

**VOLUME 1
TABLE OF CONTENTS**

EXECUTIVE SUMMARY

ES.1	Utility System Overview	ES-2
ES.1.1	Water System	ES-2
ES.1.2	Wastewater System	ES-4
ES.1.3	Existing Utility System Condition	ES-7
ES.1.4	Existing Utility System Performance	ES-7
ES.2	Planning Considerations	ES-7
ES.2.1	Service Levels	ES-7
ES.2.2	Population and Land Use Forecasts	ES-8
ES.2.3	Regulatory Issues	ES-8
ES.2.4	Water System Considerations	ES-8
ES.2.5	Wastewater System Considerations	ES-8
ES.3	Capital Improvement Program	ES-9
ES.4	Financial Program	ES-10
Exhibit ES-1	Capital Improvement Program – Base Case	ES-11

VOLUME 1 BACKGROUND SUMMARY

CHAPTER 1 – BACKGROUND

1.1	Introduction	1-1
1.1.1	Project Goals	1-1
1.1.2	Project Approach and Scope	1-1
1.1.3	Key Implementation Steps	1-5
1.2	Plan Development	1-5
1.2.1	Project Kickoff Meetings	1-5
1.2.2	Selection of Planning Committee	1-5
1.3	Conclusions	1-7

CHAPTER 2 – PLANNING REQUIREMENTS

2.1	Introduction	2-1
2.2	Stipulated Order	2-1
2.3	Resource Constraints	2-3
2.3.1	Personnel Constraints	2-3
2.3.2	Financial Constraints	2-3
2.3.3	Material Constraints	2-3
2.3.4	Summary	2-4

2.4	Preliminary Assessment of Affordability	2-4
2.4.1	Financial Situation and Master Plan Implications	2-4
2.4.2	Affordability and Rate Increases	2-5
2.5	Other Requirements	2-6
2.5.1	GWA Governance	2-6
2.5.2	Privatization	2-6
2.5.3	Changing Environmental Regulations	2-6
2.6	Conclusions	2-7
2.7	Recommendations	2-7
2.8	CIP Impacts	2-7

CHAPTER 3 – ORGANIZATION ASSESSMENT

3.1	Introduction	3-1
3.2	Current Organization	3-1
3.2.1	Peer Review Task Observations	3-2
3.2.2	2004 Hunter Water Australia Report Findings	3-3
3.2.3	Comprehensive Performance Evaluation Observations	3-4
3.2.3.1	2002 CPE's	3-4
3.2.3.2	2004 CPE's	3-4
3.2.4	EPA Stipulated Order and Quarterly Report Summaries	3-5
3.2.5	Outside Consultant Training Activities	3-5
3.3	Organization Improvement Opportunities	3-5
3.4	Internal Communication	3-7
3.5	External Communication	3-8
3.6	Implement of Early Gains	3-9
3.7	Barriers to Personnel Success	3-10
3.8	Organization Aspects of Levels of Service	3-11
3.9	Sewage Treatment Facilities – Training and Certification	3-12
3.10	Sewage Collection System Organization	3-13
3.10.1	Collection System Assessment	3-14
3.10.2	Review/Evaluation of Existing Collection System O&M Program	3-14
3.11	Water Treatment Facilities Organization	3-14
3.12	Water Distribution System	3-15
3.13	Summary of Facility Assessments and O&M Factors	3-15
3.13.1	Sewage Treatment Facilities	3-15
3.13.2	Sewage Collection	3-16
3.13.3	Water Treatment	3-16
3.13.4	Water Distribution	3-16
3.14	Conclusions	3-16

3.15	Recommendations	3-17
3.16	CIP Impacts	3-17
	Exhibit 3A – Customers, Ratepayers of GWA Organization Chart	3-18
	Exhibit 3B – Production and Treatment FTE Organization Chart	3-19
	Exhibit 3C – Collection and Distribution FTE Organization Chart	3-20
	Exhibit 3D – Finance FTE Organization Chart	3-21
	Exhibit 3E – AGMAC Services FTE Organization Chart	3-22

CHAPTER 4 – LEVELS OF SERVICE

4.1	Introduction	4-1
4.2	Service Levels and Performance Measures	4-1
4.3	Current Service Levels	4-2
	4.3.1 Drinking Water Quality	4-3
	4.3.2 Continuity of Water Supply	4-3
	4.3.3 Wastewater Effluent Discharges	4-3
	4.3.4 Wastewater System Spills	4-4
4.4	Process for Going Forward	4-4
4.5	Conclusions	4-6
4.6	Recommendations	4-6

CHAPTER 5 – STRATEGIC COMMUNICATION PLAN

5.1	Introduction	5-1
5.2	Plan Components	5-1
5.3	Research	5-1
5.4	Communication Goals	5-2
5.5	Short Term Objectives	5-2
5.6	Long Term Objectives	5-2
5.7	Public Outreach Strategies	5-3
5.8	Key Messages	5-3
5.9	Audiences	5-3
5.10	Communication Methods	5-3
	5.10.1 Employee Communication	5-4
	5.10.2 Public Outreach	5-5
5.11	Timeline	5-8
5.12	Implementation	5-8
5.13	Conclusions	5-10
5.14	Recommendations	5-10

CHAPTER 6 – POPULATION & LAND USE FORECAST

6.1	Introduction	6-1
-----	--------------------	-----

**Vol 1 Background
Table of Contents**

6.1.1	Approach	6-1
6.1.2	Relationship to Existing Land Use Master Plans	6-2
6.1.3	Key Assumptions	6-2
6.2	Existing Conditions	6-3
6.2.1	Population	6-3
6.2.2	Land Use	6-4
6.3	Future Population	6-7
6.3.1	Census History	6-8
6.3.2	Population Projections Summary	6-8
6.3.3	Methodology	6-9
6.3.4	Geographic Detail of Projections	6-9
6.3.5	Projection Periods	6-9
6.4	Future Land Use	6-10
6.4.1	Methodology	6-12
6.4.2	Private Development Proposals	6-12
6.4.3	Public Development Proposals	6-15
6.4.4	Military Development Proposals	6-15
6.4.5	Traffic Analysis Zones	6-16
6.4.6	Aquifer Protection	6-16
6.4.7	Year 2005 Land Uses	6-17
6.4.8	Year 2010 Land Uses	6-20
6.4.9	Year 2015 and 2020	6-21
6.4.10	Year 2050 and 2100	6-21
6.5	Future Population Distribution	6-33
6.6	Findings	6-33
6.7	Recommendations	6-33
	Exhibit 6A – Population Projection	6-34
	Exhibit 6B – Population Growth Table	6-40
	Exhibit 6C – Population Projection	6-43

CHAPTER 7 – ASSET INVENTORY PROGRAM

7.1	Introduction	7-1
7.2	Overview	7-1
7.3	Equipment and Maintenance Submittal Requirements	7-10
7.4	Verification Process	7-11
7.4.1	Verification and Completion by Operations and Maintenance Staff	7-11
7.4.2	Verification and Completion by Finance Staff	7-11
7.4.3	Entry into Asset Inventory Database	7-11
7.5	Conclusions	7-11

7.6	Recommendations	7-12
7.7	CIP Impacts	7-12

CHAPTER 8 – ASSET MANAGEMENT

8.1	Introduction	8-1
8.2	Asset Management Training Workshops	8-1
8.2.1	What IS Asset Management?	8-1
8.2.2	Customers and Service Levels	8-1
8.2.3	The Business Case Evaluation	8-1
8.2.4	Managing Risk	8-1
8.2.5	Community Costs and Benefits	8-2
8.3	Business Case Evaluation	8-2
8.4	Asset Management Program Evaluation	8-4
8.4.1	Corporate Asset Management Program	8-5
8.4.2	Customer Service and Risk Management	8-5
8.4.3	Asset Planning	8-6
8.4.4	Asset Acquisition	8-6
8.4.5	Asset Operations	8-6
8.4.6	Asset Maintenance	8-6
8.4.7	Asset Replacement and Renewal Strategy	8-9
8.4.8	Business Support Tools	8-9
8.4.9	Scoring	8-9
8.5	Recommendations	8-9
8.5.1	Computerized Maintenance Management System	8-9
8.5.2	Additional Asset Management Training	8-10
8.5.3	Complete AMPE Visioning Process	8-10
8.6	Conclusions	8-10

CHAPTER 9 – GIS PROGRAM

9.1	Introduction	9-1
9.2	GIS Datum and Projection	9-1
9.3	Geodatabase Structure	9-2
9.3.1	Geodatabase	9-2
9.3.2	Feature Dataset	9-2
9.3.3	Feature Class	9-2
9.3.4	Object Class	9-2
9.3.5	Raster Datasets	9-5
9.3.6	Relationship Class	9-5
9.3.7	Subtypes	9-5
9.3.8	Domains	9-5

**Vol 1 Background
Table of Contents**

9.3.9	Attributes	9-6
9.4	Base Map Geodatabase	9-7
9.5	Population Projection Data Table	9-7
9.5.1	Model Resolution	9-7
9.5.2	Population Projections and Growth Rates	9-7
9.5.3	Maximum Capacity	9-7
9.6	Wastewater Geodatabase	9-8
9.7	Water Geodatabase	9-9
9.8	Digitizing and Data Entry into Geodatabases	9-12
9.8.1	Prototype Geodatabases	9-12
9.8.2	Procedures Used to Digitize As-Builts and Record Drawings	9-13
9.8.3	Quality Control Processes	9-14
9.8.4	Data Completeness	9-14
9.9	GIS Program Recommendations	9-15
9.9.1	Staffing Recommendations	9-15
9.9.2	Software Recommendations	9-17
9.9.3	Hardware Recommendation	9-18
9.9.4	Workflow	9-18
9.9.5	CIP Projects	9-19

CHAPTER 10 – CAPACITY ASSURANCE PLANNING ENVIRONMENT

10.1	Introduction	10-1
10.1.1	Time-Series Data Manager	10-1
10.1.2	I/I Workbench	10-2
10.1.3	Capital Improvement Project Planner	10-3

CHAPTER 11 – CORROSION ASSESSMENT

11.1	Introduction	11-1
11.2	Objectives	11-1
11.3	Site Inspections	11-1
11.3.1	General	11-1
11.3.1.1	Atmospheric Corrosivity	11-1
11.3.1.2	Soil Corrosivity	11-2
11.3.1.3	Immersion	11-2
11.3.2	Deep Well Pump Station (A-25)	11-3
11.3.3	Water Booster Pump Station at Pago Bay	11-5
11.3.4	WBPS at Brigade Bay	11-7
11.3.5	Ugum River Intake	11-9
11.3.6	Ugum WTP	11-11

11.3.7	Malojloj Water Reservoir and High Level Tank	11-14
11.3.8	Barrigada Heights Reservoirs	11-16
11.3.8.1	Barrigada No 2 Reservoir – Summary	11-19
11.3.8.2	Barrigada No. 3 Reservoir – Summary	11-19
11.3.8.3	Barrigada No 1 Failed Reservoir – Summary	11-20
11.3.9	As-Tumbo Reservoirs	11-21
11.3.10	Hagatna Dry Well STP	11-23
11.3.11	Prison Wet Well Sewerage Pump Station	11-24
11.3.12	Hagatna STP	11-25
11.3.13	Northern District STP	11-29
11.3.14	Pipelines	11-32
11.4	Discussion and Conclusions	11-34
11.5	Summary of Recommendations	11-35
	Exhibit 11A – CCI Pope Investigation Report	11-38

CHAPTER 12 – ELECTRICAL ASSESSMENT

12.1	Introduction	12-1
12.2	Existing Electrical System	12-2
12.2.1	GPA System	12-2
12.2.2	Water Wells	12-3
12.2.3	Water Booster Stations	12-3
12.2.4	Wastewater Pumping Stations	12-3
12.2.5	Water Treatment Facility	12-3
12.2.6	Wastewater Treatment Facilities	12-4
12.3	Assessment Methodology	12-4
12.4	Electrical Observations and Findings	12-5
12.4.1	Electrical System Power and Grounding Discussion	12-5
12.4.2	Voltage and Current Unbalance Issues	12-8
12.4.3	Electrical Meter Failures	12-14
12.4.4	Motor Overload Protection	12-16
12.4.5	Phase Monitors or Motor Protectors	12-17
12.4.6	Reduced Voltage Motor Starting	12-17
12.4.7	Motor Oversizing	12-18
12.4.8	Standby Generators	12-18
12.4.9	Diesel Fuel Line Building Wall Penetration	12-19
12.4.10	Coordination with GPA	12-20
12.4.11	Voltage at Motor	12-20
12.4.12	Pump Station Grounding	12-21
12.4.13	Lightning and Surge Arresters	12-22

**Vol 1 Background
Table of Contents**

12.4.14	Power Factor Correction Capacitors	12-23
12.4.15	GWA Personnel Work and Maintenance Practices	12-23
12.5	Electrical Assessment	12-24
12.6	Implementation Approaches Based on Field Observations	12-27
12.6.1	Partnering Effort with GPA and GWA Quality Circle Groups	12-27
12.6.2	Relocation of the Diesel Fuel Lines	12-28
12.6.3	Power Quality	12-28
12.6.3.1	Phase Voltage Unbalance	12-28
12.6.3.2	Voltage Variation	12-29
12.6.3.3	Transient and Surge Protection	12-30
12.6.3.4	Electrical Grounding System	12-30
12.6.3.5	Transformer Connection and Ground Monitoring	12-30
12.6.4	Electrical Metering Challenges	12-31
12.6.5	GWA Operational and Maintenance Issues	12-31
12.6.5.1	Motor Protection	12-31
12.6.5.2	Power Factor Correction	12-33
12.6.5.3	Pump Operation during Commissioning	12-34
12.6.5.4	GPA Operation and Maintenance of Generators	12-34
12.6.5.5	Aluminum Service Conductor Usage	12-34
12.6.5.6	Predictive and Preventative Maintenance Program	12-35
12.6.5.7	Test Equipment and Tools	12-35
12.6.6	Training	12-38
12.6.7	Variable Frequency Drives (VFD).....	12-39
12.6.8	Grounded versus Ungrounded Electrical Systems	12-39
12.6.9	Pump Operation and Control	12-40
12.6.9.1	Wastewater Pump Stations	12-40
12.6.9.2	Station Flooding (Dry Well)	12-41
12.6.9.3	Water and Wastewater Treatment Facilities	12-42
12.6.10	Partnering with Local Vendors and Repair Shops	12-42
12.6.11	Energy Savings with Motor Operations	12-43
12.7	Conclusions	12-43
12.8	Recommendations.....	12-44
12.8.1	Electrical Testing Procedure for Deep Well Motors	12-45
12.8.2	Electrical Practice Procedure for New Motor Installation	12-46
12.9	CIP Impacts	12-47
Exhibit 12A	– GPA Rate Schedule K.....	12-48
Exhibit 12B	– NFPA 70B Electrical Maintenance Practices-Section on Voltage Unbalance.	12-51

CHAPTER 13 – SCADA & CONTROL ASSESSMENT

13.1	Introduction	13-1
13.2	Existing SCADA & Control System Description	13-1
13.3	Methodology	13-2
13.3.1	Assessment Weighting Factors	13-3
13.3.2	Water Systems Assessment Explanation	13-3
13.3.2.1	Pump Controls	13-3
13.3.2.2	Chlorination System Controls	13-4
13.3.2.3	Pump Bypass Controls	13-4
13.3.2.4	SCADA RTU	13-4
13.3.3	Wastewater Pump Station Assessment Overview	13-5
13.3.3.1	Pump Controls	13-5
13.3.3.2	Sump Pump	13-5
13.3.3.3	SCADA RTU	13-6
13.3.4	Wastewater Treatment Plants Assessment Explanation.....	13-6
13.4	SCADA & Control System Site Observations	13-6
13.4.1	SCADA Observations	13-6
13.4.1.1	SCADA General Observations	13-6
13.4.1.2	Water Pump Stations	13-7
13.4.1.3	Water Booster Stations	13-8
13.4.2	Control System Observations	13-9
13.4.2.1	Water Pump Stations	13-9
13.4.2.2	Booster Pump Stations	13-12
13.4.2.3	Water Treatment Plant	13-13
13.4.2.4	Wastewater Pump Stations	13-15
13.4.2.5	Wastewater Treatment Plants	13-17
13.4.3	Assessment Summary	13-18
13.5	SCADA & Control Implementation Activities	13-22
13.5.1	Local Process Control Improvement Recommendations	13-24
13.5.2	Local Process Control Requirements	13-24
13.5.3	Operations and Maintenance Implementation	13-25
13.5.4	GWA Maintenance Equipment Requirements	13-26
13.5.5	Site Security and Intrusion Detection Security Monitoring System	13-26
13.5.6	SCADA System Communication Improvement Implementation	13-26
13.5.6.1	Hard-Wired Technologies	13-26
13.5.6.2	Current Wireless Technologies	13-27
13.5.7	SCADA System Improvement Implementation.....	13-29
13.5.7.1	SCADA Supervisory Function	13-29

**Vol 1 Background
Table of Contents**

13.5.7.2	SCADA Data Acquisition Function	13-29
13.5.7.3	SCADA Clients	13-30
13.5.7.4	Central Command Location	13-30
13.5.7.5	SCADA Maintenance & Development Location	13-31
13.5.7.6	SCADA Security	13-31
13.5.8	Information Management System Improvements	13-31
13.5.8.1	GWA IT Department Requirements	13-31
13.5.8.2	Data Highway	13-31
13.5.8.3	Hardware Location	13-32
13.5.8.4	Thin SCADA Clients	13-32
13.5.8.5	Printers	13-32
13.5.8.6	IT Staff Responsibilities	13-32
13.6	Conclusions	13-32
13.7	Recommendations.....	13-33
13.8	CIP Impacts	13-33

CHAPTER 14 – FINANCIAL PROGRAM

14.1	Background	14-1
14.2	Financial Objectives and Rate Setting Process	14-1
14.3	Projected Revenues and Expenditures	14-3
14.3.1	Projected Costs	14-3
14.3.2	WRMP CIP Financing Plan	14-7
14.3.3	Cashflow Proforma and Rate-based Revenue Requirements	14-14
14.4	Base Case Rate Findings	14-18
14.5	Minimum Pace CIP Rate Findings	14-20
14.6	Sensitivity Analysis	14-22
14.7	Cost of Service Analysis	14-23
14.7.1	Water Cost of Service	14-25
14.7.2	Wastewater Cost of Service	14-35
14.7.3	GWA Cost of Service versus Current Bills	14-38
14.8	System Development Charges and Miscellaneous Service Fees	14-40
14.8.1	System Development Charges	14-40
14.8.2	Miscellaneous Service Fees	14-42
14.9	Rate Alternatives for Billing Services	14-44
14.9.1	Current Rates Services (Alternative 1)	14-46
14.9.2	Current Rates with Updated Lifeline Services (Alternative 2)	14-49
14.9.3	Cost of Service Rates (Alternative 3)	14-53
14.10	Utility Service Affordability	14-56

14.11	Survey of Projected Bills under Rate Alternatives	14-58
14.12	Summary of Findings and Conclusions	14-65
14.12.1	Projected Expenditures and Revenue Findings	14-65
14.12.2	Cost of Service Findings	14-66
14.12.3	Sensitivity Analysis Findings	14-66
14.12.4	Affordability Findings	14-67
14.12.5	Conclusions	14-67

CHAPTER 15 – CAPITAL IMPROVEMENT PROGRAM

15.1	Introduction	15-1
15.2	Elements for a CIP Program	15-1
15.3	Elements of a CIP Policy	15-2
15.4	Delivery of CIP Projects	15-2
15.5	WRMP CIP Projects	15-3
15.6	WRMP CIP Schedule	15-3
15.7	WRMP CIP Cost Estimating	15-4
15.8	CAPE Application	15-4
15.9	Conclusions	15-5
15.10	Recommendations	15-5
15.11	CIP Impact	15-5
	Exhibit 15A – CIP Definition	15-8

CHAPTER 16 – PRIVATIZATION/CONSOLIDATION OPPORTUNITIES

16.1	Introduction/Background	16-1
16.1.1	Privatization	16-1
16.1.1.1	Rationale for Privatization	16-1
16.1.2	Consolidation	16-2
16.1.2.1	Rationale for Consolidation	16-2
16.2	Privatization of GWA Water and Wastewater Utilities	16-3
16.2.1	Past and Present Local Initiatives	16-3
16.2.1.1	CCU’s Impact Report for Public-Private Partnership	16-3
16.2.1.2	Current Proposal for Performance Management Contracts	16-6
16.2.1.3	Steps Toward Privatization	16-7
16.3	Consolidation of Guam Utilities – GWA and Military	16-8
16.3.1	Existing Agreements with U.S. Military	16-8
16.3.2	Present Consolidation Initiatives	16-9
16.3.3	Existing Military Consolidation Examples	16-9
16.4	Conclusions	16-12
16.4.1	Privatization	16-12
16.4.2	Consolidation	16-13

16.4.3	Combination of Privatization and Consolidation	16-13
16.5	Recommendations	16-14
	References	16-14
CHAPTER 17 – MILITARY EXPANSIONS ON GUAM		17-1

TABLES

<u>No.</u>		<u>Page</u>
ES-1	Guam Waterworks Authority Facilities	ES-2
ES-2	Guam Water Supply Sources	ES-2
ES-3	GWA Sewage Treatment Plants Overview	ES-4
ES-4	Capital Improvement Program Summary	ES-9
2-1	Key Stipulated Order Requirements for WRMP	2-1
2-2	Stipulated Order Milestones	2-2
3-1	Village Meetings	3-9
3-2	Certification Status	3-12
5-1	2005 WRMP Communication Timeline	5-9
6-1	Population History	6-3
6-2	Visitor Arrivals	6-3
6-3	General Tourist Accommodations	6-4
6-4	Generalized Land Use	6-4
6-5	Population Projection Scenarios	6-7
6-6	Daily Vehicle Trips and Population	6-16
6-7	Comparison of 1990 and 2010 Vehicle Trip Origins	6-16
6-8	Year 2005 Potential Developments	6-17
6-9	Census 2000 – Housing Unit Vacancies	6-19
6-10	Year 2010 Potential Developments	6-21
6-11	Year 2015 & 2020 Potential Developments	6-22
8-1	Summary of Alternatives List	8-3
8-2	Ranking Categories	8-9
9-1	Guam Geodetic Network 1993	9-2
9-2	Example of Valid Subtypes for SewerMains	9-5
9-3	Example of Valid Domains for Manhole Type	9-5
9-4	Typical Water Meter Types	9-11
9-5	Summary of Software and Costs	9-17
9-6	Summary of Hardware and Costs	9-18
11-1	GWA Water Quality Data	11-2
11-2	Lengths of Water and Sewer Mains in GWA	11-32
11-3	Corrosivity Test Results on Guam Soils	11-33
12-1	Assessment Rating Scale	12-4

12-2	Station Y-15 Readings	12-9
12-3	Wastewater Pump Station Assessment Summary	12-24
12-4	Water Pump Station Assessment Summary	12-26
12-5	Conductor Sizing	12-31
13-1	Assessment Rating Scale	13-3
13-2	Water Pump Stations SCADA Assessment Totals	13-19
13-3	Wastewater Pump Stations SCADA Assessment Aggregated Totals	13-21
14-1	Financial Assumptions	14-4
14-2	Budget Year Operating Expenses FY 2005-06	14-5
14-3	Projected Water Supplies and Power Costs	14-6
14-4	Base Case CIP Projects	14-8
14-5	Minimum Pace CIP Projects	14-9
14-6	Base Case CIP Sources of Funds and Capitalized Labor Costs	14-10
14-7	Projected Debt Service	14-12
14-8	Cash & Construction Fund Balances – Base Case CIP	14-13
14-9a	Cashflow and Rate Adjustments – Five Year Base Case Proforma	14-15
14-9b	Cashflow and Rate Adjustments – 20 Year Base Case CIP Proforma	14-19
14-10a	Cashflow & Rate Adjustments – Five Year Minimum Pace Proforma	14-20
14-10b	Cashflow & Rate Adjustments – 20 Year Minimum Pace Proforma	14-21
14-11	Utility Expense Functional Allocations	14-24
14-12	Cost of Services Expense Allocations	14-25
14-13	Projected Water Demands	14-26
14-14	Meter Replacement Program	14-27
14-15	Residential Water Demand Elasticity with Price	14-28
14-16	Water Accounts, Charges and Meter Capacities	14-29
14-17	Water Commodity Charges	14-30
14-18	Water Demand Factors	14-32
14-19	Water Customer Class Loads	14-33
14-20	Water Customer Cost of Service Allocations	14-33
14-21	Water Cost of Service Charges vs. Current	14-34
14-22	Projected Wastewater Customer Loads	14-35
14-23	Wastewater System Mass Balance	14-36
14-24	Wastewater Customer Class Loads	14-37
14-25	Wastewater Customer Cost of Service Allocations	14-37
14-26	Wastewater Equitable Charges vs. Current Revenues	14-38
14-27	Total Sewer and Water Equitable vs. Current Rates	14-39
14-28	SDCs – Buy-in Costs	14-41
14-29	Miscellaneous Charges – Labor Rates	14-42
14-30	Miscellaneous Service Charges	14-43

**Vol 1 Background
Table of Contents**

14-31	Current Tariff Sheet for Water & Sewer Rates	14-44
14-32	Projected Billable Service Loads	14-46
14-33	Current Rate Structure Update (Alternative 1)	14-47
14-34	Projected Revenues from Current Rate Update (Alternative 1)	14-48
14-35	Bills Under Updates Current Rates (Alternative 1)	14-49
14-36	New Residential Lifeline Discount	14-50
14-37	Current Rate Structure with Updated Lifeline Service Costs (Alternative 2)	14-51
14-38	Projected Bills Using Updated Lifeline Services (Alternative 2)	14-52
14-39	Cost of Service Meter Ratios & Customer Service Charges (Alternative 3)	14-53
14-40	Water Cost of Service-based Revenues (Alternative 3)	14-54
14-41	Sewer Cost of Service-based Revenues (Alternative 3)	14-54
14-42	Cost of Service-based Rates (Alternative 3)	14-55
14-43	Typical Bills with Cost of Service-based Rates (Alternative 3)	14-56
14-44	Affordability for Households with Alternative 2 Updated Lifeline Rates	14-57
14-45	Typical Water Demands of Customer Classes	14-58
14-46	Summary of Residential Rate Alternatives	14-59
14-47	Survey of Rates – Large Hotel	14-61
14-48	Survey of Rates – Typical Hotel	14-62
14-49	Survey of Rates – Typical Golf Course	14-63
14-50	Survey of Rates – Commercial “C” Bills	14-64
14-51	Summary of Current vs. Five-Year Increase with Different Rate Alternatives	14-65
15-1	Recommended Capital Improvement Program – Base Case	15-6
15-2	Recommended Capital Improvement Program – Minimum Case	15-7
16-1	Service Management Contracts Advantages and Disadvantages	16-4
16-2	Concession Advantages and Disadvantages	16-5
17-1	Housing Assumptions for Military Relocation	17-1
17-2	Water and Sewer Demands if Military Relocations are Additive to Current Population Projections	17-2
17-3	Existing CIP Projects Accelerated to Accommodate Accelerated Military Increase ...	17-2

FIGURES

<u>No.</u>		<u>Page</u>
ES-1	Water System Boundaries	ES-3
ES-2	Wastewater Basins	ES-5
ES-3	Sewers and Unsewered Properties in the Hagatna Area	ES-6
ES-4	Existing Sewer Collection Systems	ES-8
1-1	WRMP Project Goals and Objectives	1-2
1-2	Project Approach Diagram	1-3
1-3	Key Elements of WRMP	1-6
3-1	GWA Reorganization Chart	3-2

3-2	Organization Improvement Pathway	3-6
3-3	GWA WRMP Website	3-8
3-4	Purchasing Process	3-11
4-1	Service Levels and Performance Measures	4-2
5-1	GWA Newsletter	5-10
6-1	Generalized Land Uses	6-5
6-2	Zoning	6-6
6-3	Future Private Sector Development	6-14
6-4	Future Public Sector Development	6-15
6-5	Year 2005 Potential Developments	6-18
6-6	Year 2010 Potential Developments (Central)	6-20
6-7	Year 2010 Potential Developments (North)	6-20
6-8	Year 2015 & 2020 Potential Developments (Dededo/Yigo)	6-24
6-9	Year 2015 & 2020 Potential Developments (Barrigada)	6-24
6-10	Year 2015 & 2020 Potential Developments (Tamuning)	6-25
6-11	Year 2015 & 2020 Potential Developments (Mangilao south)	6-25
6-12	Year 2015 & 2020 Potential Developments (Agana & MTM)	6-26
6-13	Year 2015 & 2020 Potential Developments (Agat)	6-26
6-14	Year 2015 & 2020 Potential Developments (Asan)	6-27
6-15	Year 2015 & 2020 Potential Developments (Chalan Pago)	6-27
6-16	Year 2015 & 2020 Potential Developments (Inarajan)	6-28
6-17	Year 2015 & 2020 Potential Developments (Merizo)	6-28
6-18	Year 2015 & 2020 Potential Developments (Mangilao north)	6-29
6-19	Year 2015 & 2020 Potential Developments (Piti)	6-29
6-20	Year 2015 & 2020 Potential Developments (Yona)	6-30
6-21	Year 2015 & 2020 Potential Developments (Talofofo)	6-31
6-22	Year 2050 & 2100 Potential Developable Lands	6-32
7-1	Typical Facility Screen Capture in InfoCollect	7-2
7-2	Typical Asset Information Collection in InfoCollect	7-3
7-3	System Designator Portion of Asset ID	7-4
7-4	Village Designator Portion of Asset ID	7-5
7-5	Facility Designation Portion of Asset ID	7-6
7-6	Asset Type Designation of Asset ID	7-7
7-7	Asset Component Designator for Asset ID	7-8
7-8	Asset Component Number Designation for Asset ID	7-9
7-9	GWA Form XXX-A - Mechanical Equipment Data Record Form	7-13
7-10	GWA Form XXX-B - Electrical Equipment Data Record Form	7-14
7-11	GWA Form XXX-C - Equipment Maintenance Data Record Form	7-15
8-1	AMPE Structure	8-4

**Vol 1 Background
Table of Contents**

8-2	AMPE Gap Chart	8-7
9-1	GIS Data Development Diagram	9-3
9-2	Geodatabase Structure	9-4
9-3	Feature Class Attributes, Subtypes and Domains	9-6
9-4	New Data Workflow	9-20
10-1	Time-Series Data Manager	10-2
10-2	I/I Workbench	10-3
10-3	Capital Improvement Project Planner	10-4
10-4	Capital Project Properties	10-4
11-1	Deep Well PS A-25	11-4
11-2	Surface Corrosion on Pipework Flange	11-4
11-3	Pago Bay Water Pump Station	11-5
11-4	Internal View of PS Pipe Layout	11-6
11-5	Segment of Old Pipe Stored at the Pump Station	11-6
11-6	Brigade Bay Pump Station	11-7
11-7	Pipework	11-8
11-8	Pump Supports	11-8
11-9	Intake Structure	11-9
11-10	Intake Pumps	11-10
11-11	Concrete Intake Pit	11-10
11-12	Ugum Water Treatment Plant	11-11
11-13	Filtration Tank	11-12
11-14	Pipe Gallery Under Control Room	11-12
11-15	Close-up of Partially Collapsed Roof	11-12
11-16	View of Malojloj 1 mg Reservoir	11-14
11-17	Malojloj High Level Tank	11-14
11-18	Hold-Down Bolts on Reservoir	11-15
11-19	View of Underside of High Level Tank	11-15
11-20	Part of Walls and Roof of Collapsed Reservoir	11-16
11-21	Adjacent 2 mg Damaged Reservoir	11-17
11-22	Collapsed Reservoir Wall Showing Positions of Sample Removed for Analysis	11-17
11-23	Samples at Floor/Wall Fillet Weld Position	11-17
11-24	Close-up of Sample Position at Floor	11-18
11-25	Pitting Corrosion Damage on 1mg Reservoir Wall	11-18
11-26	Damage to 3 mg Reservoir	11-18
11-27	Roof of 3 mg Reservoir	11-19
11-28	As-Tumbo No 1 Reservoir	11-22
11-29	As-Tumbo No 2 Reservoir	11-22
11-30	Possible Earth Connection for Under-Floor CP System	11-22

11-31	External View of Hagatna STP	11-23
11-32	Pump Arrangement Inside Dry Well	11-23
11-33	Prison Wet Well Site	11-24
11-34	Wet Well	11-24
11-35	Corrosion of Penstock Gate Valve	11-25
11-36	Corroded Electrical Motor	11-26
11-37	Failed Power Supply Support to Aerator	11-26
11-38	Corroded Primary Support Beams for Aerator	11-26
11-39	H ₂ S Corroded Copper Pipe Supernatant Lines	11-27
11-40	Outlet Drop Chamber with Exposed, Corroding Rebar	11-27
11-41	Surface Corrosion and Pitting in Pipework in Effluent BPS	11-27
11-42	Close-up of Failed Fastener from Figure 11-41	11-28
11-43	General View of Chlorination, Laboratory and Operational Buildings	11-29
11-44	Pipework H ₂ S Corrosion at Centrifuge Building	11-29
11-45	Corrosion on Blower Ductwork at Heater/Digester Building.....	11-30
11-46	Heater/Digester Tank Roof Showing Corrosion and Pounded Water.....	11-30
11-47	Empty Clarifier Showing Bolt-on Sacrificial CP Anodes	11-30
11-48	Corrosion of Perimeter Fence	11-31
12-1	Transformer Center Tap Grounded Voltage – A-10	12-5
12-2	Grounded Phase-to-Phase Voltage Recording – Station A-9	12-6
12-3	Abnormal Phase-to-Ground Voltage Recording at Station F-10	12-7
12-4	Phase-to-Ground Voltage Recording – Station F-3	12-10
12-5	Phase-to-Phase Voltage Recording – Station F-3	12-11
12-6	Phase Current Recording – F-3	12-12
12-7	Phase-to-Ground Voltage on Generator Power – F-3	12-12
12-8	Phase-to-Phase Voltage on Generator Power – F-3	12-13
12-9	Three-Day Trend Recording – Station M-20A – May 24-27, 2005	12-14
12-10	Electrical Meter Failure	12-15
12-11	Breaker Corrosion	12-15
12-12	Pole Conductor Termination	12-16
12-13	Diesel Fuel Line Penetration – Station A-3	12-19
12-14	Generator Room Fuel Line Penetration – Station A-3	12-20
12-15	Missing Lightning Arrester	12-22
12-16	Infrared Image of Motor Starter	12-37
12-17	Mechanical Failure in Submersible Motor	12-41
13-1	Corroded SCADA Cabinet at A-21/SCADA unit in Good Condition at F-10	13-8
13-2	Operational Bypass Valve at Station Y-21A	13-9
13-3	Non-Functioning Bypass Valve and SCADA Cabinet at Station A-03	13-10
13-4	Interior View of Brigade Booster Pump Station	13-12

**Vol 1 Background
Table of Contents**

13-5	Unused Control Console at Ugum WTP	13-14
13-6	Unused Control Panel at Hagatna STP	13-18
13-7	Annunciator Panel at Ugum WTP	13-29
14-1	Rate Setting Process	14-2
14-2	Twenty-Year versus Five-Year Base CIP	14-11
14-3	Fund Reserve Targets versus Cash Available	14-14
14-4	GWA Projected Expenditures	14-16
14-5	Residential Bill Sensitivity to Variables	14-22
14-6	GWA Water Demands – Typical Diurnal Curve	14-31
14-7	Residential Billing by Consumption Level	14-31
14-8	FY 2005-06 Costs & Revenues	14-40
14-9	Projected Residential Water and Sewer Bills	14-60
14-10	Projected Lifeline Bills	14-60
14-11	Large Hotel Water and Sewer Bills	14-61
14-12	Typical Hotel Water and Sewer Bills	14-62
14-13	Typical Golf Course Water Bills	14-63
14-14	Typical Commercial “C” Water and Sewer Bills	14-64

APPENDICES

1A	Scope of Work
1B	Stipulated Order
1C	Preliminary Assessment of Affordability and Early Gains
1D	QualServe™ Peer Review Report
1E	Outside Consultant Trip Report
1F	Communication Plan Documents
1G	Asset Management Workshop Presentations
1H	Life Cycle Alternative Cost Analysis
1I	Asset Management Program Evaluation Best Practices
1J	GIS Assessment Toolbox and Databases Implementation
1K	Electrical Assessment (CD format)
1L	SCADA and Control Assessment (CD format)
1M	Financial Program