles	XX	XX	XX	XX
Flushwater Interlock		XX		
TRS Feed Pump Interlock		XX		
Polymer Feed Pump Interlock		XX		
FANS	**Starter**			
H-O-A Select	XX			
H-O-A Status		XX	XX	XX
Start-Stop	XX	XX		
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
SUMP PUMP	**LCP**			
H-O-A Select	XX			
H-O-A Status	XX	XX	XX	XX
Control	XX			
Run Status	XX	XX	XX	XX
Failure Alarms		XX	XX	XX
High High Level Alarm		XX	XX	XX
AIR COMPRESSORS	**LCP**			
H-O-A Select	XX			

TABLE 13-5
Dewatering Facility

INSTRUMENT CONTROLLERS	**MCC1 or LCP**	**PLC-5/5A DFCP**	**PLC-6/6A DFMCP MMI**	**PLC-7/7A FBCP MMI**
H-O-A Status	XX	XX	XX	XX
Control	XX			
Run Status	XX	XX	XX	XX
Prefailure Trouble		XX	XX	XX
Failure Alarms		XX	XX	XX
HYDROPNEUMATIC PUMPS	**LCP**			
H-O-A Select	XX			
H-O-A Status	XX	XX	XX	XX
Control	XX			
Run Status	XX	XX	XX	XX
Prefailure Trouble		XX	XX	XX
Failure Alarms		XX	XX	XX
TRS FEED PUMP	**VFD**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
H-O-A Select		XX	XX	
H-O-A Status		XX	XX	XX
Start-Stop	XX	XX		
Flow Rate Adjust	XX	XX		
Flow Rate		XX	XX	XX
Discharge Pressure		XX	XX	XX

TABLE 13-5
Dewatering Facility

INSTRUMENT CONTROLLERS	**MCC1 or LCP**	**PLC-5/5A DFCP**	**PLC-6/6A DFMCP MMI**	**PLC-7/7A FBCP MMI**
Discharge Pressure Alarm		XX	XX	XX
Discharge Pressure Trouble		XX	XX	XX
POLYMER FEED PUMP	**VFD**			
Liquid/Dry Select	XX	XX	XX	
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
H-O-A Select		XX	XX	
H-O-A Status		XX	XX	XX
Flow Rate Adjust	XX	XX	XX	
Flow Rate	XX	XX	XX	XX
Start-Stop	XX	XX		
Run Status	XX	XX	XX	XX
Failure Alarms		XX	XX	XX
Prefailure Trouble		XX	XX	XX
POLYMER RECIRC PUMP	**Starter**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Start-Stop	XX	XX	XX	
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX

TABLE 13-5 Dewatering Facility				
INSTRUMENT CONTROLLERS	**MCC1 or LCP**	**PLC-5/5A DFCP**	**PLC-6/6A DFMCP MMI**	**PLC-7/7A FBCP MMI**
PLUG VALVE AND KNIFE GATES	**LCP**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Open-Close	XX	XX	XX	
Open-Closed Status		XX	XX	XX
PW FLUSHWATER SOLENOID VALVES	**COP**			
Operate	XX			
Open-Closed Status	XX	XX	XX	XX
SCREW CONVEYOR/ MIXER	**Starter**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Start-Stop	XX	XX	XX	
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
RESIDUALS HOPPER				
Level Indication		XX	XX	XX
High Level Alarm		XX	XX	XX
LOADOUT	**LCP**			
Control	XX			
Loading in Progress	XX	XX	XX	XX
Failure Alarms	XX	XX	XX	XX

TABLE 13-6
Thickened Residuals Pumping Station

INSTRUMENT CONTROLLERS	MCC2 or LCP	PLC-4/4A TRPSCP	PLC-6/6A DFMCP MMI	PLC-7/7A FBCP MMI
DAYTANK MIXER	**Starter**			
Local-Remote Select	XX			
Local-Remote Status		XX	XX	XX
Start-Stop	XX	XX	XX	
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
POLYMER DAYTANK				
Level Indication		XX	XX	XX
Low Level Alarm		XX	XX	XX
Low Low Level Alarm		XX	XX	XX
High Level Alarm		XX	XX	XX
FANS	**Starter**			
H-O-A Select	XX			
H-O-A Status		XX	XX	XX
Start-Stop	XX	XX		
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
SUMP PUMP	**LCP**			
H-O-A Select	XX			
H-O-A Status	XX	XX	XX	XX

TABLE 13-6
Thickened Residuals Pumping Station

INSTRUMENT CONTROLLERS	**MCC2 or LCP**	**PLC-4/4A TRPSCP**	**PLC-6/6A DFMCP MMI**	**PLC-7/7A FBCP MMI**
Control	XX			
Run Status	XX	XX	XX	XX
Failure Alarms		XX	XX	XX
High High Level Alarm		XX	XX	XX
HYDROPNEUMATIC PUMPS	**LCP**			
H-O-A Select	XX			
H-O-A Status	XX	XX	XX	XX
Control	XX			
Run Status	XX	XX	XX	XX
Prefailure Trouble		XX	XX	XX
Failure Alarms		XX	XX	XX
TDS PUMP	**VFD**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
H-O-A Select		XX		
H-O-A Status		XX	XX	XX
Start-Stop	XX	XX	XX	
Flow Rate Adjust	XX	XX	XX	
Flow Rate per Pump		XX	XX	XX
Solids Density per Thickener		XX	XX	XX
Flow Rate Totalization		XX	XX	XX

TABLE 13-6
Thickened Residuals Pumping Station

INSTRUMENT CONTROLLERS	**MCC2 or LCP**	**PLC-4/4A TRPSCP**	**PLC-6/6A DFMCP MMI**	**PLC-7/7A FBCP MMI**
Discharge Pressure		XX	XX	XX
Discharge Pressure Alarm		XX	XX	XX
Discharge Pressure Trouble		XX	XX	XX
POLYMER BATCHING SYSTEM	**LCP**			
H-O-A Select	XX			
H-O-A Status	XX	XX	XX	XX
System Control	XX			
System Run Status	XX	XX	XX	XX
System Failure Alarms	XX	XX	XX	XX
System Prefailure Trouble	XX	XX	XX	XX
Polymer Storage Low Level Alarm		XX	XX	XX
Low NPW Pressure Alarm		XX	XX	XX
Daytank Level Indication	XX	XX	XX	XX
Daytank Low Level Alarm		XX	XX	XX
Daytank Low Low Level Alarm		XX	XX	XX
Daytank High Level Alarm		XX	XX	XX
TRS DRIVES	**Starter**			
Local-Remote Select	XX			
Local-Remote Status		XX	XX	XX
Start-Stop	XX	XX	XX	

TABLE 13-6
Thickened Residuals Pumping Station

INSTRUMENT CONTROLLERS	**MCC2 or LCP**	**PLC-4/4A TRPSCP**	**PLC-6/6A DFMCP MMI**	**PLC-7/7A FBCP MMI**
Run Status	XX	XX	XX	XX
Motor/Starter Failure Alarms		XX	XX	XX
Prefailure Trouble		XX	XX	XX
METERING PUMP	**LCP**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
H-O-A Select		XX	XX	
H-O-A Status		XX	XX	XX
Start-Stop	XX	XX	XX	
Flow Rate Adjust	XX	XX	XX	
Run Status	XX	XX	XX	XX
Failure Alarms		XX	XX	XX
Check Valve Interlock		XX		
DISCHARGE CHECK SERVICE VALVES	**LCP**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Open-Close	XX	XX	XX	
Open-Closed Status		XX	XX	XX
VALVES				
Open-Closed Status		XX	XX	XX

TABLE 13-6
Thickened Residuals Pumping Station

INSTRUMENT CONTROLLERS	MCC2 or LCP	PLC-4/4A TRPSCP	PLC-6/6A DFMCP MMI	PLC-7/7A FBCP MMI
WEIR GATE	**LCP**			
Local-Remote Select	XX			
Local-Remote Status	XX	XX	XX	XX
Raise-Stop-Lower	XX	XX	XX	
Position Indication		XX	XX	XX
GRINDER PUMP	**Starter**			
Start-Stop	XX			
Run Status	XX	XX	XX	XX
Failure Alarms		XX	XX	XX
Low Level Alarm		XX	XX	XX

14.0 CONSTRUCTION CONSTRAINTS and SCHEDULE

Construction period to build the Residuals Collection and Treatment Facilities is estimated to require 36-months. During the design development culminating with this Design Memorandum, the anticipated 36 month construction period for the Residuals Collection and Treatment Facilities has been revised from 10/98 through 9/01 (mid-point of 4/00) to a revised period of 10/01 through 9/04 (mid-point of 4/03). As described in the Executive Summary section under "Recent Developments", the funding provisions for this project have not been included within the "Borrowing Authority" established for WAD capital improvement projects pursuant to the SDWA Amendments (PL104-182). Therefore, it is expected that the final design for the proposed residuals collection and treatment facilities would commence no earlier than fiscal year 2000 (September 1999), and would be initiated under the authority of a new entity that is to assume title to the facilities now operated by the Washington Aqueduct. As indicated below, the projected date that construction would commence is October, 2001.

The schedule is comprised of estimated constraints, milestones and potential shutdowns of the existing facilities. Individual activity durations have been adjusted to include potential weather impacts to overall construction time. All of the construction activities which comprise the proposed schedule are directly related to work required to implement and build the facilities presented within the Design Memorandum Drawings, Book 2 of 5, and as costed in the Design Memorandum Engineering Estimate, Book 4 of 5.

14.1 Introduction, Schedule Approach and Criteria

The proposed construction schedule for the various residuals collection and treatment facilities are organized into six major work sites. These "sites" have been further grouped and detailed into logical "areas" of work. Each of the respective "sites" and its corresponding "areas" are denoted as follows:

SCHEDULE "SITES"	**SCHEDULE "AREAS"**
Dalecarlia Sedimentation Basin Site	Procurement Process (Submittals thru Delivery)
	Sedimentation Basin Residuals Pumping Station
	Sedimentation Basin No. 3 and 4 Improvements
	Sedimentation Basin No. 1 and 2 Improvements
	Sedimentation Basin Area Site and Utilities
Georgetown Reservoir Site	Procurement Process (Submittals thru Delivery)
	Georgetown Reservoir Basin No. 2 Work
	Georgetown Reservoir Basin No. 1 Work
	Georgetown Reservoir - Divide Dam (Berm) Work
	Georgetown Reservoir Area Site and Utility Work

SCHEDULE "SITES"	**SCHEDULE "AREAS"**
Dalecarlia Reservoir Forebay Site	Procurement Process (Submittal thru Delivery)
	Forebay Area work
Dalecarlia Dewatering Facility Site	Procurement Process (Submittal thru Delivery)
	Dewatering Facility Building
	Thickened Residuals Pumping Station
	Thickener Units at the Dewatering Site
	Dewatering Facility Area - Site and Utilities
Utilities Connecting New Facilities	"RG" (Georgetown Residuals Conveyance) Forcemain and Work in the Georgetown Conduit
	Tunnel to Forebay Area (Hike/Bike Trail) Site and Utilities
	Dewatering Facility Area - Site and Utilities

Backwash Recovery Pumping Station Upgrades:

Procurement Process (Submittals thru Delivery)
Backwash Recovery Station Upgrades

Construction has been estimated to take 36 months and potentially longer if the work commences in the late fall/early winter season as dependent upon unknown future weather. The scheduling unit utilized to configure the durations are "WEEKS" of time. The milestones from execution of optional design services through construction is projected as follows:

Milestone Activity	Period	Duration	Fiscal Year Funded
Execution of Optional Design Services (Final Plans and Specs).	10/99 to 1/00	4 Months	N/A
Design and Review Phase (Final Plans & Specs)	2/00 to 4/01	15 Months	2000
Advertise, Bid and Award	5/01 to 9/01	5 Months	N/A
Construction Period (Mid-Point of Construction: April 2003)	10/01 to 9/04	36 Months	2002, 2003 and 2004

The projected construction scheduling start date of 10/01 (actual week starting date of 10-01-01) is based on the above milestone activities, and assuming the following activities/actions occur as anticipated:

- The transfer of ownership, operation, maintenance and management of the facilities known as the Washington Aqueduct from the COE to a non-Federal public or private entity occurs by August 1999 as provided for by the Safe Drinking Water Act Amendments of 1996.

- Reissuance of a National Pollutant Discharge Elimination System (NPDES) permit which confirms that the continued discharge of water treatment residuals to the Potomac River by the Washington Aqueduct must not continue.
- Concurrence by the new entity and customers that the proposed improvements are the most appropriate means to accomplish the project objectives.
- The presence of funding mechanism and budgeted funds for design and construction of the proposed improvements.

Accordingly, the overall construction period presented in the schedule reports have been generated utilizing the same overall 36 month-long schedule. The "Detailed Schedule" report, as presented on FIGURE 14-1, provides all the activities for each "site" and "area". The "Critical Path Schedule - Details" report is presented in FIGURE 14-2. This other schedule report has been sorted and/or limited to contain only portions out of the complete, overall schedule to meet the 36-month estimated construction schedule duration. The purpose of each of the various schedule reports has been described in TABLE 14.1.

The activities which comprise the overall construction schedule have each been coded to enable generation of the various graphic reports provided below. These schedule activity codes are independent of the organization, logic and duration of the work item. The overall construction schedule proposed herein can be reviewed by one of several graphic reports. The two separate reports presented herein are described in TABLE 14.1 which is followed by each of the referenced schedules accordingly.

TABLE 14.1

CONSTRUCTION SCHEDULES and DESCRIPTIONS

Schedule Graphic	**Description and Purpose**
Detailed Schedule, by Site and Area	This schedule provides all the details which comprise the construction of the facilities represented. Organization is by AREA, by SITE. This schedule is presented in FIGURE 14.1., Section 14.2.
Critical Path Schedule, Details	This schedule is a subset schedule of the "Detailed Schedule" presenting only those activities estimated as critical to meeting the 36-month schedule. Organization is by AREA and by SITE. This schedule is presented in FIGURE 14.2., Section 14.3.

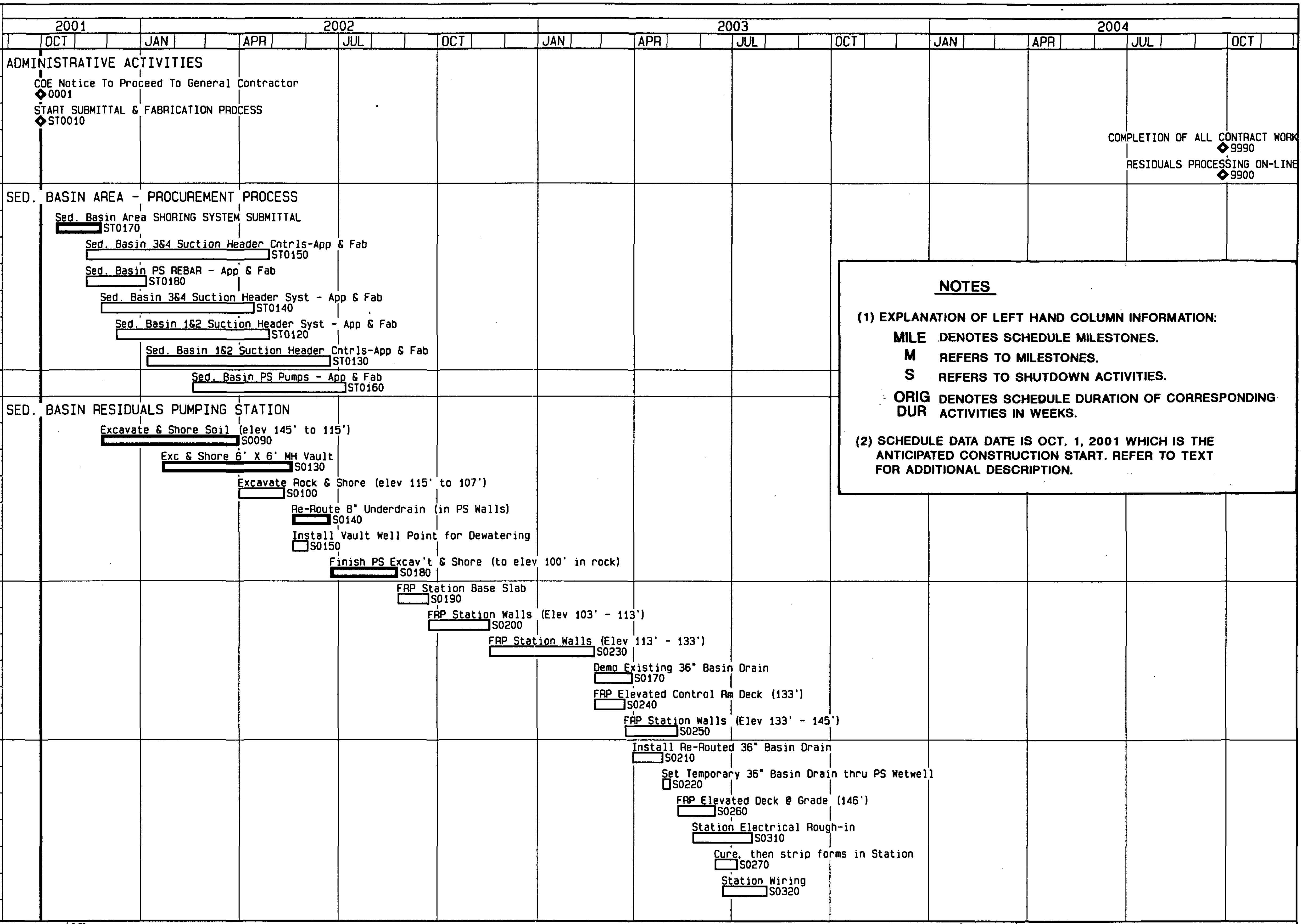
Each of these two sorts of the same schedule are presented in Section 14.2 and Section 14.3, respectively.

SECTION 14 - SCHEDULES
DESIGN MEMORANDUM - BOOK 1 OF 5

14.2 DETAILED SCHEDULE, BY SITE AND AREA

This schedule provides all the details which comprise the construction of the facilities represented. Organization is by AREA, by SITE.

EARLY START	EARLY FINISH	ORIG DUR	MILE		
				ADMINISTRATIVE ACTIVITIES	
1OCT01	30SEP01	0	M	COE Notice To Proceed To General Contractor	0001
1OCT01		0		START SUBMITTAL & FABRICATION PROCESS	ST0010
	26SEP04	0	M	COMPLETION OF ALL CONTRACT WORK	9990
	26SEP04	0	M	RESIDUALS PROCESSING ON-LINE	9900
				SED. BASIN AREA - PROCUREMENT PROCESS	
15OCT01	25NOV01	6		Sed. Basin Area SHORING SYSTEM SUBMITTAL	ST0170
12NOV01	28APR02	24		Sed. Basin 3&4 Suction Header Cntrls-App & Fab	ST0150
12NOV01	6JAN02	8		Sed. Basin PS REBAR - App & Fab	ST0180
26NOV01	14APR02	20		Sed. Basin 3&4 Suction Header Syst - App & Fab	ST0140
10DEC01	28APR02	20		Sed. Basin 1&2 Suction Header Syst - App & Fab	ST0120
7JAN02	23JUN02	24		Sed. Basin 1&2 Suction Header Cntrls-App & Fab	ST0130
18FEB02	7JUL02	20		Sed. Basin PS Pumps - App & Fab	ST0160
				SED. BASIN RESIDUALS PUMPING STATION	
26NOV01	31MAR02	18		Excavate & Shore Soil (elev 145' to 115')	S0090
21JAN02	19MAY02	17		Exc & Shore 6' X 6' MH Vault	S0130
1APR02	12MAY02	6		Excavate Rock & Shore (elev 115' to 107')	S0100
20MAY02	23JUN02	5		Re-Route 8" Underdrain (in PS Walls)	S0140
20MAY02	2JUN02	2		Install Vault Well Point for Dewatering	S0150
24JUN02	25AUG02	9		Finish PS Excav't & Shore (to elev 100' in rock)	S0180
26AUG02	22SEP02	4		FRP Station Base Slab	S0190
23SEP02	17NOV02	8		FRP Station Walls (Elev 103' - 113')	S0200
18NOV02	23FEB03	14		FRP Station Walls (Elev 113' - 133')	S0230
24FEB03	30MAR03	5		Demo Existing 36" Basin Drain	S0170
24FEB03	23MAR03	4		FRP Elevated Control Rm Deck (133')	S0240
24MAR03	11MAY03	7		FRP Station Walls (Elev 133' - 145')	S0250
31MAR03	27APR03	4		Install Re-Routed 36" Basin Drain	S0210
28APR03	4MAY03	1		Set Temporary 36" Basin Drain thru PS Wetwell	S0220
12MAY03	15JUN03	5		FRP Elevated Deck @ Grade (146')	S0260
26MAY03	20JUL03	8		Station Electrical Rough-in	S0310
16JUN03	6JUL03	3		Cure, then strip forms in Station	S0270
23JUN03	3AUG03	6		Station Wiring	S0320



NOTES

(1) EXPLANATION OF LEFT HAND COLUMN INFORMATION:

MILE DENOTES SCHEDULE MILESTONES.
M REFERS TO MILESTONES.
S REFERS TO SHUTDOWN ACTIVITIES.
ORIG DUR DENOTES SCHEDULE DURATION OF CORRESPONDING ACTIVITIES IN WEEKS.

(2) SCHEDULE DATA DATE IS OCT. 1, 2001 WHICH IS THE ANTICIPATED CONSTRUCTION START. REFER TO TEXT FOR ADDITIONAL DESCRIPTION.

Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
Project Finish 26SEP04

▭ Activity Bar/Early Dates
▬ Critical Activity
▭ Progress Bar
◇/▶ Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

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Chapter 14

FIGURE 14.1-1

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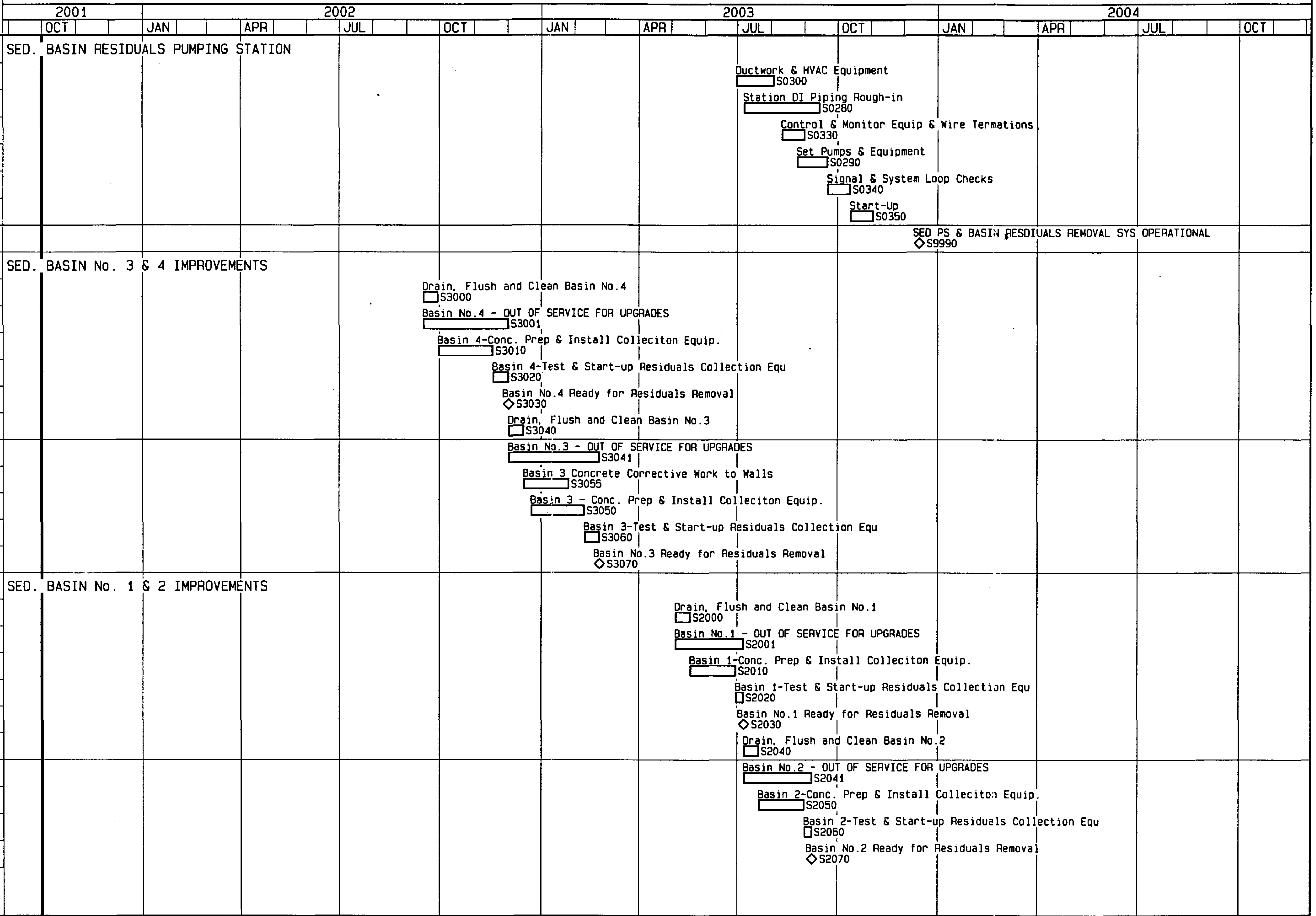
WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

EARLY START	EARLY FINISH	ORIG DUR	MILE	
				SED. BASIN RESIDUALS PUMPING STATION
30JUN03	3AUG03	5		Ductwork & HVAC Equipment S0300
7JUL03	14SEP03	10		Station DI Piping Rough-in S0280
11AUG03	31AUG03	3		Control & Monitor Equip & Wire Termations S0330
25AUG03	21SEP03	4		Set Pumps & Equipment S0290
22SEP03	12OCT03	3		Signal & System Loop Checks S0340
13OCT03	2NOV03	3		Start-Up S0350
15DEC03	14DEC03	0	M	SED PS & BASIN RESDIUALS REMOVAL SYS OPERATIONAL ◇S9990
				SED. BASIN No. 3 & 4 IMPROVEMENTS
16SEP02	29SEP02	2		Drain, Flush and Clean Basin No.4 S3000
16SEP02	1DEC02	11	S	Basin No.4 - OUT OF SERVICE FOR UPGRADES S3001
30SEP02	17NOV02	7		Basin 4-Conc. Prep & Install Colleciton Equip. S3010
18NOV02	1DEC02	2		Basin 4-Test & Start-up Residuals Collection Equ S3020
	1DEC02	0	M	Basin No.4 Ready for Residuals Removal ◇S3030
2DEC02	15DEC02	2		Drain, Flush and Clean Basin No.3 S3040
2DEC02	23FEB03	12	S	Basin No.3 - OUT OF SERVICE FOR UPGRADES S3041
16DEC02	26JAN03	6		Basin 3 Concrete Corrective Work to Walls S3055
23DEC02	9FEB03	7		Basin 3 - Conc. Prep & Install Colleciton Equip. S3050
10FEB03	23FEB03	2		Basin 3-Test & Start-up Residuals Collection Equ S3060
	23FEB03	0	M	Basin No.3 Ready for Residuals Removal ◇S3070
				SED. BASIN No. 1 & 2 IMPROVEMENTS
5MAY03	18MAY03	2		Drain, Flush and Clean Basin No.1 S2000
5MAY03	6JUL03	9	S	Basin No.1 - OUT OF SERVICE FOR UPGRADES S2001
19MAY03	29JUN03	6		Basin 1-Conc. Prep & Install Colleciton Equip. S2010
30JUN03	6JUL03	1		Basin 1-Test & Start-up Residuals Collection Equ S2020
	6JUL03	0	M	Basin No.1 Ready for Residuals Removal ◇S2030
7JUL03	20JUL03	2		Drain, Flush and Clean Basin No.2 S2040
7JUL03	7SEP03	9	S	Basin No.2 - OUT OF SERVICE FOR UPGRADES S2041
21JUL03	31AUG03	6		Basin 2-Conc. Prep & Install Colleciton Equip. S2050
1SEP03	7SEP03	1		Basin 2-Test & Start-up Residuals Collection Equ S2060
	7SEP03	0	M	Basin No.2 Ready for Residuals Removal ◇S2070



Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
Project Finish 26SEP04

(c) Primavera Systems, Inc.

▭	Activity Bar/Early Dates
▬	Critical Activity
▭	Progress Bar
◇/▸	Milestone/Flag Activity

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RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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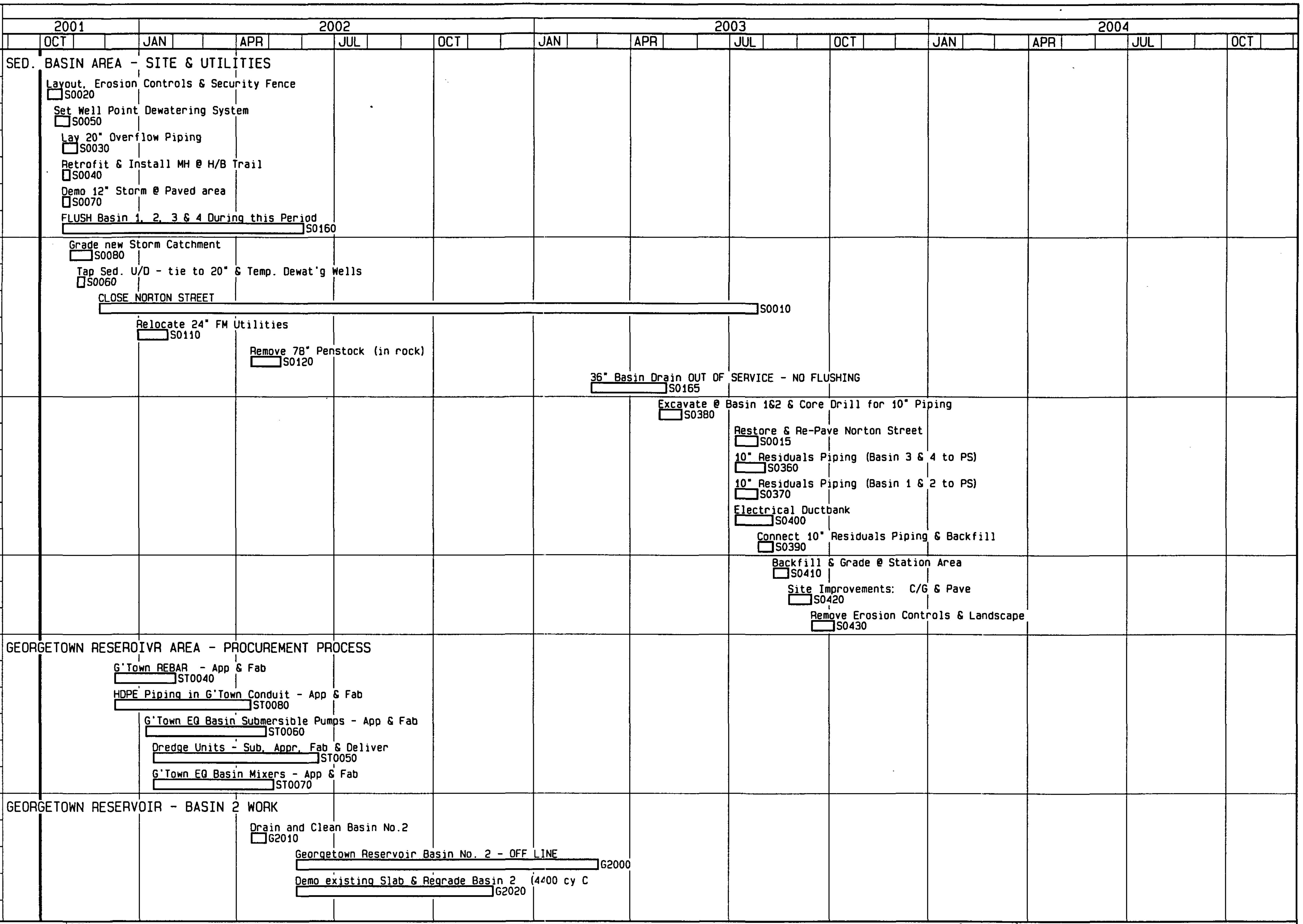
DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

Date	Revision	Checked	Approved

FIGURE 14.1-2

WR&A
WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners



EARLY START	EARLY FINISH	ORIG DUR	MILE		
				SED. BASIN AREA - SITE & UTILITIES	
8OCT01	21OCT01	2		Layout, Erosion Controls & Security Fence	S0020
15OCT01	28OCT01	2		Set Well Point Dewatering System	S0050
22OCT01	4NOV01	2		Lay 20" Overflow Piping	S0030
22OCT01	28OCT01	1		Retrofit & Install MH @ H/B Trail	S0040
22OCT01	28OCT01	1		Demo 12" Storm @ Paved area	S0070
22OCT01	2JUN02	32	M	FLUSH Basin 1, 2, 3 & 4 During this Period	S0160
29OCT01	18NOV01	3		Grade new Storm Catchment	S0080
5NOV01	11NOV01	1		Tap Sed. U/D - tie to 20" & Temp. Dewat'g Wells	S0060
26NOV01	27JUL03	87	S	CLOSE NORTON STREET	S0010
31DEC01	27JAN02	4		Relocate 24" FM Utilities	S0110
15APR02	12MAY02	4		Remove 78" Penstock (in rock)	S0120
24FEB03	4MAY03	10	S	36" Basin Drain OUT OF SERVICE - NO FLUSHING	S0165
28APR03	18MAY03	3		Excavate @ Basin 1&2 & Core Drill for 10" Piping	S0380
7JUL03	27JUL03	3		Restore & Re-Pave Norton Street	S0015
7JUL03	3AUG03	4		10" Residuals Piping (Basin 3 & 4 to PS)	S0360
7JUL03	27JUL03	3		10" Residuals Piping (Basin 1 & 2 to PS)	S0370
7JUL03	10AUG03	5		Electrical Ductbank	S0400
28JUL03	10AUG03	2		Connect 10" Residuals Piping & Backfill	S0390
11AUG03	24AUG03	2		Backfill & Grade @ Station Area	S0410
25AUG03	14SEP03	3		Site Improvements: C/G & Pave	S0420
15SEP03	5OCT03	3		Remove Erosion Controls & Landscape	S0430
				GEORGETOWN RESEROIVR AREA - PROCUREMENT PROCESS	
10DEC01	3FEB02	8		G'Town REBAR - App & Fab	ST0040
10DEC01	14APR02	18		HDPE Piping in G'Town Conduit - App & Fab	ST0080
7JAN02	28APR02	16		G'Town EQ Basin Submersible Pumps - App & Fab	ST0060
14JAN02	16JUN02	22		Dredge Units - Sub, Appr, Fab & Deliver	ST0050
14JAN02	5MAY02	16		G'Town EQ Basin Mixers - App & Fab	ST0070
				GEORGETOWN RESERVOIR - BASIN 2 WORK	
15APR02	28APR02	2		Drain and Clean Basin No.2	G2010
27MAY02	2MAR03	40	S	Georgetown Reservoir Basin No. 2 - OFF LINE	G2000
27MAY02	24NOV02	26		Demo existing Slab & Regrade Basin 2 (4400 cy C	G2020

Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
Project Finish 26SEP04

▭	Activity Bar/Early Dates
▬	Critical Activity
▭	Progress Bar
◇/⚑	Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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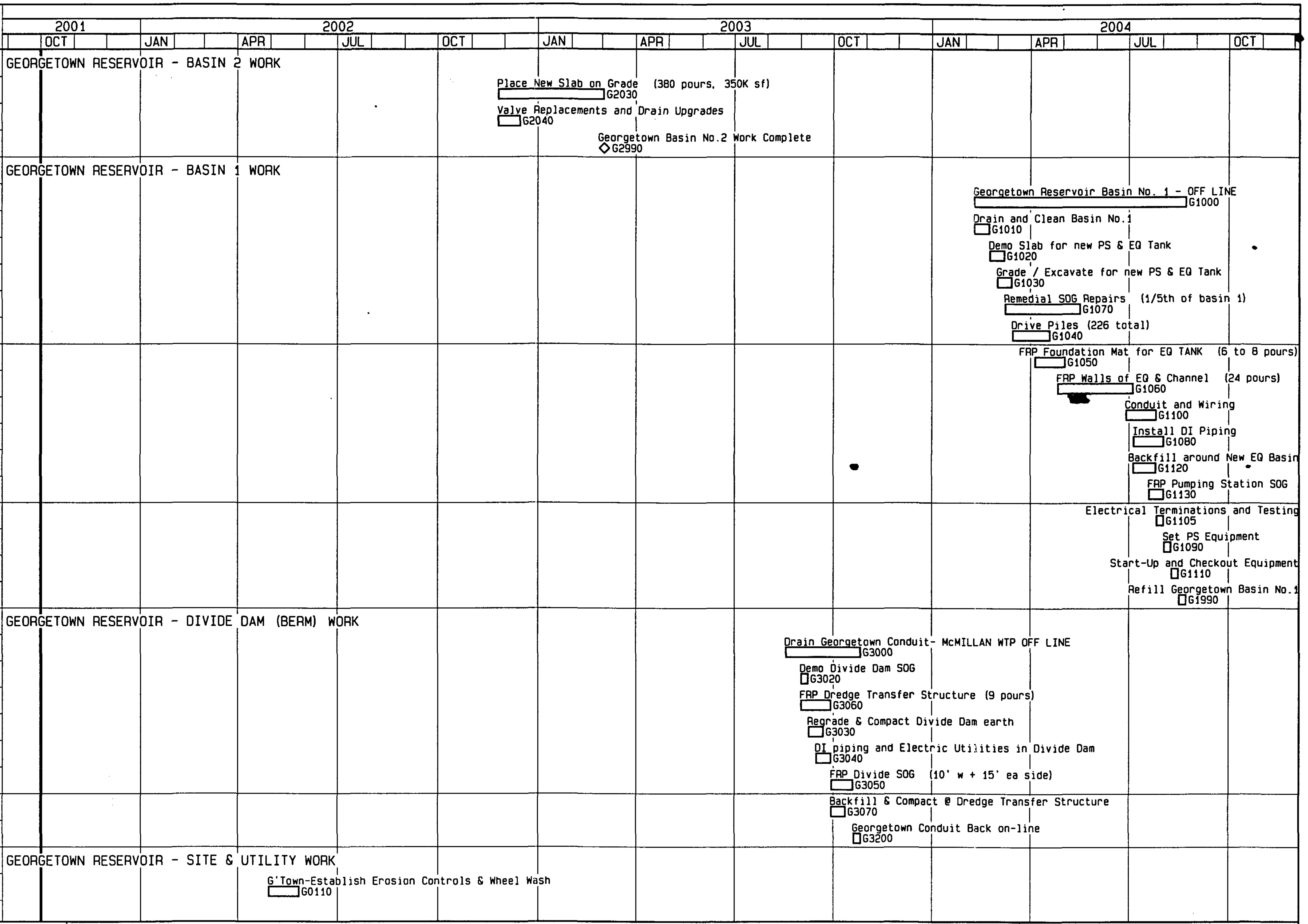
DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

Date	Revision	Checked	Approved

FIGURE 14.1-3

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

EARLY START	EARLY FINISH	ORIG DUR	MILE	
				GEORGETOWN RESERVOIR - BASIN 2 WORK
25NOV02	2MAR03	14		Place New Slab on Grade (380 pours, 350K sf) G2030
25NOV02	15DEC02	3		Valve Replacements and Drain Upgrades G2040
	2MAR03	0	M	Georgetown Basin No.2 Work Complete G2990
				GEORGETOWN RESERVOIR - BASIN 1 WORK
9FEB04	22AUG04	28	S	Georgetown Reservoir Basin No. 1 - OFF LINE G1000
9FEB04	22FEB04	2		Drain and Clean Basin No.1 G1010
23FEB04	7MAR04	2		Demo Slab for new PS & EQ Tank G1020
1MAR04	14MAR04	2		Grade / Excavate for new PS & EQ Tank G1030
8MAR04	16MAY04	10		Remedial SOG Repairs (1/5th of basin 1) G1070
15MAR04	18APR04	5		Drive Piles (226 total) G1040
5APR04	2MAY04	4		FRP Foundation Mat for EQ TANK (6 to 8 pours) G1050
26APR04	4JUL04	10		FRP Walls of EQ & Channel (24 pours) G1060
28JUN04	25JUL04	4		Conduit and Wiring G1100
5JUL04	1AUG04	4		Install DI Piping G1080
5JUL04	25JUL04	3		Backfill around New EQ Basin G1120
19JUL04	1AUG04	2		FRP Pumping Station SOG G1130
26JUL04	1AUG04	1		Electrical Terminations and Testing G1105
2AUG04	8AUG04	1		Set PS Equipment G1090
9AUG04	15AUG04	1		Start-Up and Checkout Equipment G1110
16AUG04	22AUG04	1	M	Refill Georgetown Basin No.1 G1990
				GEORGETOWN RESERVOIR - DIVIDE DAM (BERM) WORK
18AUG03	26OCT03	10	S	Drain Georgetown Conduit- McMILLAN WTP OFF LINE G3000
1SEP03	7SEP03	1		Demo Divide Dam SOG G3020
1SEP03	28SEP03	4		FRP Dredge Transfer Structure (9 pours) G3060
8SEP03	21SEP03	2		Regrade & Compact Divide Dam earth G3030
15SEP03	28SEP03	2		DI piping and Electric Utilities in Divide Dam G3040
29SEP03	19OCT03	3		FRP Divide SOG (10' w + 15' ea side) G3050
29SEP03	12OCT03	2		Backfill & Compact @ Dredge Transfer Structure G3070
20OCT03	26OCT03	1	M	Georgetown Conduit Back on-line G3200
				GEORGETOWN RESERVOIR - SITE & UTILITY WORK
29APR02	26MAY02	4		G'Town-Establish Erosion Controls & Wheel Wash G0110



Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
Project Finish 26SEP04

▭	Activity Bar/Early Dates
▬	Critical Activity
▭	Progress Bar
◇/▶	Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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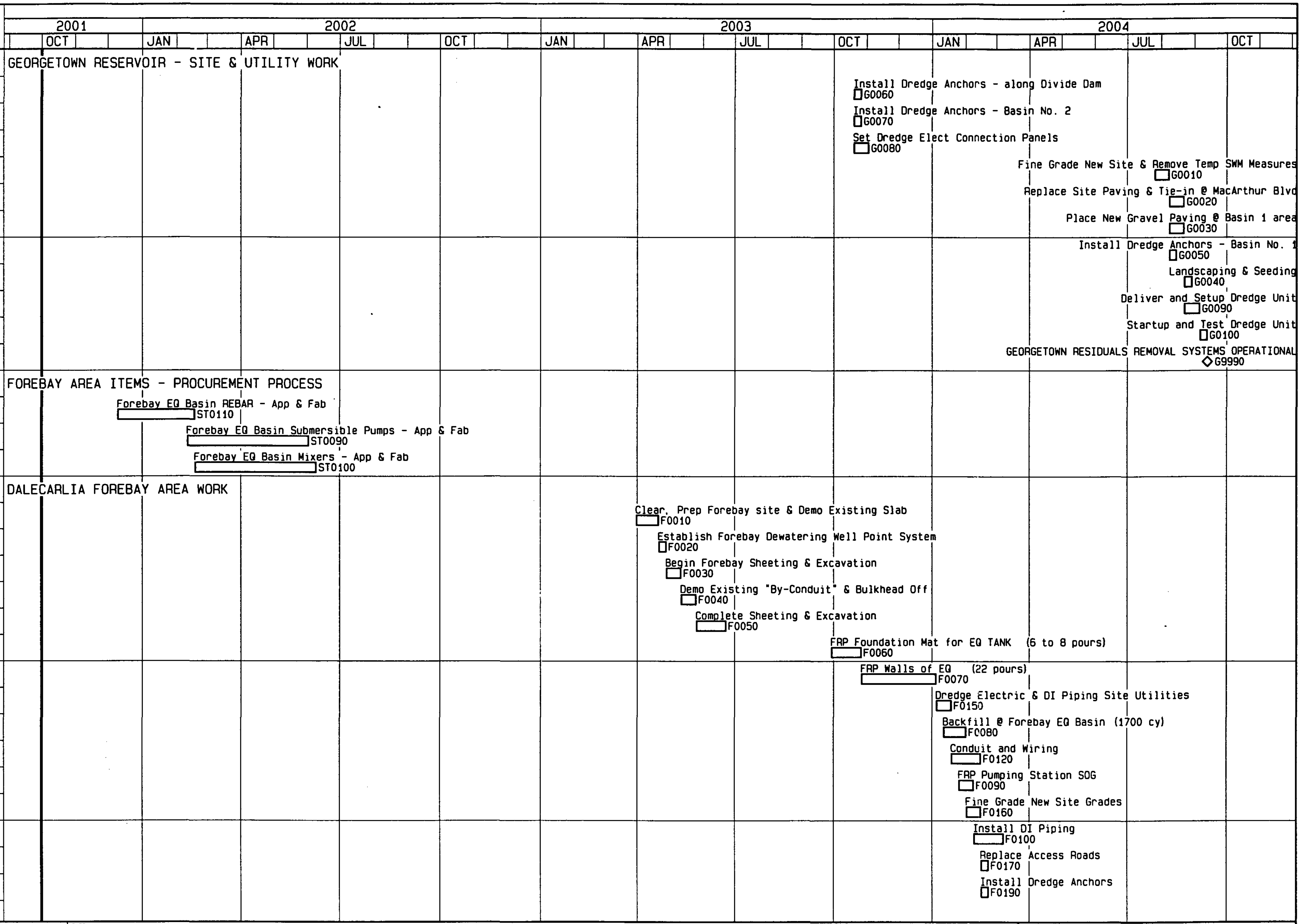
FIGURE 14.1-4

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

EARLY START	EARLY FINISH	ORIG DUR	MILE
20OCT03	26OCT03	1	
20OCT03	26OCT03	1	
20OCT03	2NOV03	2	
26JUL04	8AUG04	2	
9AUG04	22AUG04	2	
9AUG04	22AUG04	2	
9AUG04	15AUG04	1	
23AUG04	29AUG04	1	
23AUG04	5SEP04	2	
6SEP04	12SEP04	1	
	12SEP04	0	M
10DEC01	17FEB02	10	
11FEB02	2JUN02	16	
18FEB02	9JUN02	16	
31MAR03	20APR03	3	
21APR03	27APR03	1	
28APR03	11MAY03	2	
12MAY03	25MAY03	2	
26MAY03	22JUN03	4	
29SEP03	26OCT03	4	
27OCT03	4JAN04	10	
5JAN04	18JAN04	2	
12JAN04	1FEB04	3	
19JAN04	15FEB04	4	
26JAN04	8FEB04	2	
2FEB04	15FEB04	2	
9FEB04	7MAR04	4	
16FEB04	22FEB04	1	
16FEB04	22FEB04	1	



Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
Project Finish 26SEP04

▭	Activity Bar/Early Dates
▬	Critical Activity
▭	Progress Bar
◇ / ⚑	Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

Date	Revision	Checked	Approved

FIGURE 14.1-5

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

DALECARLIA FOREBAY AREA WORK

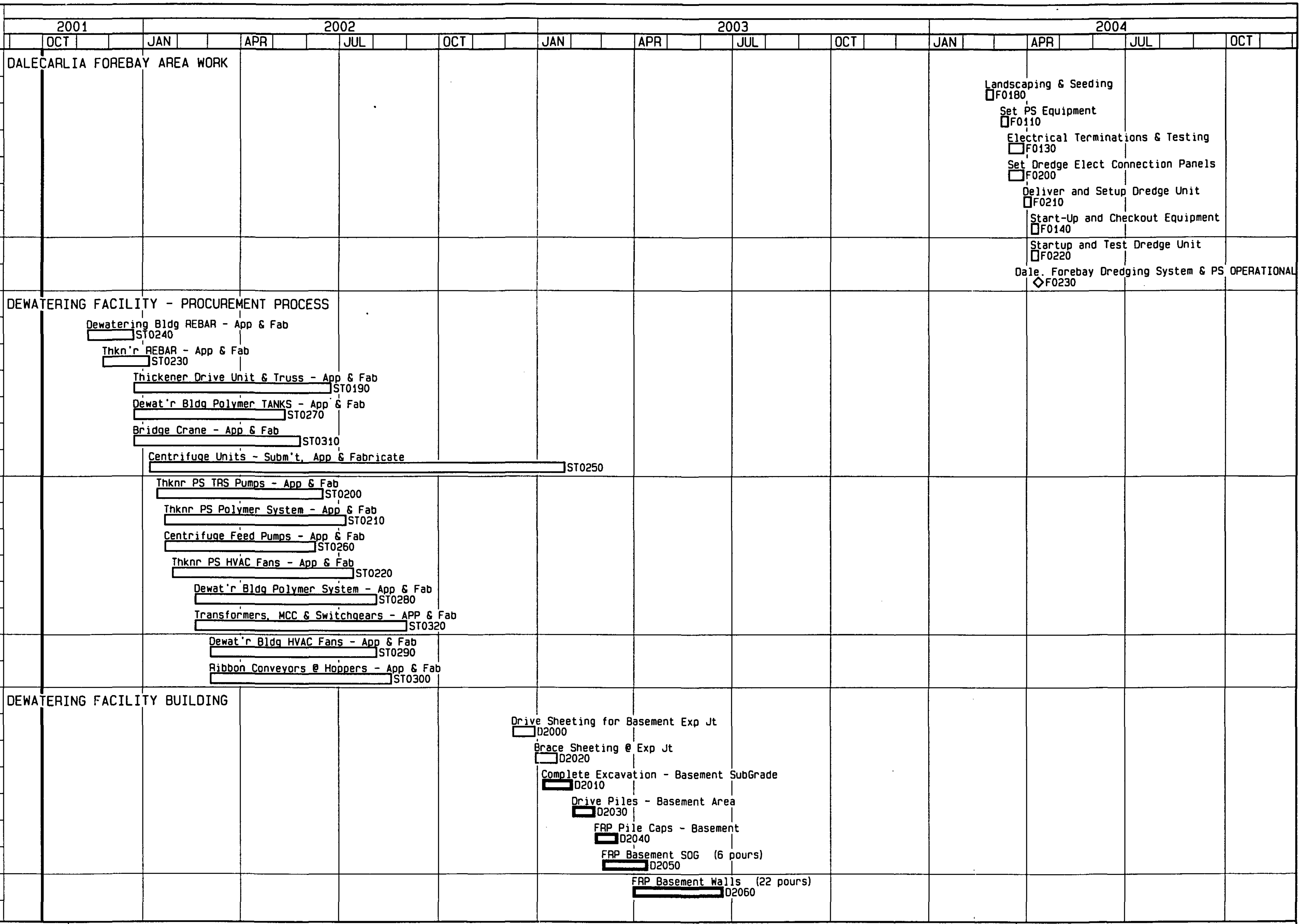
EARLY START	EARLY FINISH	ORIG DUR	MILE
23FEB04	29FEB04	1	
8MAR04	14MAR04	1	
15MAR04	28MAR04	2	
15MAR04	28MAR04	2	
29MAR04	4APR04	1	
5APR04	11APR04	1	
5APR04	11APR04	1	
12APR04	11APR04	0	M

DEWATERING FACILITY - PROCUREMENT PROCESS

EARLY START	EARLY FINISH	ORIG DUR	MILE
12NOV01	23DEC01	6	
26NOV01	6JAN02	6	
24DEC01	23JUN02	26	
24DEC01	12MAY02	20	
24DEC01	26MAY02	22	
7JAN02	26JAN03	55	
14JAN02	16JUN02	22	
21JAN02	7JUL02	24	
21JAN02	9JUN02	20	
28JAN02	14JUL02	24	
18FEB02	4AUG02	24	
18FEB02	1SEP02	28	
4MAR02	4AUG02	22	
4MAR02	18AUG02	24	

DEWATERING FACILITY BUILDING

EARLY START	EARLY FINISH	ORIG DUR	MILE
9DEC02	29DEC02	3	
30DEC02	19JAN03	3	
6JAN03	2FEB03	4	
3FEB03	23FEB03	3	
24FEB03	16MAR03	3	
3MAR03	13APR03	6	
31MAR03	22JUN03	12	



Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
Project Finish 26SEP04

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Activity Bar/Early Dates
Critical Activity
Progress Bar
◇/▷ Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

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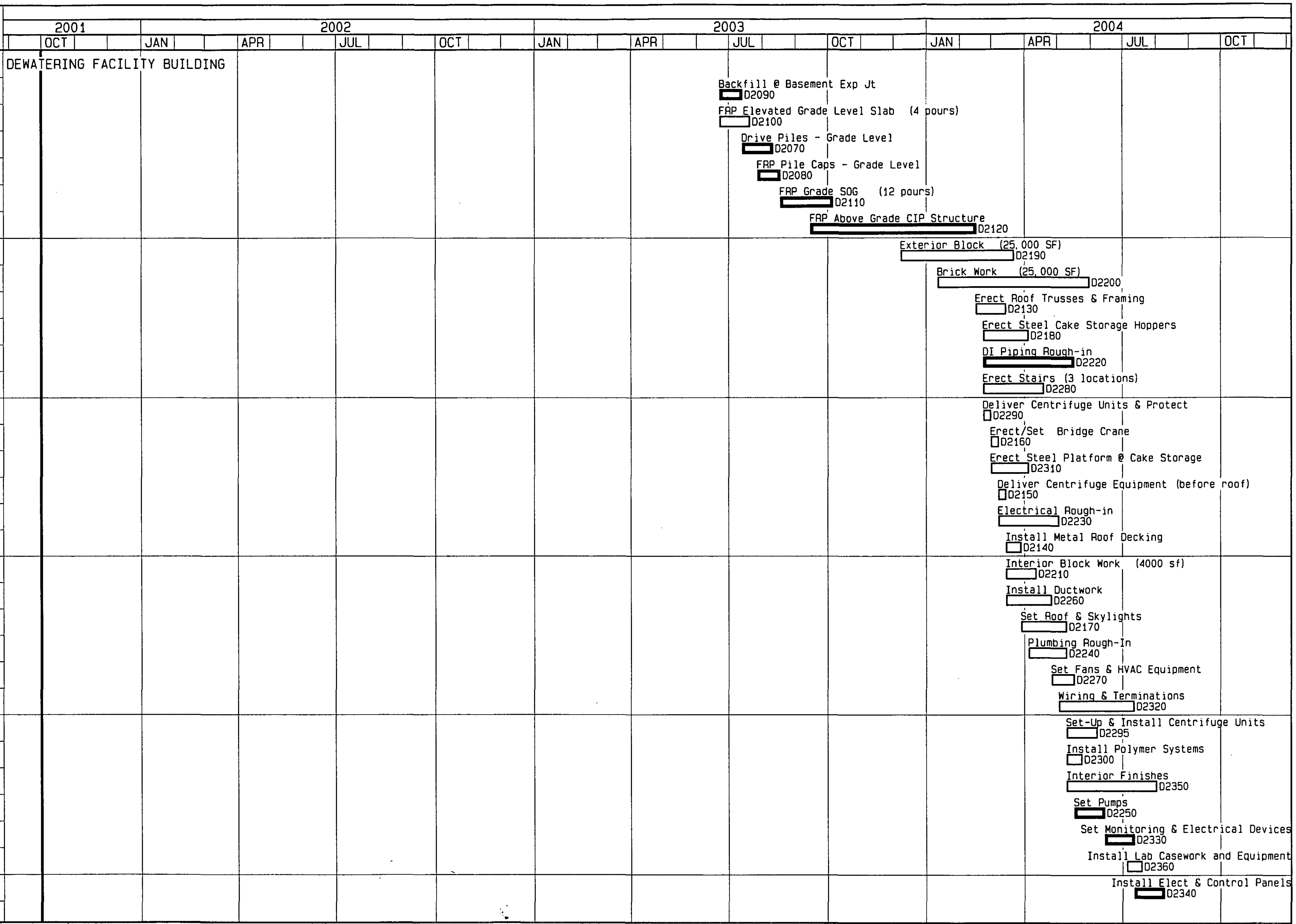
FIGURE 14.1-6

WR&A
WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

EARLY START	EARLY FINISH	ORIG DUR	MILE	
				DEWATERING FACILITY BUILDING
23JUN03	13JUL03	3		Backfill @ Basement Exp Jt D2090
23JUN03	20JUL03	4		FRP Elevated Grade Level Slab (4 pours) D2100
14JUL03	10AUG03	4		Drive Piles - Grade Level D2070
28JUL03	17AUG03	3		FRP Pile Caps - Grade Level D2080
18AUG03	5OCT03	7		FRP Grade SOG (12 pours) D2110
15SEP03	15FEB04	22		FRP Above Grade CIP Structure D2120
8DEC03	21MAR04	15		Exterior Block (25,000 SF) D2190
12JAN04	30MAY04	20		Brick Work (25,000 SF) D2200
16FEB04	14MAR04	4		Erect Roof Trusses & Framing D2130
23FEB04	4APR04	6		Erect Steel Cake Storage Hoppers D2180
23FEB04	16MAY04	12		DI Piping Rough-in D2220
23FEB04	18APR04	8		Erect Stairs (3 locations) D2280
23FEB04	29FEB04	1		Deliver Centrifuge Units & Protect D2290
1MAR04	7MAR04	1		Erect/Set Bridge Crane D2160
1MAR04	4APR04	5		Erect Steel Platform @ Cake Storage D2310
8MAR04	14MAR04	1		Deliver Centrifuge Equipment (before roof) D2150
8MAR04	2MAY04	8		Electrical Rough-in D2230
15MAR04	28MAR04	2		Install Metal Roof Decking D2140
15MAR04	11APR04	4		Interior Block Work (4000 sf) D2210
15MAR04	25APR04	6		Install Ductwork D2260
29MAR04	9MAY04	6		Set Roof & Skylights D2170
5APR04	9MAY04	5		Plumbing Rough-In D2240
26APR04	16MAY04	3		Set Fans & HVAC Equipment D2270
3MAY04	11JUL04	10		Wiring & Terminations D2320
10MAY04	6JUN04	4		Set-Up & Install Centrifuge Units D2295
10MAY04	23MAY04	2		Install Polymer Systems D2300
10MAY04	1AUG04	12		Interior Finishes D2350
17MAY04	13JUN04	4		Set Pumps D2250
14JUN04	11JUL04	4		Set Monitoring & Electrical Devices D2330
5JUL04	18JUL04	2		Install Lab Casework and Equipment D2360
12JUL04	8AUG04	4		Install Elect & Control Panels D2340



Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
Project Finish 26SEP04

▭	Activity Bar/Early Dates
▬	Critical Activity
▭	Progress Bar
◇/▸	Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

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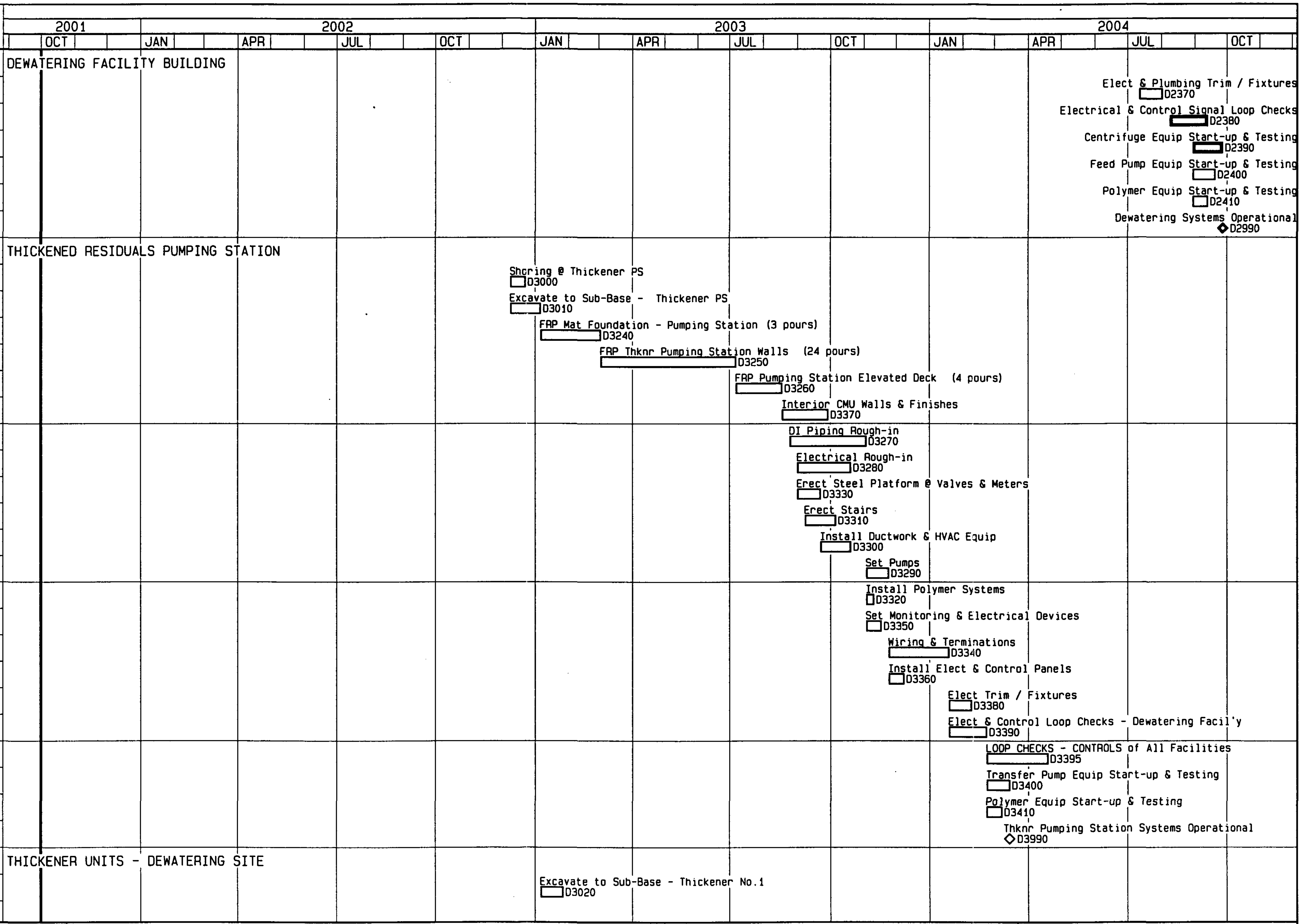
FIGURE 14.1-7

EARLY START	EARLY FINISH	ORIG DUR	MILE		
				DEWATERING FACILITY BUILDING	
12JUL04	1AUG04	3		Elect & Plumbing Trim / Fixtures	D2370
9AUG04	12SEP04	5		Electrical & Control Signal Loop Checks	D2380
30AUG04	26SEP04	4		Centrifuge Equip Start-up & Testing	D2390
30AUG04	19SEP04	3		Feed Pump Equip Start-up & Testing	D2400
30AUG04	12SEP04	2		Polymer Equip Start-up & Testing	D2410
27SEP04	26SEP04	0	M	Dewatering Systems Operational	D2990
				THICKENED RESIDUALS PUMPING STATION	
9DEC02	22DEC02	2		Shoring @ Thickener PS	D3000
9DEC02	5JAN03	4		Excavate to Sub-Base - Thickener PS	D3010
6JAN03	2MAR03	8		FRP Mat Foundation - Pumping Station (3 pours)	D3240
3MAR03	6JUL03	18		FRP Thknr Pumping Station Walls (24 pours)	D3250
7JUL03	17AUG03	6		FRP Pumping Station Elevated Deck (4 pours)	D3260
18AUG03	28SEP03	6		Interior CMU Walls & Finishes	D3370
25AUG03	2NOV03	10		DI Piping Rough-in	D3270
1SEP03	19OCT03	7		Electrical Rough-in	D3280
1SEP03	21SEP03	3		Erect Steel Platform @ Valves & Meters	D3330
8SEP03	5OCT03	4		Erect Stairs	D3310
22SEP03	19OCT03	4		Install Ductwork & HVAC Equip	D3300
3NOV03	23NOV03	3		Set Pumps	D3290
3NOV03	9NOV03	1		Install Polymer Systems	D3320
3NOV03	16NOV03	2		Set Monitoring & Electrical Devices	D3350
24NOV03	18JAN04	8		Wiring & Terminations	D3340
24NOV03	7DEC03	2		Install Elect & Control Panels	D3360
19JAN04	8FEB04	3		Elect Trim / Fixtures	D3380
19JAN04	22FEB04	5		Elect & Control Loop Checks - Dewatering Facil'y	D3390
23FEB04	18APR04	8		LOOP CHECKS - CONTROLS of All Facilities	D3395
23FEB04	14MAR04	3		Transfer Pump Equip Start-up & Testing	D3400
23FEB04	7MAR04	2		Polymer Equip Start-up & Testing	D3410
15MAR04	14MAR04	0	M	Thknr Pumping Station Systems Operational	D3990
				THICKENER UNITS - DEWATERING SITE	
6JAN03	26JAN03	3		Excavate to Sub-Base - Thickener No.1	D3020



Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
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▭	Activity Bar/Early Dates
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US ARMY COE-WASHINGTON AQUEDUCT DIV.
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DETAILED SCHEDULE by "SITE and AREA"

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DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

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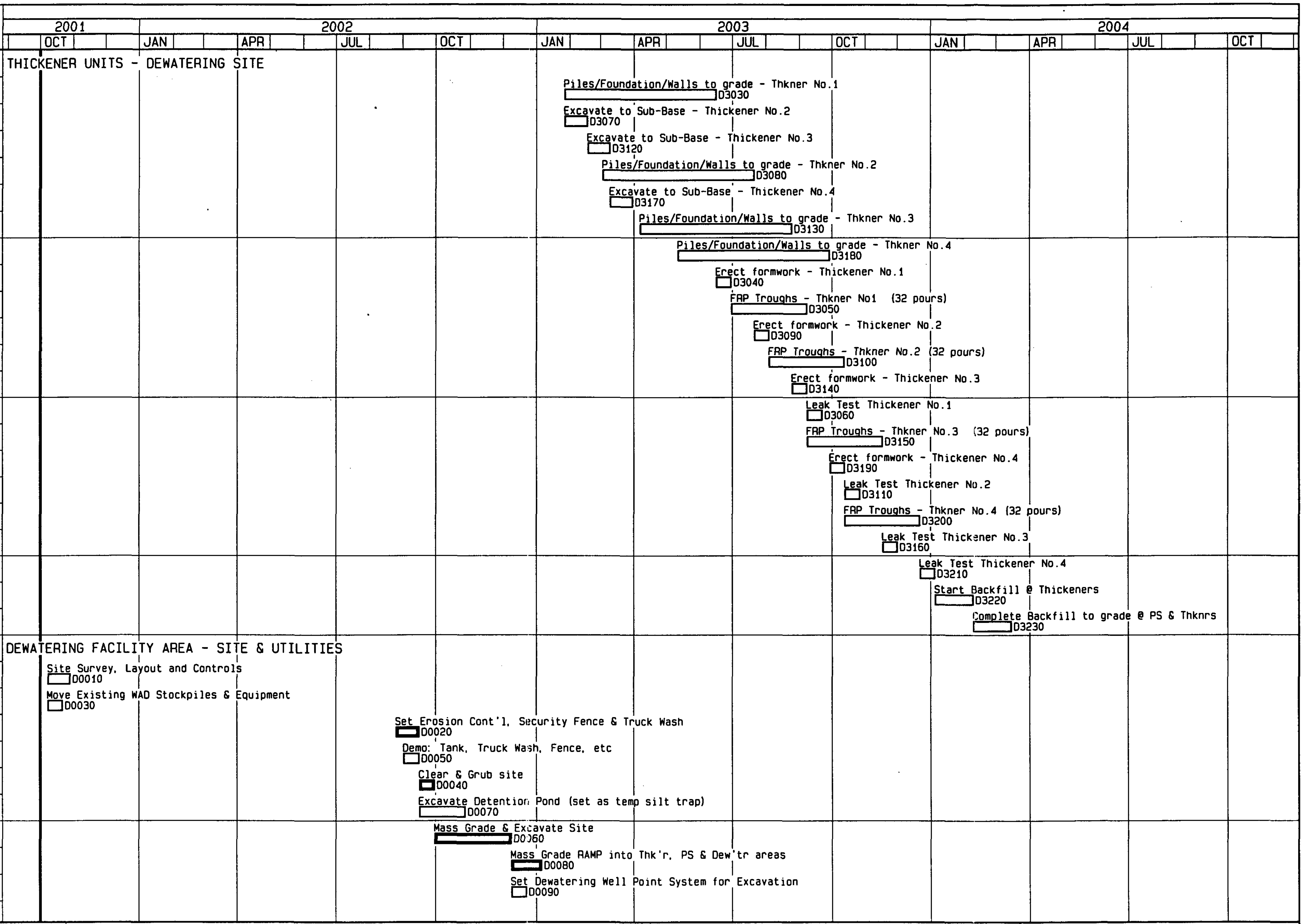
FIGURE 14.1-8

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

EARLY START	EARLY FINISH	ORIG DUR	MILE
27JAN03	15JUN03	20	
27JAN03	16FEB03	3	
17FEB03	9MAR03	3	
3MAR03	20JUL03	20	
10MAR03	30MAR03	3	
7APR03	24AUG03	20	
12MAY03	28SEP03	20	
16JUN03	29JUN03	2	
30JUN03	7SEP03	10	
21JUL03	3AUG03	2	
4AUG03	12OCT03	10	
25AUG03	7SEP03	2	
8SEP03	21SEP03	2	
8SEP03	16NOV03	10	
29SEP03	12OCT03	2	
13OCT03	26OCT03	2	
13OCT03	21DEC03	10	
17NOV03	30NOV03	2	
22DEC03	4JAN04	2	
5JAN04	8FEB04	5	
9FEB04	14MAR04	5	
8OCT01	28OCT01	3	
8OCT01	21OCT01	2	
26AUG02	15SEP02	3	
2SEP02	15SEP02	2	
16SEP02	29SEP02	2	
16SEP02	27OCT02	6	
30SEP02	8DEC02	10	
9DEC02	5JAN03	4	
9DEC02	22DEC02	2	



Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
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▭	Activity Bar/Early Dates
▬	Critical Activity
▭	Progress Bar
◇/▶	Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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Chapter 14

DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

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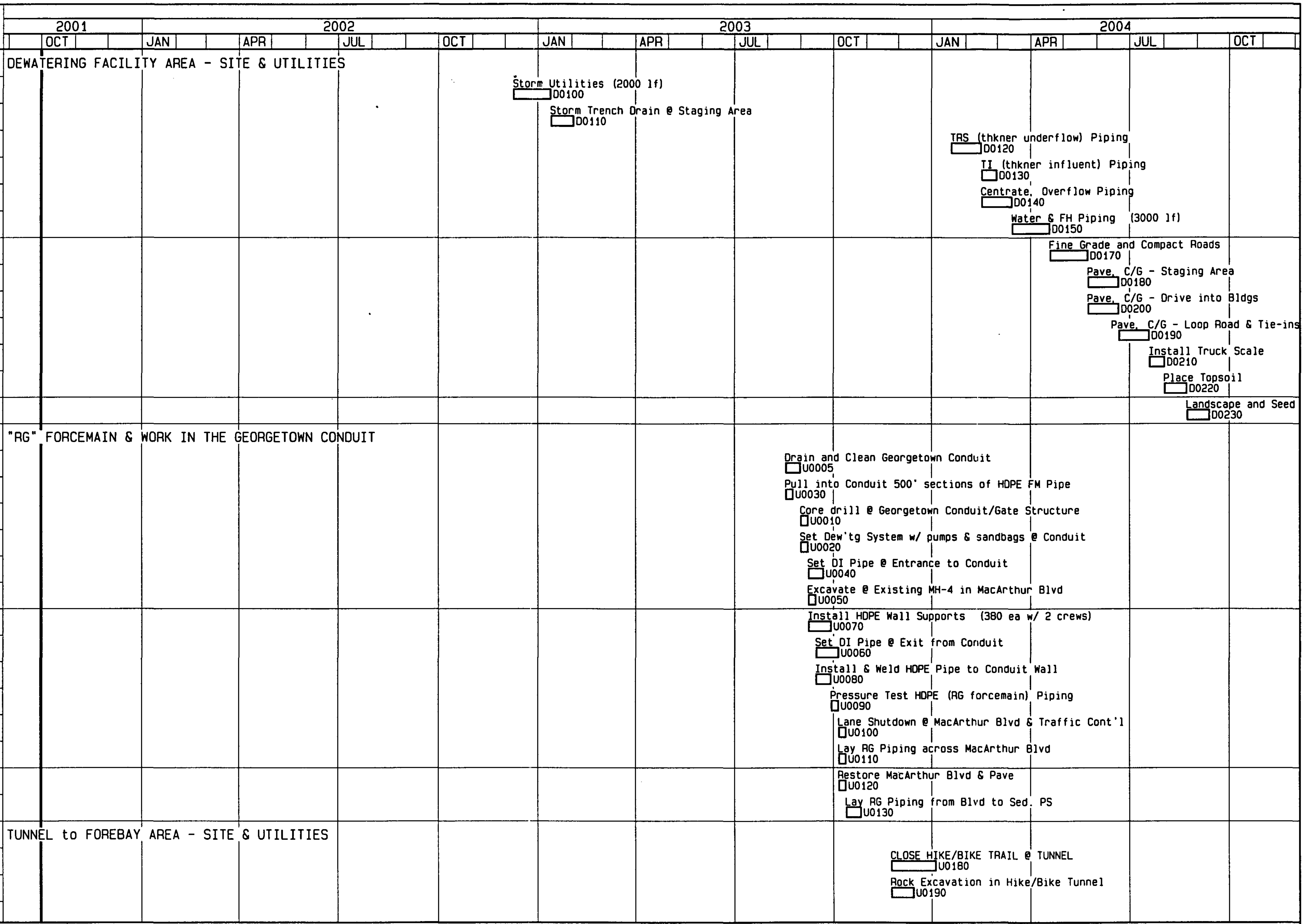
FIGURE 14.1-9

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners



EARLY START	EARLY FINISH	ORIG DUR	MILE		
				DEWATERING FACILITY AREA - SITE & UTILITIES	
9DEC02	12JAN03	5		Storm Utilities (2000 lf)	D0100
13JAN03	2FEB03	3		Storm Trench Drain @ Staging Area	D0110
19JAN04	15FEB04	4		TRS (thkner underflow) Piping	D0120
16FEB04	29FEB04	2		TI (thkner influent) Piping	D0130
16FEB04	14MAR04	4		Centrate, Overflow Piping	D0140
15MAR04	18APR04	5		Water & FH Piping (3000 lf)	D0150
19APR04	23MAY04	5		Fine Grade and Compact Roads	D0170
24MAY04	20JUN04	4		Pave, C/G - Staging Area	D0180
24MAY04	20JUN04	4		Pave, C/G - Drive into Bldgs	D0200
21JUN04	18JUL04	4		Pave, C/G - Loop Road & Tie-ins	D0190
19JUL04	1AUG04	2		Install Truck Scale	D0210
2AUG04	22AUG04	3		Place Topsoil	D0220
23AUG04	12SEP04	3		Landscape and Seed	D0230
				"RG" FORCEMAIN & WORK IN THE GEORGETOWN CONDUIT	
18AUG03	31AUG03	2		Drain and Clean Georgetown Conduit	U0005
18AUG03	24AUG03	1		Pull into Conduit 500' sections of HDPE FM Pipe	U0030
1SEP03	7SEP03	1		Core drill @ Georgetown Conduit/Gate Structure	U0010
1SEP03	7SEP03	1		Set Dew'tg System w/ pumps & sandbags @ Conduit	U0020
8SEP03	21SEP03	2		Set DI Pipe @ Entrance to Conduit	U0040
8SEP03	14SEP03	1		Excavate @ Existing MH-4 in MacArthur Blvd	U0050
8SEP03	28SEP03	3		Install HDPE Wall Supports (380 ea w/ 2 crews)	U0070
15SEP03	5OCT03	3		Set DI Pipe @ Exit from Conduit	U0060
15SEP03	28SEP03	2		Install & Weld HDPE Pipe to Conduit Wall	U0080
29SEP03	5OCT03	1		Pressure Test HDPE (RG forcemain) Piping	U0090
6OCT03	12OCT03	1	S	Lane Shutdown @ MacArthur Blvd & Traffic Cont'l	U0100
6OCT03	12OCT03	1		Lay RG Piping across MacArthur Blvd	U0110
6OCT03	12OCT03	1		Restore MacArthur Blvd & Pave	U0120
13OCT03	26OCT03	2		Lay RG Piping from Blvd to Sed. PS	U0130
				TUNNEL to FOREBAY AREA - SITE & UTILITIES	
24NOV03	4JAN04	6	S	CLOSE HIKE/BIKE TRAIL @ TUNNEL	U0180
24NOV03	14DEC03	3		Rock Excavation in Hike/Bike Tunnel	U0190

Plot Date 1NOV96
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▭	Activity Bar/Early Dates
▬	Critical Activity
▭	Progress Bar
◇ / ▶	Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

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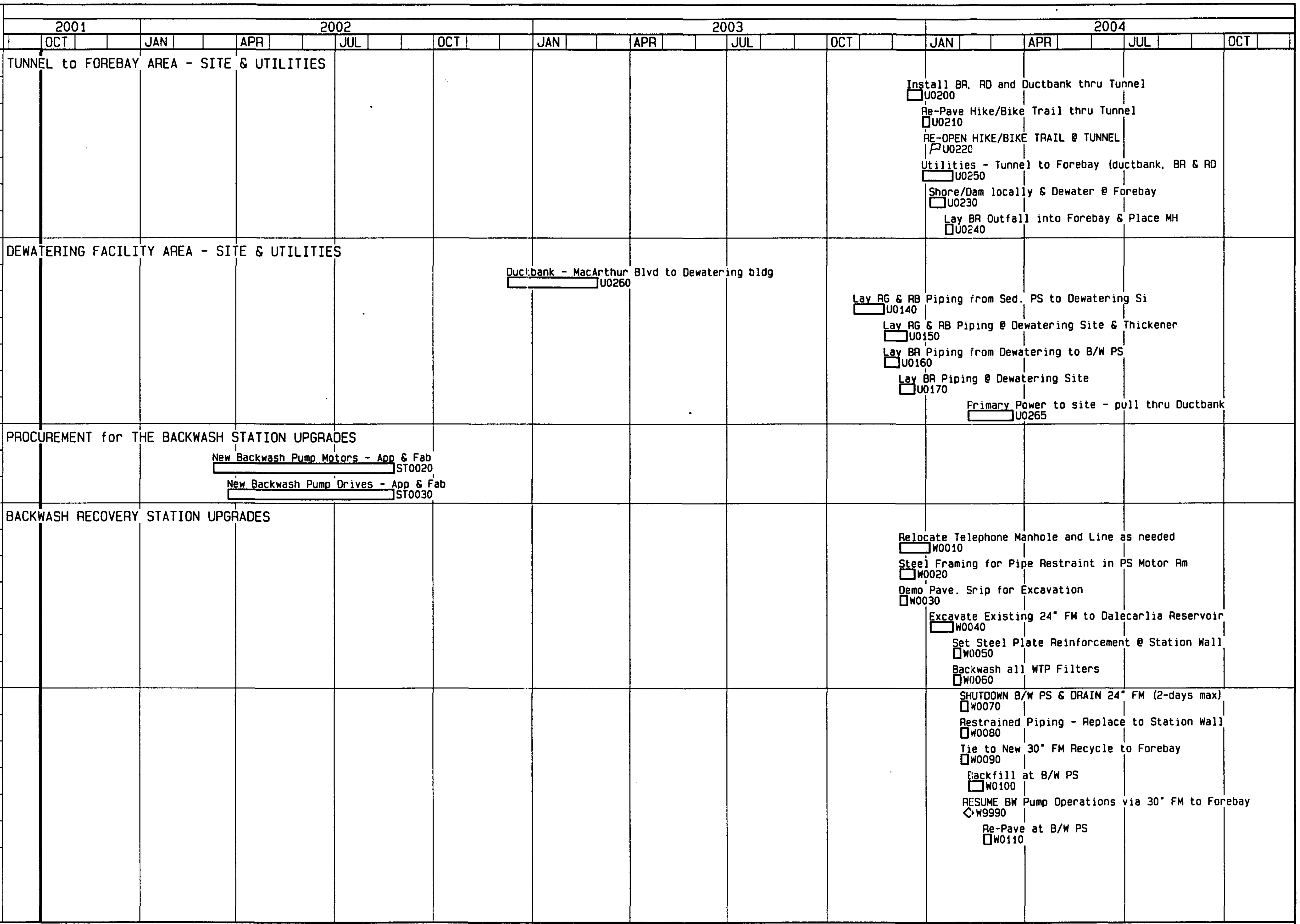
Chapter 14

FIGURE 14.1-10

WR&A
WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners



EARLY START	EARLY FINISH	ORIG DUR	MILE		
				TUNNEL to FOREBAY AREA - SITE & UTILITIES	
15DEC03	28DEC03	2		Install BR, RD and Ductbank thru Tunnel	U0200
29DEC03	4JAN04	1		Re-Pave Hike/Bike Trail thru Tunnel	U0210
	4JAN04	0	M	RE-OPEN HIKE/BIKE TRAIL @ TUNNEL	U0220
29DEC03	25JAN04	4		Utilities - Tunnel to Forebay (ductbank, BR & RD	U0250
5JAN04	18JAN04	2		Shore/Dam locally & Dewater @ Forebay	U0230
19JAN04	25JAN04	1		Lay BR Outfall into Forebay & Place MH	U0240
				DEWATERING FACILITY AREA - SITE & UTILITIES	
9DEC02	2MAR03	12		Ductbank - MacArthur Blvd to Dewatering bldg	U0260
27OCT03	23NOV03	4		Lay RG & RB Piping from Sed. PS to Dewatering Si	U0140
24NOV03	14DEC03	3		Lay RG & RB Piping @ Dewatering Site & Thickener	U0150
24NOV03	7DEC03	2		Lay BR Piping from Dewatering to B/W PS	U0160
8DEC03	21DEC03	2		Lay BR Piping @ Dewatering Site	U0170
9FEB04	21MAR04	6		Primary Power to site - pull thru Ductbank	U0265
				PROCUREMENT for THE BACKWASH STATION UPGRADES	
11MAR02	25AUG02	24		New Backwash Pump Motors - App & Fab	ST0020
25MAR02	25AUG02	22		New Backwash Pump Drives - App & Fab	ST0030
				BACKWASH RECOVERY STATION UPGRADES	
8DEC03	4JAN04	4		Relocate Telephone Manhole and Line as needed	W0010
8DEC03	21DEC03	2		Steel Framing for Pipe Restraint in PS Motor Rm	W0020
8DEC03	14DEC03	1		Demo Pave. Srip for Excavation	W0030
5JAN04	25JAN04	3		Excavate Existing 24" FM to Dalecarlia Reservoir	W0040
26JAN04	1FEB04	1		Set Steel Plate Reinforcement @ Station Wall	W0050
26JAN04	1FEB04	1	M	Backwash all WTP Filters	W0060
2FEB04	8FEB04	1	S	SHUTDOWN B/W PS & DRAIN 24" FM (2-days max)	W0070
2FEB04	8FEB04	1		Restrained Piping - Replace to Station Wall	W0080
2FEB04	8FEB04	1		Tie to New 30" FM Recycle to Forebay	W0090
9FEB04	22FEB04	2		Backfill at B/W PS	W0100
9FEB04	8FEB04	0	M	RESUME BW Pump Operations via 30" FM to Forebay	W9990
23FEB04	29FEB04	1		Re-Pave at B/W PS	W0110

Plot Date 1NOV96
Data Date 1OCT01
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▭	Activity Bar/Early Dates
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▭	Progress Bar
◇/⚑	Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
DETAILED SCHEDULE by "SITE and AREA"

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DESIGN MEMO - PRELIMINARY CONSTRUCTION SCHEDULE

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FIGURE 14.1-11

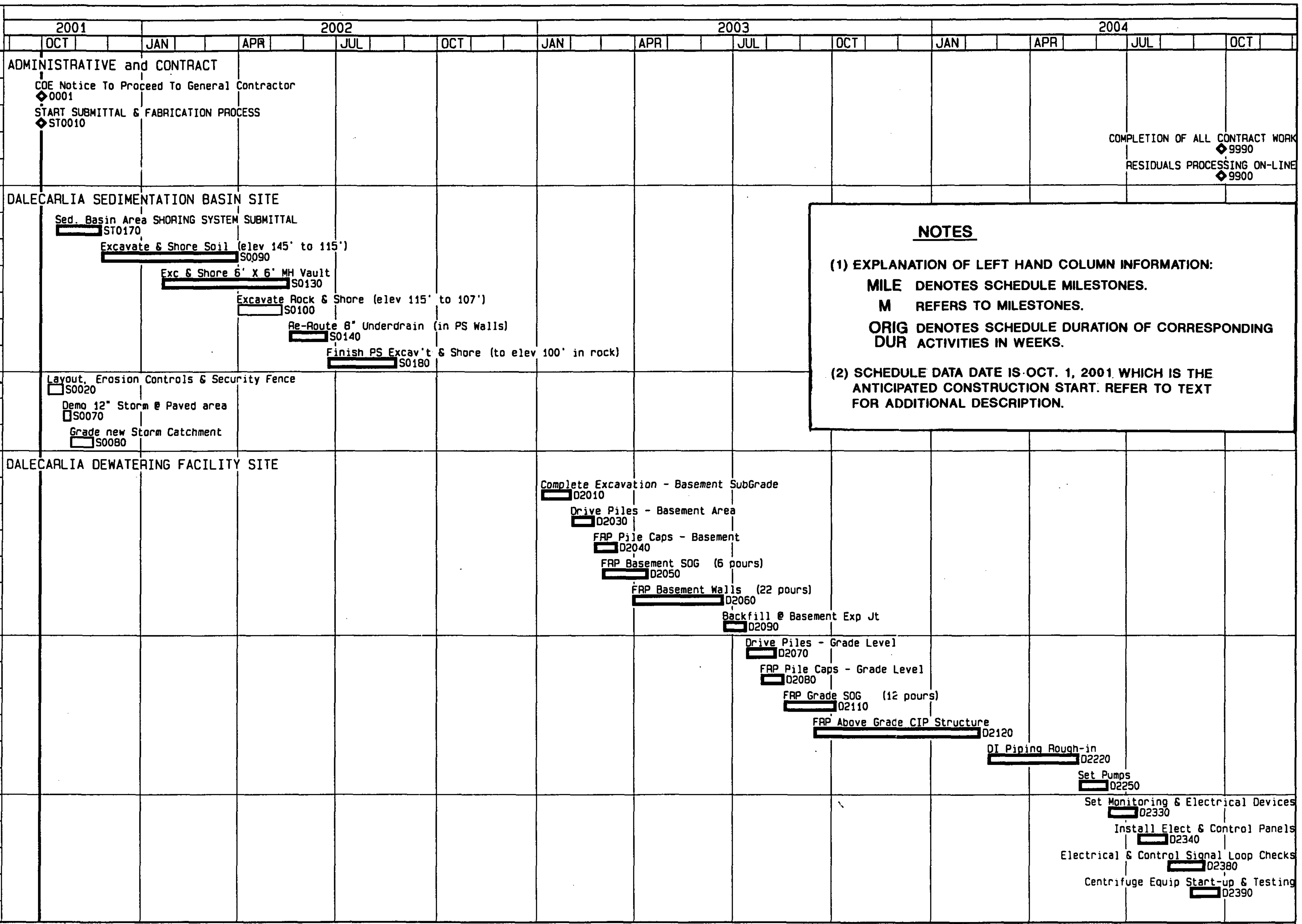
WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

SECTION 14 - SCHEDULES
DESIGN MEMORANDUM - BOOK 1 OF 5

14.3 CRITICAL PATH SCHEDULE, DETAILS

This schedule provides all the details of only the critical path work activitites which comprise the 36-month construction period. Organization is by AREA, by SITE.

EARLY START	EARLY FINISH	ORIG DUR	MILE
1OCT01	30SEP01	0	M
1OCT01		0	
	26SEP04	0	M
27SEP04	26SEP04	0	M
15OCT01	25NOV01	6	
26NOV01	31MAR02	18	
21JAN02	19MAY02	17	
1APR02	12MAY02	6	
20MAY02	23JUN02	5	
24JUN02	25AUG02	9	
8OCT01	21OCT01	2	
22OCT01	28OCT01	1	
29OCT01	18NOV01	3	
6JAN03	2FEB03	4	
3FEB03	23FEB03	3	
24FEB03	16MAR03	3	
3MAR03	13APR03	6	
31MAR03	22JUN03	12	
23JUN03	13JUL03	3	
14JUL03	10AUG03	4	
28JUL03	17AUG03	3	
18AUG03	5OCT03	7	
15SEP03	15FEB04	22	
23FEB04	16MAY04	12	
17MAY04	13JUN04	4	
14JUN04	11JUL04	4	
12JUL04	8AUG04	4	
9AUG04	12SEP04	5	
30AUG04	26SEP04	4	



NOTES

(1) EXPLANATION OF LEFT HAND COLUMN INFORMATION:

MILE	DENOTES SCHEDULE MILESTONES.
M	REFERS TO MILESTONES.
ORIG DUR	DENOTES SCHEDULE DURATION OF CORRESPONDING ACTIVITIES IN WEEKS.

(2) SCHEDULE DATA DATE IS OCT. 1, 2001 WHICH IS THE ANTICIPATED CONSTRUCTION START. REFER TO TEXT FOR ADDITIONAL DESCRIPTION.

Plot Date 1NOV96
Data Date 1OCT01
Project Start 27AUG01
Project Finish 26SEP04

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
CRITICAL PATH SCHEDULE - DETAILS

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Chapter 14

PRELIMINARY DESIGN - CONSTRUCTION SCHEDULE

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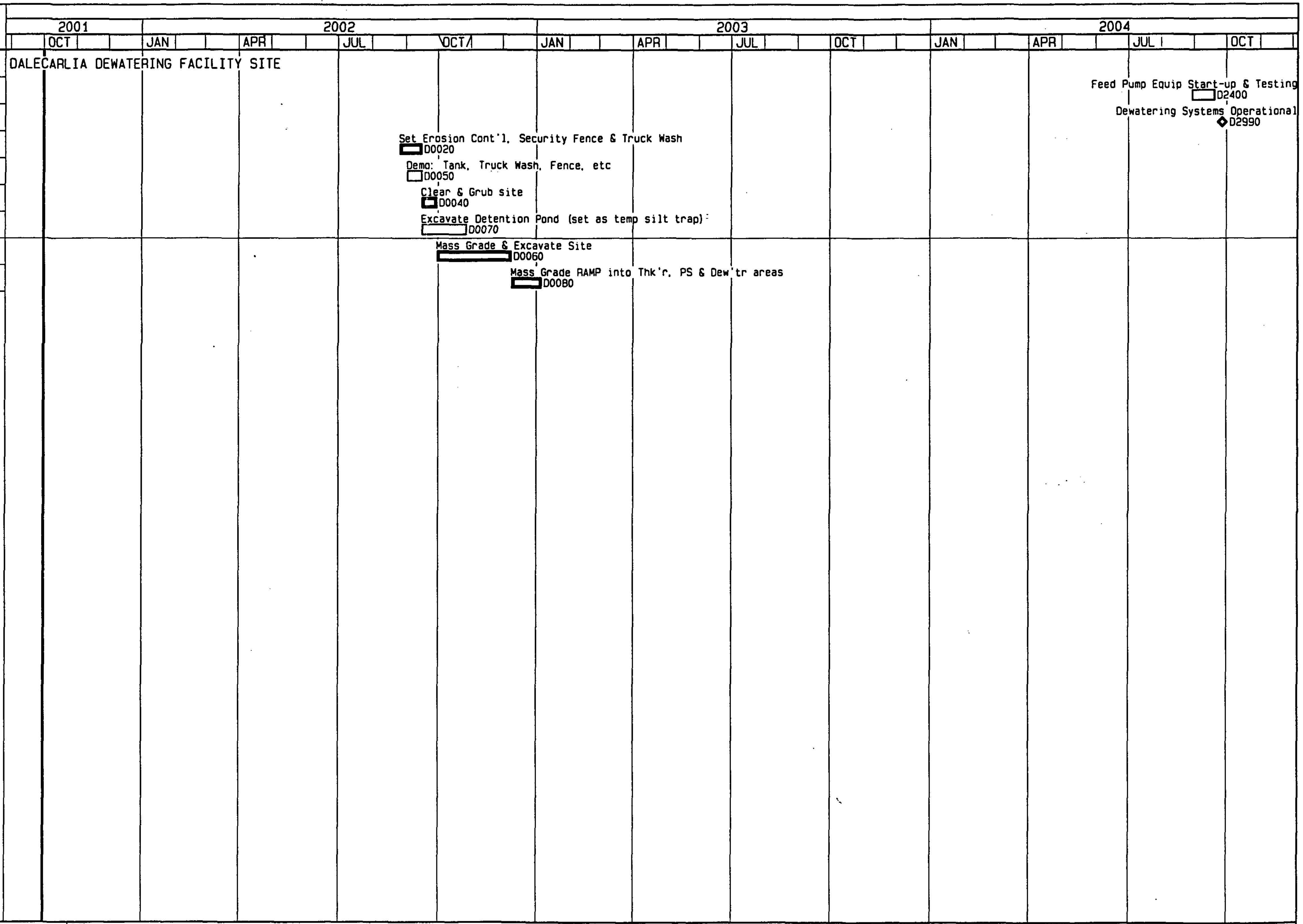
FIGURE 14.2-1

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

DALECARLIA DEWATERING FACILITY SITE

EARLY START	EARLY FINISH	ORIG DUR	MILE	
30AUG04	19SEP04	3		Feed Pump Equip Start-up & Testing D2400
27SEP04	26SEP04	0	M	Dewatering Systems Operational D2990
26AUG02	15SEP02	3		Set Erosion Cont'l, Security Fence & Truck Wash D0020
2SEP02	15SEP02	2		Demo: Tank, Truck Wash, Fence, etc D0050
16SEP02	29SEP02	2		Clear & Grub site D0040
16SEP02	27OCT02	6		Excavate Detention Pond (set as temp silt trap) D0070
30SEP02	8DEC02	10		Mass Grade & Excavate Site D0060
9DEC02	5JAN03	4		Mass Grade RAMP into Thk'r, PS & Dew'tr areas D0080



Plot Date 1NOV96
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▭	Activity Bar/Early Dates
▬	Critical Activity
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US ARMY COE-WASHINGTON AQUEDUCT DIV.
RESIDUALS COLLECTION and TREATMENT
CRITICAL PATH SCHEDULE - DETAILS

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Chapter 14

PRELIMINARY DESIGN - CONSTRUCTION SCHEDULE

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FIGURE 14.2-2

WHITMAN, REQUARDT AND ASSOCIATES
Engineers and Planners

APPENDIX A

APPENDIX A

EXCERPT FROM SAFE DRINKING WATER ACT AMENDMENTS OF 1996

TITLE III. MISCELLANEOUS PROVISIONS

SEC. 306. WASHINGTON AQUEDUCT.

(a) DEFINITIONS- In this section:

(1) NON-FEDERAL PUBLIC WATER SUPPLY CUSTOMER- The terms `non-Federal public water supply customer' and `customer' mean--

(A) the District of Columbia;

(B) Arlington County, Virginia; and

(C) the city of Falls Church, Virginia.

(2) SECRETARY- The term `Secretary' means the Secretary of the Army, acting through the Chief of Engineers.

(3) VALUE TO THE GOVERNMENT- The term `value to the Government' means the net present value of a contract entered into under subsection (e)(2), calculated in accordance with subparagraphs (A) and (B) of section 502(5) of the Congressional Budget Act of 1974 (2 U.S.C. 66la(5)), other than section 502(5)(B)(I) of the Act, as though the contract provided for repayment of a direct loan to a customer.

(4) WASHINGTON AQUEDUCT- The term `Washington Aqueduct' means the Washington Aqueduct facilities and related facilities owned by the Federal Government as of the date of enactment of this Act, including--

(A) the dams, intake works, conduits, and pump stations that capture and transport raw water from the Potomac River to the Dalecarlia Reservoir;

(B) the infrastructure and appurtenances used to treat water taken from the Potomac River to potable standards; and

(C) related water distribution facilities.

(b) REGIONAL ENTITY-

(1) IN GENERAL- The Congress encourages and grants consent to the customers to establish a non-Federal public or private entity, or to enter into an agreement with an existing non-Federal public or private entity, to--

(A) receive title to the Washington Aqueduct; and

(B) operate, maintain, and manage the Washington Aqueduct in a manner that adequately represents all interests of its customers.

(2) CONSIDERATION- If an entity receiving title to the Washington Aqueduct is not composed entirely of non-Federal public water supply customers, the entity shall consider the customers' historical provision of equity for the Aqueduct.

(3) PRIORITY ACCESS- The customers shall have priority access to any water produced by the Washington Aqueduct.

(4) CONSENT OF THE CONGRESS- The Congress grants consent to the customers to enter into any interstate agreement or compact required to carry out this section.

(5) STATUTORY CONSTRUCTION- This section shall not preclude the customers from pursuing any option regarding ownership, operation, maintenance, and management of the Washington Aqueduct.

(c) PROGRESS REPORT AND PLAN- Not later than 1 year after the date of enactment of this Act, the Secretary shall report to the Committee on Environment and Public Works of the Senate and the Committee on Transportation and Infrastructure of the House of Representatives on any progress in achieving the objectives of subsection (b)(1) and shall submit a plan for the transfer of ownership, operation, maintenance, and management of the Washington Aqueduct to a non-Federal public or private entity. Such plan shall include a detailed consideration of any proposal to transfer such ownership, maintenance, or management to a private entity.

(d) TRANSFER-

(1) IN GENERAL- Subject to subsection (b)(2), the other provisions of this subsection, and any other terms and conditions the Secretary considers appropriate to protect the interests of the United States, the Secretary shall, not later than 3 years after the date of enactment of this Act and with the consent of a majority of the customers and without consideration to the Federal Government, transfer all right, title, and interest of the United States in the Washington Aqueduct, and its real property, facilities, and personalty, to a non-Federal, public or private entity. Approval of such transfer shall not be unreasonably withheld by the Secretary.

(2) ADEQUATE CAPABILITIES- The Secretary shall transfer ownership of the Washington Aqueduct under paragraph (1) only if the Secretary determines, after opportunity for public input, that the entity to receive ownership of the Aqueduct has the technical, managerial, and financial capability to operate, maintain, and manage the Aqueduct.

(3) RESPONSIBILITIES- The Secretary shall not transfer title under this subsection unless the entity to receive title assumes full responsibility for performing and financing the operation, maintenance, repair, replacement, rehabilitation, and necessary capital improvements of the Washington Aqueduct so as to ensure the continued operation of the Washington Aqueduct consistent with the Aqueduct's intended purpose of providing an uninterrupted supply of potable water sufficient to meet the current and future needs of the Aqueduct's service area.

(e) BORROWING AUTHORITY-

(1) BORROWING-

(A) IN GENERAL- Subject to the other provisions of this paragraph and paragraph (2), the Secretary is authorized to borrow from the Treasury of the United States such amounts for fiscal years 1997, 1998, and 1999 as are sufficient to cover any obligations that the Army Corps of Engineers is required to incur in carrying out capital improvements during fiscal years 1997, 1998, and 1999 for the Washington Aqueduct to ensure continued operation of the Aqueduct until such time as a transfer of title to the Aqueduct has taken place.

(E) LIMITATION- The amount borrowed by the Secretary under subparagraph (A) may not exceed $29,000,000 for fiscal year 1997, $24,000,000 for fiscal year 1998, and $22,000,000 for fiscal year 1999.

(C) AGREEMENT- Amounts borrowed under subparagraph (A) may only be used for capital improvements agreed to by the Army Corps of Engineers and the customers.

(D) TERMS OF BORROWING-

(i) IN GENERAL- The Secretary of the Treasury shall provide the funds borrowed under subparagraph (A) under such terms and conditions as the Secretary of Treasury determines to be necessary and in the public interest and subject to the contracts required under paragraph (2).

(ii) TERM- The term of any loan made under subparagraph (A) shall be for a period of not less than 20 years.

(iii) PREPAYMENT- There shall be no penalty for the prepayment of any amounts borrowed under subparagraph (A).

(2) CONTRACTS WITH CUSTOMERS-

(A) IN GENERAL- The borrowing authority under paragraph (1)(A) shall be effective only after the Chief of Engineers has entered into contracts with each customer under which the customer commits to repay a pro rata share (based on water purchase) of the principal and interest owed by the Secretary to the Secretary of the Treasury under paragraph (1).

(B) PREPAYMENT- Any customer may repay, at any time, the pro rata share of the principal and interest then owed by the customer and outstanding, or any portion thereof, without penalty.

(C) RISK OF DEFAULT- Under each of the contracts, the customer that enters into the contract shall commit to pay any additional amount necessary to fully offset the risk of default on the contract.

(D) OBLIGATIONS- Each contract under subparagraph (A) shall include such terms and conditions as the Secretary of the Treasury may require so that the value to the Government of the contracts entered into under subparagraph (A) is estimated to be equal to the obligations of the Army Corps of Engineers for carrying out capital improvements at the Washington Aqueduct at the time that each series of contracts is entered into.

(E) OTHER CONDITIONS- Each contract entered into under subparagraph (A) shall--

(i) provide that the customer pledges future income only from fees assessed for principal and interest payments required by such contracts and costs to operate and maintain the Washington Aqueduct;

(ii) provide the United States priority in regard to income from fees assessed to operate and maintain the Washington Aqueduct; and

(iii) include other conditions consistent with this section that the Secretary of the Treasury determines to be appropriate.

(3) LIMITATIONS-

(A) BORROWING AUTHORITY- The Secretary's borrowing authority for making capital improvements at the Washington Aqueduct under paragraph (1) shall not extend beyond fiscal year 1999.

(B) OBLIGATION AUTHORITY- Upon expiration of the borrowing authority exercised under paragraph (1), the Secretary shall not obligate funds for making capital improvements at the Washington Aqueduct except funds which are provided in advance by the customers. This limitation does not affect the Secretary's authority to conduct normal operation and maintenance activities, including minor repair and replacement work.

(4) IMPACT ON IMPROVEMENT PROGRAM- Not later than 180 days after the date of enactment of this Act, the Secretary, in consultation with other Federal agencies, shall transmit to the Committee on Environment and Public Works of the Senate and the Committee on Transportation and Infrastructure of the House of Representatives a report that assesses the impact of the borrowing authority provided under this subsection on the near-term improvement projects in the Washington Aqueduct Improvement Program, work scheduled, and the financial liability to be incurred.

(f) REISSUANCE OF NPDES PERMIT- Prior to reissuing a National Pollutant Discharge Elimination System (NPDES) permit for the Washington Aqueduct, the Administrator of the Environmental Protection Agency shall consult with the customers and the Secretary regarding opportunities for more efficient water facility configurations that might be achieved through various possible transfers of the Washington Aqueduct. Such consultation shall include specific consideration of concerns regarding a proposed solids recovery facility, and may include a public hearing.

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