



City of McMinnville

Water Reclamation Facilities Plan

Volume I
Chapters 1-7



Water Reclamation Facilities Plan

Prepared for

City of McMinnville

August 2009



513-01-06-12



TABLE OF CONTENTS

EXECUTIVE SUMMARY	ES-1
CONVEYANCE SYSTEM	ES-1
Regulatory Setting	ES-1
Description of Existing Collection System.....	ES-1
Flow Monitoring.....	ES-3
Flow Development and Calibration.....	ES-3
System Capacity Performance	ES-6
Structural Condition Data Evaluation.....	ES-7
Alternatives Evaluation.....	ES-8
Collection System Recommended Plan	ES-8
WATER RECLAMATION FACILITY	ES-10
Existing Wastewater Treatment Facilities	ES-10
Wastewater Flows and Loads	ES-12
Regulatory Requirements.....	ES-12
Liquid Stream Treatment Alternatives.....	ES-15
Solids Management Alternatives	ES-20
Water Reclamation.....	ES-23
Water Reclamation Facility Recommended Plan	ES-24
IMPLEMENTATION PLAN	ES-27
CHAPTER 1. INTRODUCTION, PURPOSE AND NEED.....	1-28
INTRODUCTION	1-28
CHAPTER 2. STUDY AREA CHARACTERISTICS	2-1
BACKGROUND	2-1
PLANNING AREA	2-1
TOPOGRAPHY.....	2-1
SOILS	2-4
CLIMATE.....	2-4
Precipitation	2-4
Temperature	2-4
HISTORICAL POPULATION TRENDS	2-4
LAND USE.....	2-6
DEVELOPMENT FORECASTS	2-10
MEASURE 37 ISSUES	2-11
CHAPTER 3. EXISTING WASTEWATER FACILITIES.....	3-1
MCMINNVILLE WATER RECLAMATION FACILITY OVERVIEW	3-1
Operational Modes.....	3-4
Process Unit Design Data	3-4
TREATMENT PERFORMANCE.....	3-4
HYDRAULIC EVALUATION	3-17

Model Description	3-17
Model Development.....	3-17
Model Results	3-17
RELIABILITY/REDUNDANCY CRITERIA	3-19
Wet Weather Operations.....	3-19
Dry Weather Operations	3-23
UNIT PROCESSES-CONDITION AND ASSESSMENT	3-24
Off-Site Screening	3-24
Raw Sewage Pumping	3-26
WRF Screening System.....	3-27
Grit Removal System.....	3-28
Orbals.....	3-29
Secondary Clarifiers.....	3-32
Return Activated Sludge (RAS)/Waste Activated Sludge (WAS) Pump Station.....	3-32
Tertiary Clarifiers.....	3-33
Chemical Sludge Pump Station	3-33
Alum System.....	3-33
Effluent Filters	3-34
Ultraviolet (UV) Disinfection and Post Aeration System.....	3-34
Sodium Hypochlorite System	3-35
Sodium Hydroxide System	3-35
Thickening/Dewatering.....	3-35
ATAD Digestion.....	3-36
Biosolids Storage	3-37
ELECTRICAL DISTRIBUTION/CONTROL AND INSTRUMENTATION SYSTEM	3-38
General.....	3-38
Raw Sewage Pump Station and Main Switchgear.....	3-38
Headworks Building – Push Button Station	3-39
Headworks Building – HVAC/Mechanical Room	3-39
Headworks Building – Motor Control Center	3-39
CONDITION ASSESSMENT METHODOLOGY	3-40
Approach.....	3-40
Condition Rating System	3-40
CHAPTER 4. WASTEWATER FLOWS AND LOADS.....	4-41
EXISTING FLOWS.....	4-41
Wastewater Flows.....	4-42
Rainfall Records.....	4-42
Flow Records and Measurement.....	4-43
Flow Analysis	4-43
CURRENT WASTEWATER LOADS.....	4-52
Load Analysis	4-53
FLOW AND LOAD PROJECTIONS	4-59
Distribution of Average Flows	4-59
Projected Wastewater Flows.....	4-60
Projected Wastewater Loads.....	4-63
PEAK FLOW RECONCILIATION	4-64

WASTEWATER CHARACTERISTICS SUMMARY	4-64
CHAPTER 5. REGULATORY REQUIREMENTS	5-1
INTRODUCTION	5-1
REGULATORY FRAMEWORK	5-1
Oregon Administrative Rules for Wastewater Treatment	5-2
Clean Water Act Section 303(d) List.....	5-2
Total Maximum Daily Loads.....	5-3
WATER QUALITY.....	5-4
Temperature	5-4
Dissolved Oxygen.....	5-4
pH.....	5-5
Chlorophyll a.....	5-5
Bacteria	5-5
Phosphorus.....	5-5
Mixing Zone.....	5-5
Toxics.....	5-6
Summary Table.....	5-7
TREATMENT REQUIREMENTS	5-7
Current Discharge Permit	5-15
Compliance with Water Quality Criteria	5-15
Anticipated Future Treatment Requirements.....	5-15
CHAPTER 6. BASIS OF PLANNING	6-18
FACTORS FOR CONDUCTING ECONOMIC EVALUATION.....	6-18
Capital Cost Estimates	6-18
Operation and Maintenance (O&M) Costs.....	6-20
CRITERIA FOR NON-ECONOMIC EVALUATIONS.....	6-21
CHAPTER 7. LIQUID STREAM TREATMENT ALTERNATIVES.....	7-1
WASTEWATER MANAGEMENT STRATEGIES.....	7-1
Management Strategy Evaluation Criteria.....	7-1
Development of Management Strategies	7-4
Management Strategy Screening	7-9
Recommended Wastewater Management Strategies.....	7-12
WRF Design Peak Flow Capacity	7-12
Influent Pumping and Preliminary treatment Alternatives.....	7-15
Raw Sewage Pump Station.....	7-15
Screening at the WRF Headworks.....	7-16
Grit Removal.....	7-18
SECONDARY TREATMENT ALTERNATIVES.....	7-21
Existing Secondary Treatment Capacity.....	7-21
Alkalinity Addition.....	7-29
Alternative 1. Construct Third Secondary Treatment Train.....	7-30
Alternative 2. Construct Third Orbal and Wet Weather Upgrades.....	7-31
Evaluation of Secondary Treatment Alternatives.....	7-37
TERTIARY TREATMENT ALTERNATIVES.....	7-41

Capacity Review	7-41
Hydraulic Considerations.....	7-43
Alternative 1. Expand Existing Tertiary Facilities	7-44
Alternative 2. Construct Parallel Membrane Filtration System.....	7-51
Alternative 3. Replace Existing Facilities with Membrane Filtration System.....	7-55
Evaluation of Tertiary Treatment Alternatives	7-56
DISINFECTION ALTERNATIVES	7-61
UV Disinfection Alternatives	7-61
Sodium Hypochlorite System	7-62
OTHER PLANT FACILITIES	7-63
Outfall	7-63
CHAPTER 8. SOLIDS MANAGEMENT ALTERNATIVES	8-1
EXISTING SYSTEM	8-1
SOLIDS MANAGEMENT STRATEGY EVALUATION CRITERIA	8-2
Regulatory Criteria.....	8-2
Agricultural Practices.....	8-3
Public Acceptance.....	8-3
Odor	8-3
Energy Cost.....	8-3
Fuel Cost	8-3
Ease of Operation and Maintenance	8-3
Volatile Solids Reduction	8-4
Increased Sustainability Requirements	8-4
Flexibility in End Use	8-4
Implementation	8-4
BIOSOLIDS PRODUCT	8-4
DEVELOPMENT OF SOLIDS MANAGEMENT STRATEGIES	8-5
MANAGEMENT STRATEGY SCREENING	8-15
STRATEGY PRESENT WORTH COST EVALUATION	8-17
Capital Cost.....	8-17
Operation and Maintenance Cost.....	8-18
Total Present Worth Cost.....	8-19
Non-Economic Evaluation.....	8-19
SOLIDS UNIT PROCESS IMPROVEMENT ALTERNATIVES	8-21
CHAPTER 9. WATER RECLAMATION.....	9-1
SHORT-TERM AND LONG-TERM REUSE GOALS.....	9-1
TRIGGERS FOR FURTHER EVALUATION OF REUSE OPPORTUNITIES	9-1
Treatment Requirements.....	9-2
Temperature TMDL.....	9-3
Iron, Mercury, and Other Parameters	9-4
BASIS OF PLANNING.....	9-5
Wastewater Flows and Loads	9-5
Reuse Regulatory Requirements.....	9-5
Indirect Discharge to Surface Water.....	9-7

PRELIMINARY ASSESSMENT OF POTENTIAL REUSE OPPORTUNITIES	9-8
Land Application	9-8
Treatment Wetlands	9-11
Hyporheic Discharge with High-Rate-Irrigation Land Application or Permeable Wetlands	9-12
Industrial Reuse	9-14
ENVIRONMENTAL IMPACTS OF REUSE ALTERNATIVES.....	9-15
NEXT STEPS	9-17
REFERENCES	9-18
CHAPTER 10. RECOMMENDED PLAN	10-1
DESCRIPTION OF RECOMMENDED FACILITIES AND IMPROVEMENTS.....	10-1
Liquid Stream Treatment Facilities	10-1
Solids Management Facilities	10-16
Odor Control	10-20
Effluent Reuse Facilities	10-20
Other Facilities.....	10-20
ESTIMATED COSTS	10-21
STAFFING	10-25
IMPLEMENTATION PLAN	10-25

APPENDIX A: Unit Process Condition Assessment

APPENDIX B: NPDES Permit

APPENDIX C: Reclaimed Water Regulations

APPENDIX D: Wetlands Treatment Calculations

List of Tables

Table ES-1. Collection System Pipe Length and Sub-Basin Gross Area within the UGB	ES-2
Table ES-2. Model Results of the Peak Wet Weather Flows	ES-7
Table ES-3. Recommended Collection System Improvements for Existing and Future Conditions, 5-year, 24-hour Storm Event with Recommended Rehabilitation	ES-10
Table ES-4. Summary of WRF Design Flows and Loads after Collection System Rehabilitation	ES-13
Table ES-5. Capital Costs for the WRF Recommended Plan.....	ES-26
Table ES-6. Implementation Plan	ES-27
Table 2-1. Historical Precipitation (inches) – 1971 through 2000.....	2-5
Table 2-2. Historical Population Trends – 1980 through 2005	2-5
Table 2-3. Land Use Designation by Basin within UGB – Gross Area	2-7
Table 2-4. Developed Land within UGB – Existing Net Area	2-9

Table 2-5. Developed Land within Proposed UGB – Future Additional	2-10
Table 2-6. Developed Land within Proposed UGB – Buildout Total Net Area	2-11
Table 3-1. Design Data for the WRF (2015)	3-5
Table 3-2. Effluent Permit Limits, Permit No. 101062	3-13
Table 3-3. Plant Performance Data, 2006.....	3-16
Table 3-4. Process Reliability/Redundancy Criteria.....	3-21
Table 3-5. Unit Process Capacity Summary	3-25
Table 3-6. Condition Rating System.....	3-41
Table 4-1. Average Summer Flow	4-44
Table 4-2. Summary of Wet and Dry Season Rainfall and Influent Flow.....	4-45
Table 4-3. Current Wastewater Flows	4-52
Table 4-4. Plant Loading Summary	4-56
Table 4-5. Nutrient Loading Summary	4-59
Table 4-6. Wintertime Water Use ^a	4-59
Table 4-7. Average Dry Weather Flow Projection for Buildout Conditions	4-61
Table 4-8. Flow Projections.....	4-62
Table 4-9. Projected Plant Influent Loading Summary	4-63
Table 4-10. Peak Wet Weather Flow Comparison	4-64
Table 4-11. Wastewater Characteristics Summary	4-65
Table 5-1. South Yamhill River Water Quality Parameters	5-3
Table 5-2. Summary of Minimum Dilutions at the McMinnville Outfall ZID and MZB	5-6
Table 5-3. Water Quality Regulations and Impacts – Current and Future	5-10
Table 5-4. Effluent Permit Limits, Permit No. 101062	5-16
Table 6-1. Mark Up Factors Used in Developing Preliminary Construction Cost Estimates ...	6-19
Table 6-2. Mark Up Factors Used in Developing Project Capital Cost Estimates	6-20
Table 6-3. Operation and Maintenance Unit Costs.....	6-20
Table 7-1. Initial Management Strategy Assessment from October 2007 Workshop	7-10
Table 7-2. Wastewater Management Strategy Screening Matrix	7-13
Table 7-3. WRF Design Flows after Collection System Rehabilitation.....	7-15
Table 7-4. Capital Cost Comparison of Influent Screening Alternatives	7-17
Table 7-5. Operation and Maintenance Cost Comparison of Influent Screening Alternatives .	7-18
Table 7-6. Economic Comparison of Influent Screening Alternatives.....	7-18
Table 7-7. Non-Economic Comparison of Influent Screening Alternatives.....	7-19
Table 7-8. Estimated Capital Costs for an Additional Vortex Grit Removal Tank.....	7-20

Table 7-9. BioWin Calibration Summary	7-22
Table 7-10. Orbal Capacity based on Modeling Analysis	7-23
Table 7-11. Clarifier State Point Analysis	7-28
Table 7-12. Estimated Aeration Requirements	7-29
Table 7-13. Secondary Capacity Requirements	7-30
Table 7-14. Secondary Treatment Alternative 1: Third Secondary Treatment Train - Design Data.....	7-32
Table 7-15. Secondary Treatment Alternative 2: Third Orbal and Wet Weather Upgrades - Design Data	7-35
Table 7-16. Secondary Treatment Alternatives Capital Project Cost Comparison	7-38
Table 7-17. Secondary Treatment Alternatives Annual Operation and Maintenance Cost Comparison.....	7-39
Table 7-18. Secondary Treatment Alternatives Summary Alternative Cost Comparison.....	7-39
Table 7-19. Non-Economic Comparison of Secondary Treatment Alternatives	7-40
Table 7-20. Buildout Dry Weather Flow Conditions.....	7-42
Table 7-21. Tertiary Capacity Requirements.....	7-43
Table 7-22. Comparison of Alternative Tertiary Filtration Technologies	7-47
Table 7-23. Design Data for Tertiary Treatment Alternative 1: Expand Existing Filtration System.....	7-50
Table 7-24. Design Data for Tertiary Treatment Alternative 2: Membrane Filtration System in Parallel with Existing Filtration System	7-53
Table 7-25. Design Data for Tertiary Treatment Alternative 3: Replace Existing Filtration System with Membrane Filtration System.....	7-55
Table 7-26. Tertiary Treatment Alternatives Capital Cost Comparison.....	7-57
Table 7-27. Tertiary Treatment Alternatives Annual Operation and Maintenance Cost Comparison.....	7-57
Table 7-28. Tertiary Treatment Alternatives Present Worth Cost Comparison	7-58
Table 7-29. Non-Economic Comparison of Effluent Filtration Alternatives	7-59
Table 7-30. Non-Economic Comparison of UV Disinfection Alternatives.....	7-62
Table 8-1. Solids Loading Projections.....	8-1
Table 8-2. Existing Solids Processing Capacity	8-2
Table 8-3. Potential End Uses for Forms of Class A Biosolids.....	8-5
Table 8-4. Strategy SM1A. Expand ATAD – Design Data.....	8-6
Table 8-5. Strategy SM1B. Expand ATAD and Dewater – Design Data.....	8-8
Table 8-7. Strategy SM2B: Add Dewatering and Lime Stabilization – Design Data	8-12
Table 8-8. Strategy SM2C: Add Dewatering and Composting – Design Data	8-Error! Bookmark not defined.

Table 8-9. Solids Management Strategies Screening Results.....	8-16
Table 8-10. Solids Management Strategies Estimated Capital Costs, 2008 \$ (\$1,000)	8-18
Table 8-11. Estimated Present Worth O&M Cost, 2008 \$ (\$1,000).....	8-19
Table 8-12. Solids Management Strategies Estimated Present Worth Cost, 2008 \$ (\$1,000).....	8-19
Table 8-13. Non-economic Evaluation of Solids Management Strategies.	8-20
Table 8-14. Comparison of Dewatering Technologies.....	8-22
Table 8-15. Unit Cost for Biosolids Disposal and Reuse, \$/dry ton in 2008 \$.....	8-22
Table 9-1. McMinnville WRF Effluent Loads During 2006 Dry Weather Season.....	9-5
Table 9-2. Previous Recycled Water Regulation.....	9-6
Table 9-3. Newly Adopted Reclaimed Water Regulations.....	9-6
Table 9-4. Major Differences Between Previous and Newly Adopted Regulations	9-7
Table 9-5. Typical Tualatin Valley Crop Net Irrigation Rates (inches)	9-8
Table 9-6. Crop Uptake Data (lb/acre)	9-10
Table 9-7. Nutrient Balance Summary	9-11
Table 9-8. Cascade Steel Water Use by Process.....	9-15
Table 10-1. Buildout Design Data	10-2
Table 10-2. Capital Costs for the WRF Recommended Plan	10-22
Table 10-3. Master Plan Equipment Replacement List	10-23
Table 10-4. Recommended Staffing Levels for the Wastewater Reclamation Facility.....	10-26
Table 10-5. Implementation Plan.....	10-27

List of Figures

Figure ES-1. City of McMinnville Existing Wastewater Collection System (2.1)	ES-4
Figure ES-2. City of McMinnville Planning Boundaries (3.1).....	ES-5
Figure ES-3. Sewer System Recommended Improvements 5-year, 24-hour Storm.....	ES-11
Figure ES-4. WRF Site Plan and Layout.....	ES-14
Figure ES-5. Dry Weather Alternative Management Strategy: Expansion of Existing Facilities.....	ES-18
Figure ES-6. Wet Weather Alternative Management Strategy: Collection System Improvements.....	ES-18
Figure ES-7. Recommended Solids Management Strategy.....	ES-22
Figure ES-8. Site Plan and Plant Layout	ES-25
Figure 2-2. City of McMinnville Drainage Basins	2-3

Figure 2-3. City of McMinnville Zoning Map.....	2-8
Figure 3-1. Site Plan and Plant Layout	3-2
Figure 3-2. Process Flow Schematic	3-3
Figure 3-3. Hydraulic Profile.....	3-18
Figure 3-4. Aeration Basin Splitter Box	3-20
Figure 3.5. Typical Orba.....	3-31
Figure 4-1. Average Monthly Plant Influent Flows.....	4-44
Figure 4-2. Average Dry Weather Flow	4-46
Figure 4-3. Average Wet Weather Flow.....	4-46
Figure 4-4. Maximum Month Flows.....	4-47
Figure 4-5. Daily Plant Flow during High Rainfall Events	4-48
Figure 4-6. Calibrated Wet Weather Influent Flows	4-49
Figure 4-7. Simulated MDWWF	4-50
Figure 4-8. Probability Analysis.....	4-51
Figure 4-9. MWWWF Determination.....	4-51
Figure 4-10. Biochemical Oxygen Demand (BOD ₅) Concentrations: 1996-2007	4-53
Figure 4-11. Total Suspended Solids (TSS) Concentrations: 1996-2007.....	4-54
Figure 4-12. Daily Plant BOD5 Loading: 1996-2007	4-54
Figure 4-13. Daily Plant TSS Loading: 1996-2007	4-55
Figure 4-14. Average Monthly BOD5 Load.....	4-55
Figure 4-15. Average Monthly TSS Load	4-56
Figure 4-16. Ammonia Concentrations.....	4-57
Figure 4-17. Phosphorus Concentrations.....	4-57
Figure 4-18. Daily Ammonia Loading.....	4-58
Figure 4-19. Daily Phosphorus Loading.....	4-58
Figure 4-20. Buildout Flow Probability Analysis.....	4-62
Figure 5-1. Reasonable Potential Analysis for Aquatic Life Criteria.....	5-8
Figure 5-2. Reasonable Potential Analysis for Human Health Criteria.....	5-9
Figure 7-1. Dry Weather Alternative Management Strategy: Expansion of Existing Facilities	7-4
Figure 7-2. Dry Weather Alternative Management Strategy: Membrane Treatment.....	7-4
Figure 7-3. Dry Weather Alternative Management Strategy: Dry Weather Reuse	7-5
Figure 7-4. Dry Weather Alternative Management Strategy: Zero Discharge.....	7-6
Figure 7-5. Dry Weather Alternative Management Strategy: Subsurface Discharge.....	7-6

Figure 7-6. Dry Weather Alternative Management Strategy: Effluent Cooling.....	7-7
Figure 7-7 Dry Weather Alternative Management Strategy: Constructed Wetlands	7-7
Figure 7-8. Wet Weather Alternative Management Strategy: Expansion of WRF	7-8
Figure 7-9. Wet Weather Alternative Management Strategy: Collection System Improvements.....	7-8
Figure 7-10. Wet Weather Alternative Management Strategy: Peak Flow Attenuation Through Storage	7-8
Figure 7-11. Wet Weather Alternative Management Strategy: Satellite Treatment Facility	7-9
Figure 7-12. Orbal Capacity during Maximum Month Dry Weather Flow and Loading Conditions at 2500 mg/l of MLSS	7-23
Figure 7-13. Orbal Capacity during Maximum Month Dry Weather Flow and Loading Conditions at 3000 mg/L of MLSS.....	7-24
Figure 7-14. Orbal Capacity during Maximum Month Dry Weather Flow and Loading Conditions at 3500 mg/L of MLSS.....	7-24
Figure 7-15. Orbal Capacity during Average Dry Weather Flow and Maximum Month Loading Conditions at 3500 mg/L of MLSS.....	7-25
Figure 7-16. Average Plant and River Flow Relationship.....	7-27
Figure 7-17. Secondary Treatment Alternative 1: Third Secondary Treatment Train Process Flow Schematic.....	7-34
Figure 7-18. Secondary Treatment Alternative 2: Third Orbal and Wet Weather Upgrades Process Flow Schematic	7-37
Figure 7-19. Typical Dry Weather Flow Variations at the WRF	7-42
Figure 7-20. Flow Schematic for Tertiary Filtration Alternative 1: Expand Existing Filtration System	7-51
Figure 7-21. Flow Schematic for Tertiary Filtration Alternative 2: Parallel Membrane Filtration System	7-54
Figure 7-22. Flow Schematic for Tertiary Filtration Alternative 3: Replace Existing Facilities with a Membrane Filtration System.....	7-56
Figure 8-1. Strategy SM1A: Expand ATAD Facilities.....	8-7
Figure 8-2. Strategy SM1B: Expand ATAD Facilities and Dewater.....	8-9
Figure 8-3. Strategy SM2A: Add Dewater and Thermal Drying.....	8-11
Figure 8-4. Strategy SM2B: Add Dewatering and Lime Stabilization.....	8-13
Figure 8-5. Strategy SM2C. Add Dewatering and Composting	8-15
Figure 9-1. TMDL Stepped Approach to Phosphorus Waste Load Allocation.....	9-3
Figure 9-2. Variation of Phosphorus Waste Load Allocation with South Yamhill River Flow.	9-4
Figure 9-3. Site Map	9-9
Figure 9-4. Wetland Temperature Reduction	9-13

Figure 9-5. Cascade Steel Water Use History 9-14
Figure 9-6. Joe Dancer Park Water Use History..... 9-16
Figure 9-7. Combined Industrial Water Demand 9-17
Figure 10-1. Site Plan and Plant Layout 10-12
Figure 10-2. Liquid Stream Process Flow Schematic..... 10-13
Figure 10-3. Biosolids Handling Process Flow Schematic..... 10-18
Figure 10-4. Estimated Capital Equipment Replacement Plan..... 10-29