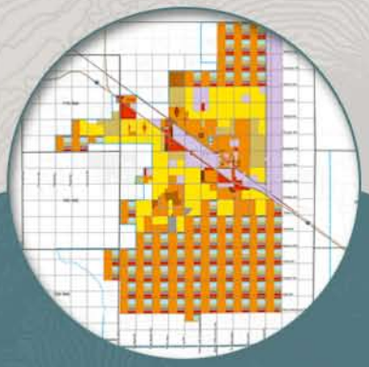
FINAL

City of Eloy, Arizona

Wastewater Master Plan

Summary Report

September 2007



carollo

Engineers...Working Wonders With Water™

City of Eloy

WASTEWATER MASTER PLAN

SUMMARY REPORT

FINAL

September 2007

Registered Professional Engineer (Civil)
CERTIFICATE NO.
35483
RUSSELL A.
WACHTER
Date Signed 9-20-07
ARIZONA, U. S. A.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
14615
MARK EVERETT
COURTNEY
Date Signed 9/20/07
ARIZONA, U. S. A.

carollo
Engineers...Working Wonders With Water™

3033 NORTH 44TH STREET • SUITE 101 • PHOENIX, ARIZONA 85018 • (602) 263-9500 • FAX (602) 265-1422
H:\Client\Eloy_PHXW\7266B00\Rpt\Final\Summary Report-Final.doc

City of Eloy
Wastewater Master Plan

SUMMARY REPORT

TABLE OF CONTENTS

Page No.

Chapter 1 INTRODUCTION

Chapter 2 PLANNING AREA
2.1 EXISTING PLANNING AREAS 2-1
2.2 REVISED PLANNING AREAS 2-1
2.3 WASTEWATER SUB-BASINS 2-1

Chapter 3 LAND USE, POPULATION AND FLOW PROJECTIONS
3.1 EXISTING AND FUTURE LAND USE 3-1
3.2 POPULATION PROJECTIONS 3-3
3.3 FLOW PROJECTIONS 3-4

Chapter 4 EXISTING WWTP EVALUATION AND EXPANSION PLANNING
4.1 EXISTING PLANT 4-1
4.2 FUTURE PLANT FLOWS AND ALTERNATIVES 4-3
4.3 WWTP PROJECT PHASES 4-6
4.3.1 Phase 1 4-6
4.3.2 Phase 2 4-6
4.3.3 Buildout 4-7
4.4 EXISTING WWTP EFFLUENT REUSE AND DISPOSAL 4-10
4.5 SOLIDS DISPOSAL 4-10

Chapter 5 SUB-BASIN COLLECTION AND TREATMENT SYSTEM 5-1
5.1 SOFTWARE SELECTION 5-1
5.2 COLLECTION SYSTEM DESIGN CRITERIA 5-2
5.3 SUB-BASIN COLLECTION SYSTEM 5-6
5.4 WRF DESIGN AND CONSTRUCTION GUIDELINES 5-6

Registered Professional Engineer (Civil)
CERTIFICATE NO.
25483
RUSSELL A.
WACHTER
Date Signed 9-21-07
ARIZONA, U.S.A.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
14615
MARK EVERETT
COURTNEY
Date Signed 9/20/07
ARIZONA, U.S.A.

Chapter 6 IMPLEMENTATION PLAN 6-1
6.1 INTRODUCTION 6-1
6.2 WATER RECLAMATION FACILITIES 6-1
6.2.1 Basic Requirements 6-1
6.2.2 Design Considerations 6-2
6.3 COLLECTION SYSTEM 6-3
6.3.1 Sewer Sizing 6-4
6.3.2 Lift Stations 6-4
6.4 EXISTING WWTP EXPANSION 6-4

APPENDIX A – Type the name of Appendix A here if there is one
APPENDIX B – Type the name of Appendix B here if there is one

LIST OF TABLES

Table 1 Land Use Classifications 3-1
Table 2 Summary of Developed Acres 3-3
Table 3 Land Use Based Population Estimates (by Sub-Basin) 3-4
Table 4 Summary of Wastewater Unit Flows 3-5
Table 5 Land Use Based Population/Flow Projections (by Sub-Basin) 3-6
Table 6 Summary of WWTP and APP Parameters 4-3
Table 7 Expansion Plan Matrix - Existing WWTP Evaluation and Expansion Plan ... 4-11
Table 8 Software Selection 5-3
Table 9 Wastewater System Criteria Summary 5-5
Table 10 Preliminary Opinion of Costs 6-5

LIST OF FIGURES

Figure 1 Existing DMA Boundaries 2-2
Figure 2 Proposed Planned Developments 2-3
Figure 3 Adopted Planning Area and Proposed DMA Area 2-4
Figure 4 WRF Sub-Basins 2-5
Figure 5 Land Use Plan 3-2
Figure 6 Existing WWTP Layout 4-2
Figure 7 Schematic of Existing WWTP Process 4-4
Figure 8 Buildout WWTP Process Schematic 4-8
Figure 9 Buildout WWTP Layout 4-9
Figure 10 Sub-Basin Collection System 5-7
Figure 11 Pipe Diameters and Flow Rates - Sewer System at Buildout 5-8
Figure 12 Manhole Invert and Rim Elevations- Sewer System at Buildout 5-9

LIST OF APPENDICES

Appendix A	Technical Memorandum No. 1 - Existing Wastewater Treatment Plant Evaluation and Expansion Plan, September 2006
Appendix B	Technical Memorandum No. 2 - Phased Regional Wastewater Reclamation Facilities Review and Approval Process, September 2006
Appendix C	Technical Memorandum No. 3 - Phased Regional Water Reclamation Facility Design and Construction Guidelines, September 2006
Appendix D	Technical Memorandum No. 4 - Software Selection, March 2006
Appendix E	Cost Summary Documentation

Chapter 1

INTRODUCTION

The City of Eloy (City) has recently received tremendous interest from developers wishing to build within its existing Planning and Designated Management Agency (DMA) area, as well as in adjacent areas. To be prepared for this potential growth, the City has undertaken the development of a Wastewater Master Plan. This document describes the results of this planning effort.

To fund the planning effort, the City was assisted by a consortium of private developers and landowners who have tracts of land located in the project planning area.

The approach used in the development of the Wastewater Master Plan was to complete a series of Technical Memoranda (TMs). These Memoranda are summarized in this Summary Report. The full detailed TMs are included as appendices under separate tabs within this Summary Report. They include:

TM 1 – Existing Wastewater Treatment Plant Evaluation and Expansion Plan

TM 2 – Phased Regional Wastewater Reclamation Facilities (WRF), Review and Approval Process

TM 3 – Phased Regional Water Reclamation Facility Design and Construction Guidelines

TM 4 – Software Selection

In addition to development of the TMs and this summary report, a 208 Amendment was produced as a separate document. The Amendment defined the proposed expansion of the City's DMA area, and it revised the water quality management plan to include expansion of the existing treatment plant and future development of eight new WRFs in the planning area. The Amendment is currently in the final stages of the approval process through the Central Arizona Association of Governments (CAAG).

PLANNING AREA

2.1 EXISTING PLANNING AREAS

Figure 1 shows the original City planning area and the existing 208 Designated Management Area (DMA). These encompassed an area of approximately 97 square miles.

2.2 REVISED PLANNING AREAS

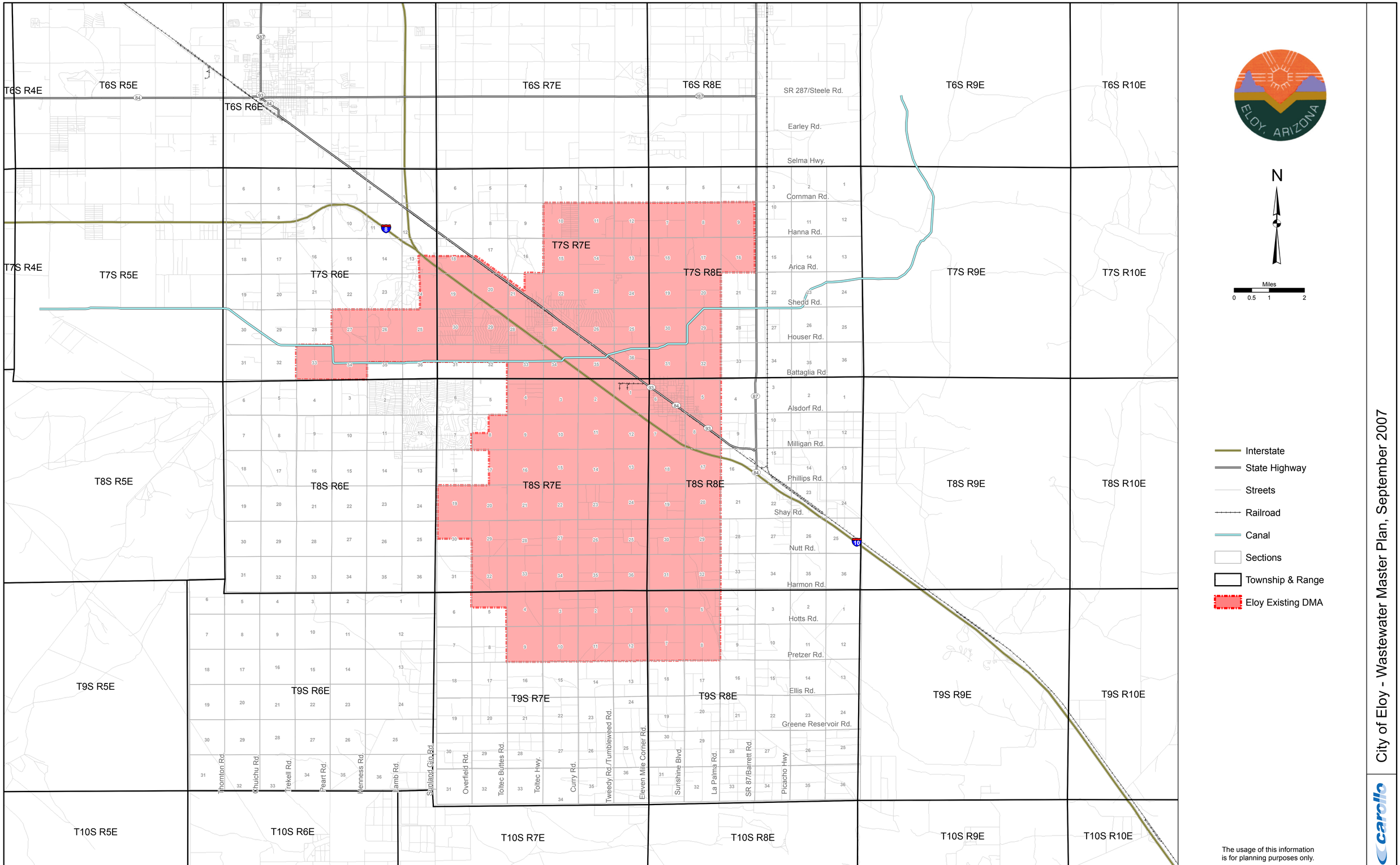
To identify the new planning area, Eloy identified the known planned developments in the surrounding area. These planned developments are shown on Figure 2. Based on the location of these developments and other factors, a revised Planning Area was identified and adopted by the City in 2006. This revised Planning Area covers an area of approximately 256 square miles.

With this expanded Planning Area, the 208 DMA was also expanded to encompass many of the planned developments. However, the proposed DMA (158 square miles) is currently smaller than the Planning Area in order to minimize inter-governmental concerns.

Figure 3 shows the revised adopted Planning Area and the proposed DMA area.

2.3 WASTEWATER SUB-BASINS

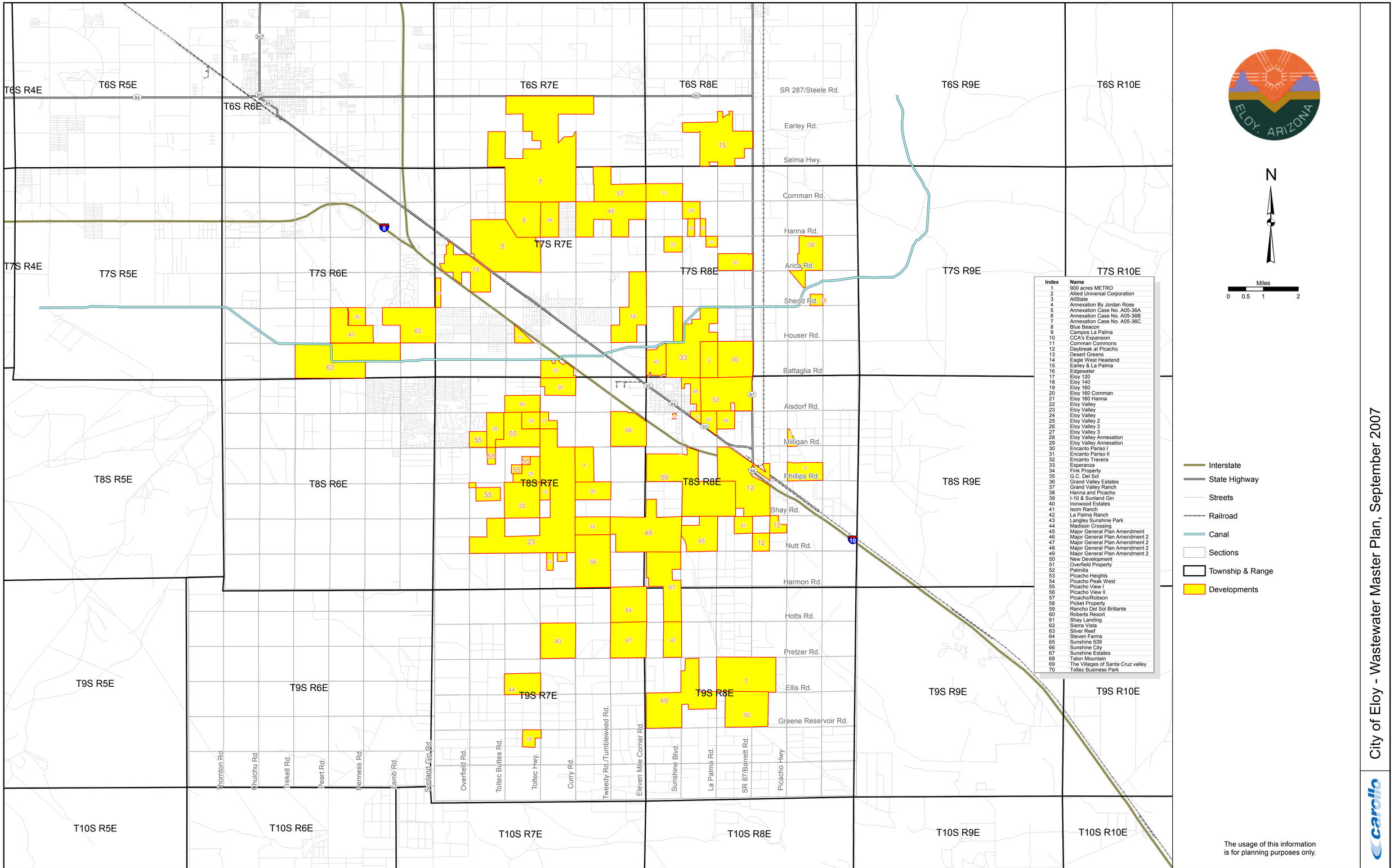
Given the size of the proposed Eloy DMA Area, topography, and infrastructure boundaries (such as Interstate 10, State Highway 84, Santa Rosa Canal, railroad, etc.), it was determined that a multi-plant regional water reclamation system (as opposed to one large centralized treatment facility) would be a more effective means of treating and reclaiming wastewater within the planning area. Figure 4 shows the proposed DMA divided into nine (9) sub-basin areas -- the existing plant sub-basin (Sub-Basin 1) and eight (8) new sub-basin areas. These areas were identified based on the topography, developer's plans, and physical boundaries such as roads, railroads, etc.



EXISTING DMA AREA

Figure 1

M:\Client\Eloy_PHXMP\7266B00 Eloy Sewer Study-TO#3\Analysis\GIS Analysis\Maps\Sept 07\Fig1_DMAboundaries.mxd

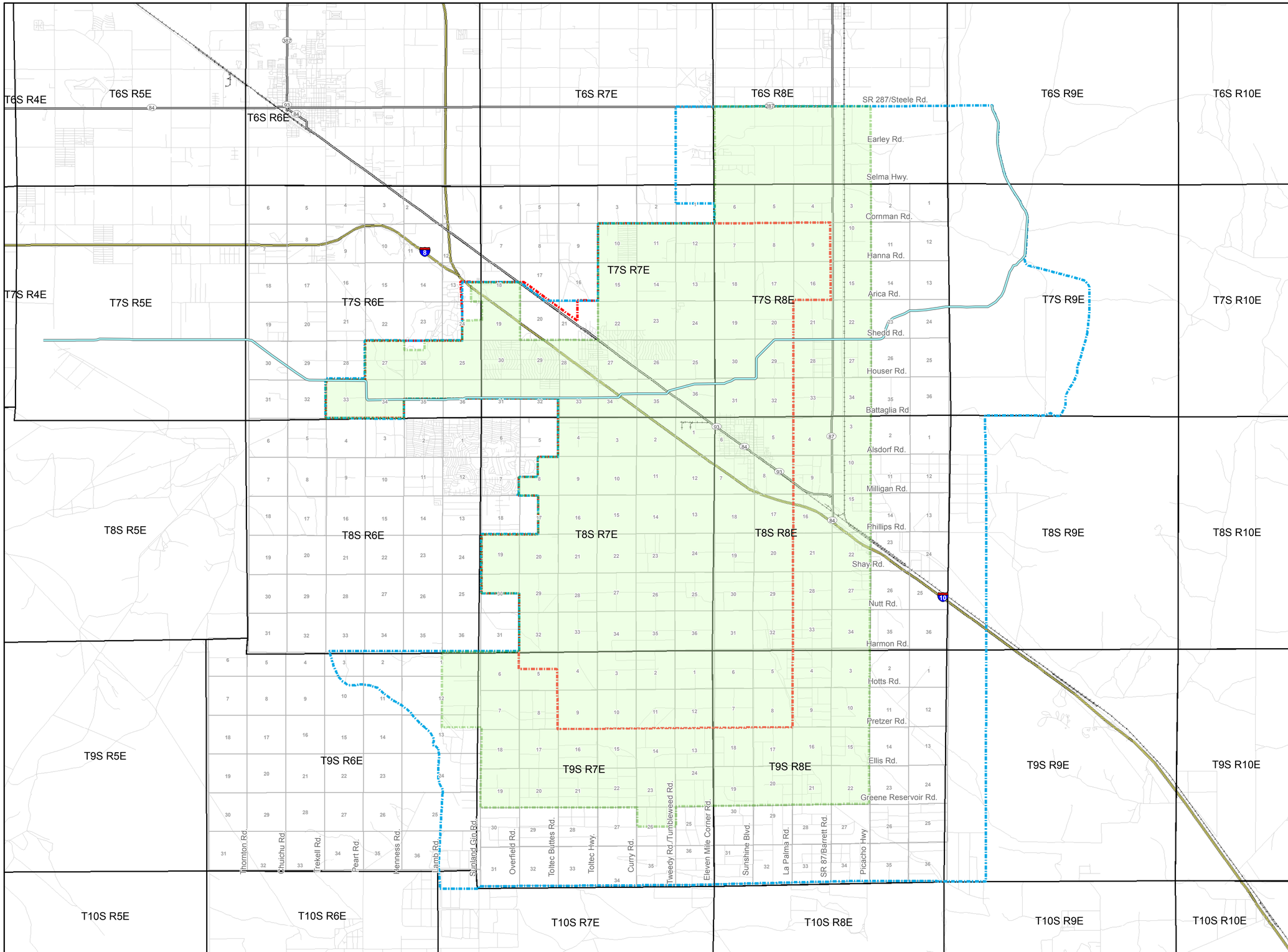


Index	Name
1	900 acres METRO
2	Allied Universal Corporation
3	AllState
4	Annexation By Jordan Rose
5	Annexation Case No. A05-36A
6	Annexation Case No. A05-36B
7	Annexation Case No. A05-36C
8	Blue Beacon
9	Campos La Palma
10	CCA's Expansion
11	Cornman Commons
12	Daybreak at Picacho
13	Desert Greens
14	Eagle West Headend
15	Earley & La Palma
16	Edgewater
17	Eloy 120
18	Eloy 140
19	Eloy 160
20	Eloy 160 Cornman
21	Eloy 160 Hanna
22	Eloy Valley
23	Eloy Valley
24	Eloy Valley
25	Eloy Valley 2
26	Eloy Valley 3
27	Eloy Valley 3
28	Eloy Valley Annexation
29	Eloy Valley Annexation
30	Encanto Pariso I
31	Encanto Pariso II
32	Encanto Travera
33	Esperanza
34	Fink Property
35	G.C. Del Sol
36	Grand Valley Estates
37	Grand Valley Ranch
38	Hanna and Picacho
39	I-10 & Sunland Gin
40	Ironwood Estates
41	Isom Ranch
42	La Palma Ranch
43	Langley Sunshine Park
44	Madison Crossing
45	Major General Plan Amendment
46	Major General Plan Amendment 2
47	Major General Plan Amendment 2
48	Major General Plan Amendment 2
49	Major General Plan Amendment 2
50	New Development
51	Overfield Property
52	Palmilla
53	Picacho Heights
54	Picacho Peak West
55	Picacho View I
56	Picacho View II
57	Picacho/Robson
58	Picket Property
59	Rancho Del Sol Brillante
60	Roberts Resort
61	Shay Landing
62	Sierra Vista
63	Silver Reef
64	Steven Farms
65	Sunshine 539
66	Sunshine City
67	Sunshine Estates
68	Talon Mountain
69	The Villages of Santa Cruz valley
70	Toltec Business Park

PROPOSED ELOY AREA DEVELOPMENTS

Figure 2

M:\Client\Eloy_PHXMP\7266B00 Eloy Sewer Study-TO#3\Analysis\GIS Analysis\Maps\Sept 07\Fig2_Proposeddevelopments.mxd



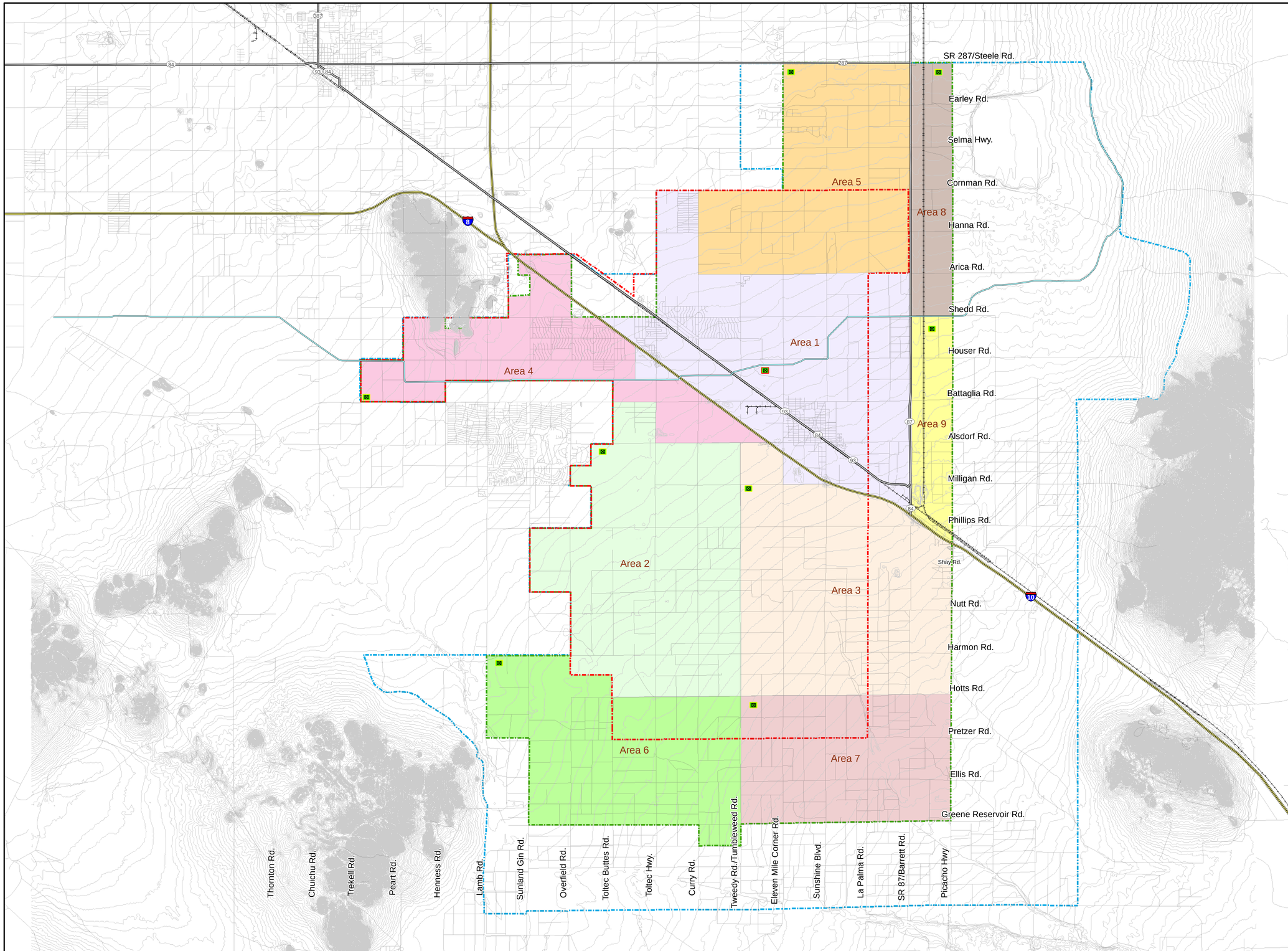
City of Eloy - Wastewater Master Plan, September 2007

carollo

EXISTING AND PROPOSED DMA AREAS

Figure 3

M:\Client\Eloy_PHXMP\7266B00 Eloy Sewer Study-TO#3\Analysis\GIS Analysis\Maps\Sept 07\Fig3_Existing and Proposed 208 Planning and DMA Areas.mxd



Notes:

1. The Transportation layers are GIS data from ESRI Data & Maps (2004).

2. The planning boundary and developments are based on information obtained from the City of Eloy.

3. This GIS map is a limited representation of facilities, intended for planning purposes only. It is not intended for construction or other purposes requiring greater positional accuracy.

City of Eloy - Wastewater Master Plan, September 2007

carollo

WATER RECLAMATION FACILITY (WRF) SUB-BASINS

Figure 4

M:\Client\Eloy_PHXMP\7266B00 Eloy Sewer Study-TO#3\Analysis\GIS Analysis\Maps\Sept 07\Fig4_WRF Sub-Basins.mxd

LAND USE, POPULATION AND FLOW PROJECTIONS

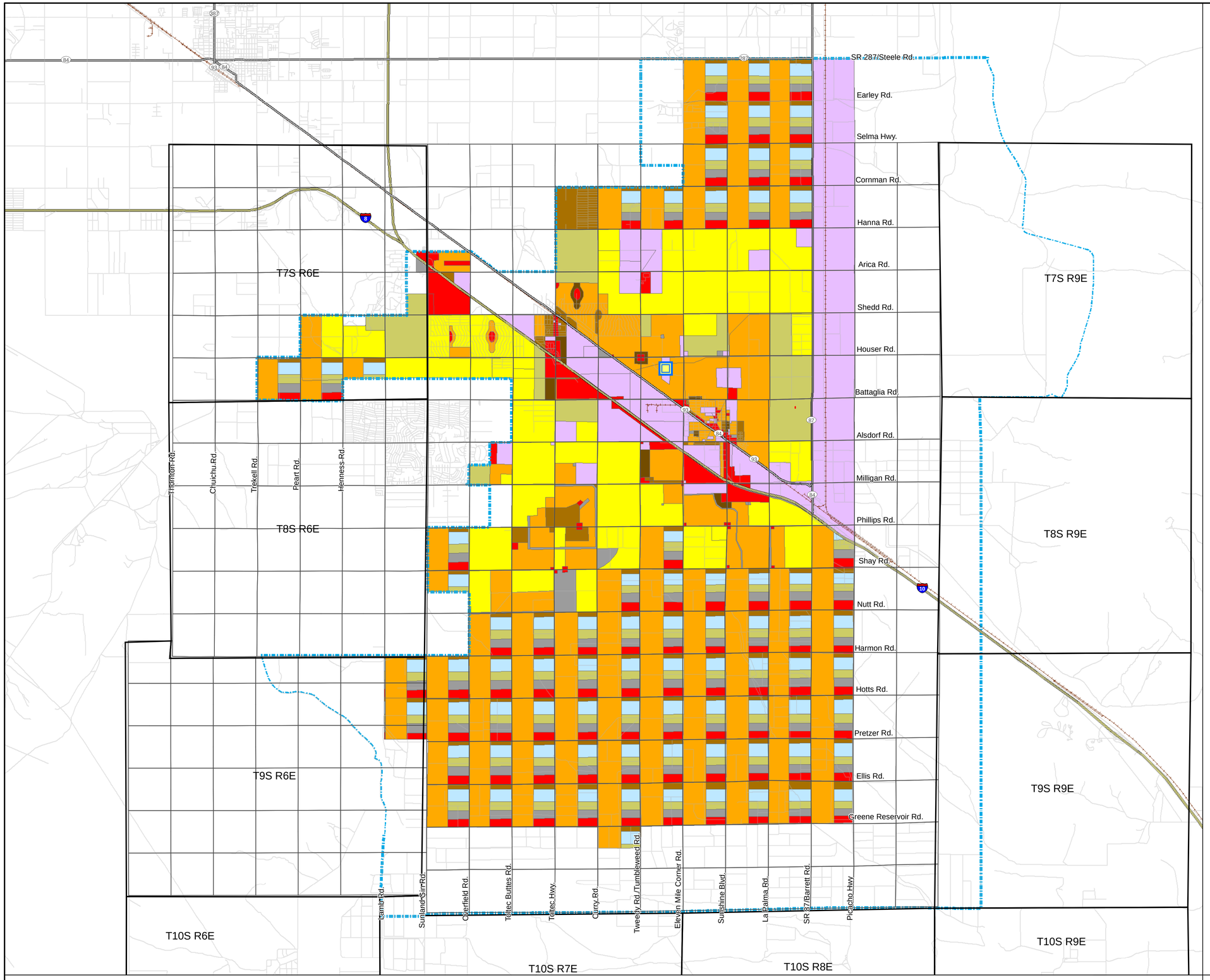
3.1 EXISTING AND FUTURE LAND USE

The City's general plan identifies the land uses in the existing planning area. Figure 5 shows this land use. Categories of the different land uses utilized in the plan are shown in Table 1.

Table 1 Land Use Classifications
Wastewater Master Plan
City of Eloy

Land Use Category	Dwelling Density (DU/AC)(1)
High Density Residential	14
Medium High Density Residential	10
Medium Density Residential	4
Low Density Residential	1
Rural Residential	0.5
Commercial	-
Industrial	-
Public/Institutional	-
Other	-

(1) Dwelling unit per acre.

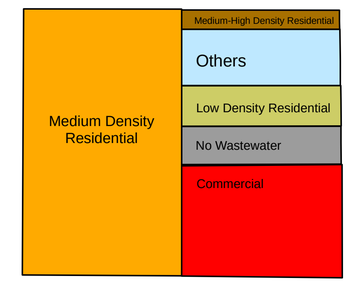


N

Miles

0 1 2 4

Typical Square Mile Breakdown:



- Existing Wastewater Treatment Plant
- Streets
- Interstate
- State Highway
- Railroad
- Sections
- Township & Range
- Eloy Adopted Planning Area (2006)

Land Use

- Rural Residential (0.5 DU/AC)
- Low Density Residential (1 DU/AC)
- Medium Density Residential (4 DU/AC)
- Medium-High Density Residential (10 DU/AC)
- High Density Residential (14 DU/AC)
- Commercial
- Institutional / Public / Industrial
- Others
- No Wastewater

Land Use Category	Area (Acres)	% of Square Mile
Low Density Residential	64	10
Medium Density Residential	320	50
Medium-High Density Residential	32	5
Others	96	15
Commercial	64	10
No Wastewater	64	10

The usage of of this information is for planning purposes only.

City of Eloy - Wastewater Master Plan, September 2007

carollo

LAND USE PLAN

Figure 5

M:\Client\Eloy_PHXMP\7266B00 Eloy Sewer Study-TO#3\Analysis\GIS Analysis\Maps\Sept 07\Fig5_Land Use Map.mxd

Portions of the proposed DMA area do not yet have a defined land use plan and some larger portions are "generically" defined as low density residential. To assist in the estimation of future wastewater flows from the proposed DMA area, some form of land use planning is required. To this end, a "typical" square mile of land uses was developed. The "typical" land use was used for portions of the planning area that lack specific land use designations, and for large areas designated as low density residential to more accurately represent a likely mix of land uses. This "typical" land use plan for the revised DMA area is shown on Figure 5. Table 2 shows a summary of the estimated buildout acreage.

Table 2 Summary of Developed Acres
Wastewater Master Plan
City of Eloy

Land Use Category	Developed Acres at Buildout
High Density Residential	418
Medium High Density Residential	4,108
Medium Density Residential	36,055
Low Density Residential	9,403
Rural Residential	17,885
Commercial	7,249
Industrial	7,807
Public/Institutional	1,895
Other	8,113

3.2 POPULATION PROJECTIONS

The Eloy population in the existing WWTP service area (Sub-Basin 1) in 2005 was estimated at 10,375.

To develop some estimate of the 10- to 20-year future population in the nine sub-basins, projections were made as to possible starting and buildout dates for the known developments in the DMA area (Figure 2). For the areas with no currently defined developments, an assessment was made that 25 percent of the area would start development by 2020.

Table 3 shows the estimated projected population in the wastewater sub-basins through 2030. Also shown in the table is the projected buildout population for the DMA area based on the land use plan and related densities.

Table 3	Land Use Based Population Estimates (by Sub-Basin) Wastewater Master Plan City of Eloy				
Year	**2005 Population**	**2010[1] Population**	**2020 Population**	**2030 Population**	**Buildout Population**
Sub-Basin 1	10,375	44,347	77,607	115,080	115,080
Sub-Basin 2	0	0	35,770	95,047	102,201
Sub-Basin 3	0	0	42,389	112,633	121,111
Sub-Basin 4	0	0	12,285	34,503	37,100
Sub-Basin 5	0	0	26,099	69,348	74,568
Sub-Basin 6	0	0	34,253	91,015	97,866
Sub-Basin 7	0	0	30,137	74,020	80,557
Sub-Basin 8[2]	0	0	0	0	0
Sub-Basin 9[2]	0	0	0	0	0
Totals	**10,375**	**44,347**	**258,540**	**591,647**	**628,484**

Notes:

(1) Although some of the new WRFs may start with initial flows in the 2010 timeframe, they are shown beyond 2010 for planning level estimates.

(2) Sub-Basins 8 and 9 include only commercial/industrial flows, with zero population.

3.3 FLOW PROJECTIONS

The critical element in the design of a wastewater collection and treatment system is the amount of wastewater, gallons per day (gpd) or mgd, to be collected, transported, treated, and reclaimed. In master planning, this flow is generally estimated from the land use where each type of land use generates a particular volume of wastewater (gallons per acre per day, gpad). For residential land use, the land use classification defines the number of dwelling units per acre (DU/AC) (see Table 1), and the City Planning Department identifies the average number of persons per dwelling unit. In Eloy, this has been estimated as 3.0 persons per dwelling unit. Table 4 shows the unit flows for the Eloy Wastewater Master Plan. Since no flow measurements have been made in Eloy, the unit flows used in the planning are typical for communities similar to Eloy.

Table 4	**Summary of Wastewater Unit Flows Wastewater Master Plan City of Eloy**
Land Use Category	**Unit Flows**
High Density Residential	65 gpcd
Medium High Density Residential	65 gpcd
Medium Density Residential	65 gpcd
Low Density Residential	65 gpcd
Rural Residential	65 gpcd
Commercial	1,000 gpad
Industrial	1,000 gpad
Public/Institutional	500 gpad
Other	1,000 gpad

The estimated flow from the planning area for residential is calculated by multiplying the area (acres), by the housing density (DU/AC), by the estimated number of people per dwelling unit (3), and by the unit flow (gpcd).

Residential flow = acres x DU/AC x 3.0 x 65 (gpcd)

For industrial and commercial land uses, the flow is estimated by multiplying the acres by the unit flow for the type of land use.

Industrial/Commercial flow = acres x unit flow (gpad)

Table 5 shows the estimated projected population and flow from the wastewater sub-basins through 2030. Also shown in the table is the projected buildout population and wastewater flows for the DMA area.

Table 5 Land Use Based Population/Flow Projections (by Sub-Basin)
Wastewater Master Plan
City of Eloy

Year	2005		2010(1)		2020		2030		Buildout	
	Population	Flow (mgd)	Population	Flow (mgd)	Population	Flow (mgd)	Population	Flow (mgd)	Population	Flow (mgd)
Sub-Basin 1	10,375	0.74	44,347	4.0	77,607	7.0	115,080	10.38	115,080	10.38
Sub-Basin 2	0	0	0	0	35,770	2.10	95,047	6.48	102,201	8.41
Sub-Basin 3	0	0	0	0	42,389	2.69	112,633	8.28	121,111	10.75
Sub-Basin 4	0	0	0	0	12,285	1.08	34,503	3.33	37,100	4.32
Sub-Basin 5	0	0	0	0	26,099	1.90	69,348	5.86	74,568	7.61
Sub-Basin 6	0	0	0	0	34,253	2.33	91,015	7.17	97,866	9.31
Sub-Basin 7	0	0	0	0	30,137	1.88	74,020	5.78	80,557	7.51
Sub-Basin 8(2)	0	0	0	0	0	0.96	0	2.94	0	3.82
Sub-Basin 9(2)	0	0	0	0	0	1.06	0	2.58	0	3.20
Totals	**10,375**	**0.74**	**44,347**	**4.0**	**258,540**	**21.0**	**591,647**	**52.8**	**628,484**	**65.31**

Notes:

(1) Although some of the new WRFs may start with initial flows in the 2010 timeframe, they are shown beyond 2010 for planning level estimates.

(2) Sub-Basins 8 and 9 include only commercial/industrial flows, with zero population.

EXISTING WWTP EVALUATION AND EXPANSION PLANNING

A detailed description of the WWTP evaluation and proposed expansion is contained in Technical Memorandum No. 1 – Existing WWTP Evaluation and Expansion Plan (see Appendix A).

4.1 EXISTING PLANT

A wastewater treatment facility has been located at the existing 51.6 acre site for many years and it serves Wastewater Sub-Basin No. 1. Before the current facility was constructed at the site, the previous treatment facility included four aerated lagoons with four recharge basins. In 1998, the facility was upgraded to include the following:

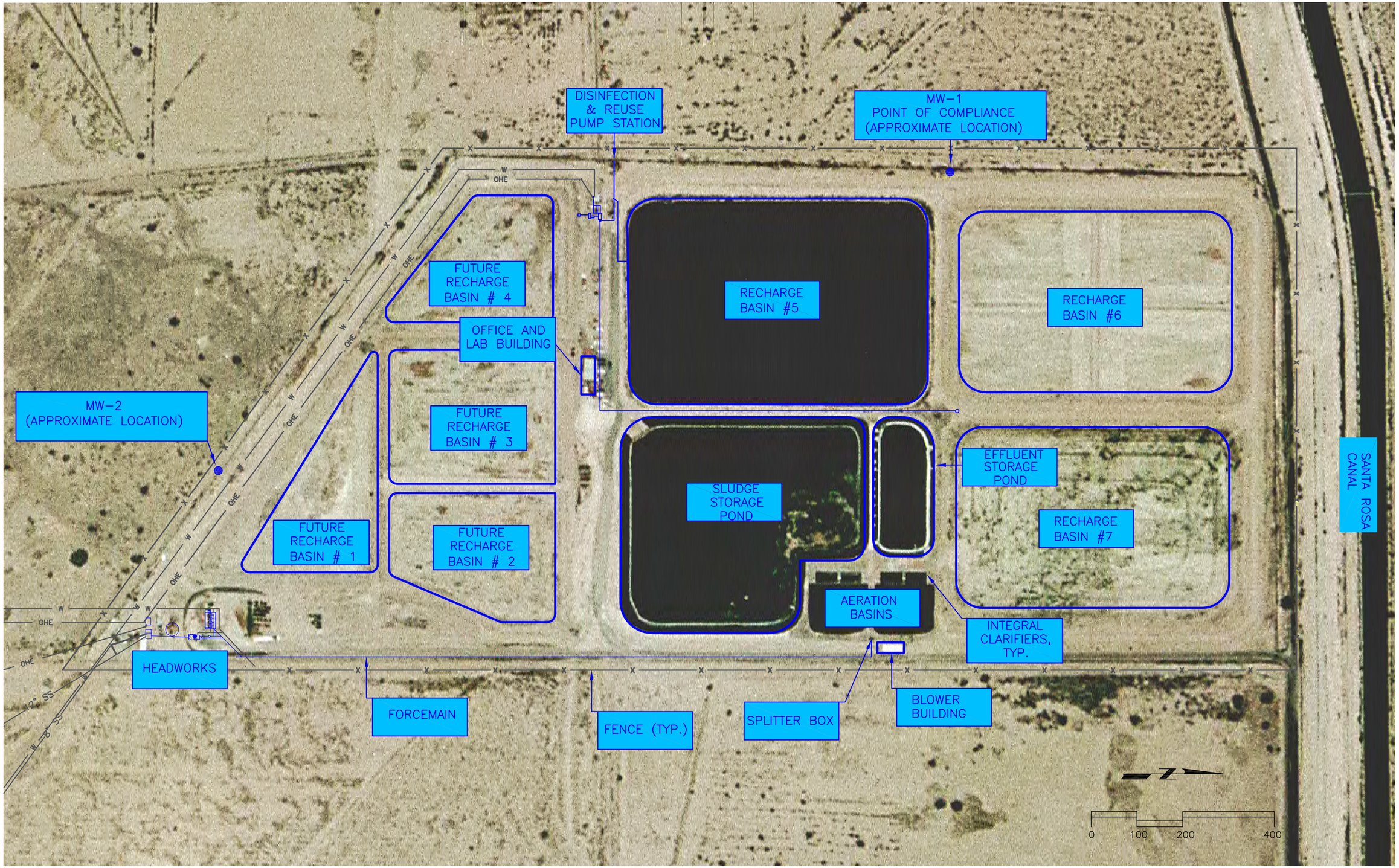
- Influent pump station
- Static screens (4 units)
- Extended aeration biological process for nitrogen removal (Biolac®) (2 basins)
- Integrated secondary clarifiers (4 clarifiers)
- Effluent storage pond
- Effluent recharge basins (3 basins)

The plant also has a chlorine contact chamber, a bulk hypochlorite storage tank, and an effluent pump. However, the disinfection and effluent pumping systems are not used since agriculture irrigation is no longer an acceptable disposal option and the reuse permit has lapsed.

Treated effluent from the secondary clarifiers flows to the effluent storage pond, and from there it is directed to the recharge basins. The discharge to the basins is cycled between basins to allow for wet and dry cycles. The estimated recharge rate for the basins is approximately 1.2 feet/acre/day, which was set at 0.6 feet/acre/day for the design of the basins to account for the wet-dry cycling.

Solids from the treatment process are initially directed to a sludge holding pond, with the dried sludge sent to the City landfill for disposal. Figure 6 shows the layout of the existing plant.

The plant operates under an Aquifer Protection Permit (APP) No. 101689, dated March 21, 2005. Table 6 shows the permit standards and the current plant effluent quality.



City of Eloy – Wastewater Master Plan, September 2007

carollo Engineers...Working Wonders With Water™

EXISTING WASTEWATER TREATMENT PLANT LAYOUT

Figure 6

H:\Client\ELOY_PHXC\7266B00\TASK004\MP.FIG-6 9-20-07 08:09am TTNguyen ; 1117-bdr.208 ;20060302085357.bmp;H:\CanonScans\CAD\1st Floor\20060302085357.tif;eloy_image.tif

Table 6	Summary of WWTP and APP Parameters Wastewater Master Plan City of Eloy	
Parameter	**Plant Effluent**	**APP Standard**
Average Annual Flow, mgd	0.74	1.90
Maximum Discharge, mgd	0.89	2.0
Total Nitrogen, Average, mg/L	3.4	8.0
Total Nitrogen, Maximum, mg/L	4.2	10.0

In summary, the plant is currently operating at approximately 37 percent of its capacity of 2.0 mgd and is producing a well-treated effluent that meets all permit requirements. Also, with the low plant loading, the solids produced at the plant are well digested and dry easily for disposal. Figure 7 shows a schematic of the existing WWTP process.

4.2 FUTURE PLANT FLOWS AND ALTERNATIVES

Based on the land use plan for Sub-Basin No. 1, the buildout population is expected to be approximately 125,000 with an average annual wastewater flow of 10.38 mgd (see Table 5). To adequately treat such a flow, the existing plant will have to be modified. Successfully expanding the existing plant from 2.0 mgd to its nominal buildout capacity of 10.5 mgd requires careful thought and the development of a long-term conceptual plan.

Some of the issues considered in the conceptual planning for the WWTP expansion included:

- Short-term expansion versus buildout expansion needs
- Future setback requirements
- Good neighbor practices
- Unit process footprints
- Headworks
- Secondary treatment
- Solids handling and disposal
- Tertiary treatment for turbidity removal and disinfection
- Odor, noise, and aesthetic controls
- Effluent reuse and disposal requirements and options
- Project phasing

EXISTING WWTP PROCESS SCHEMATIC

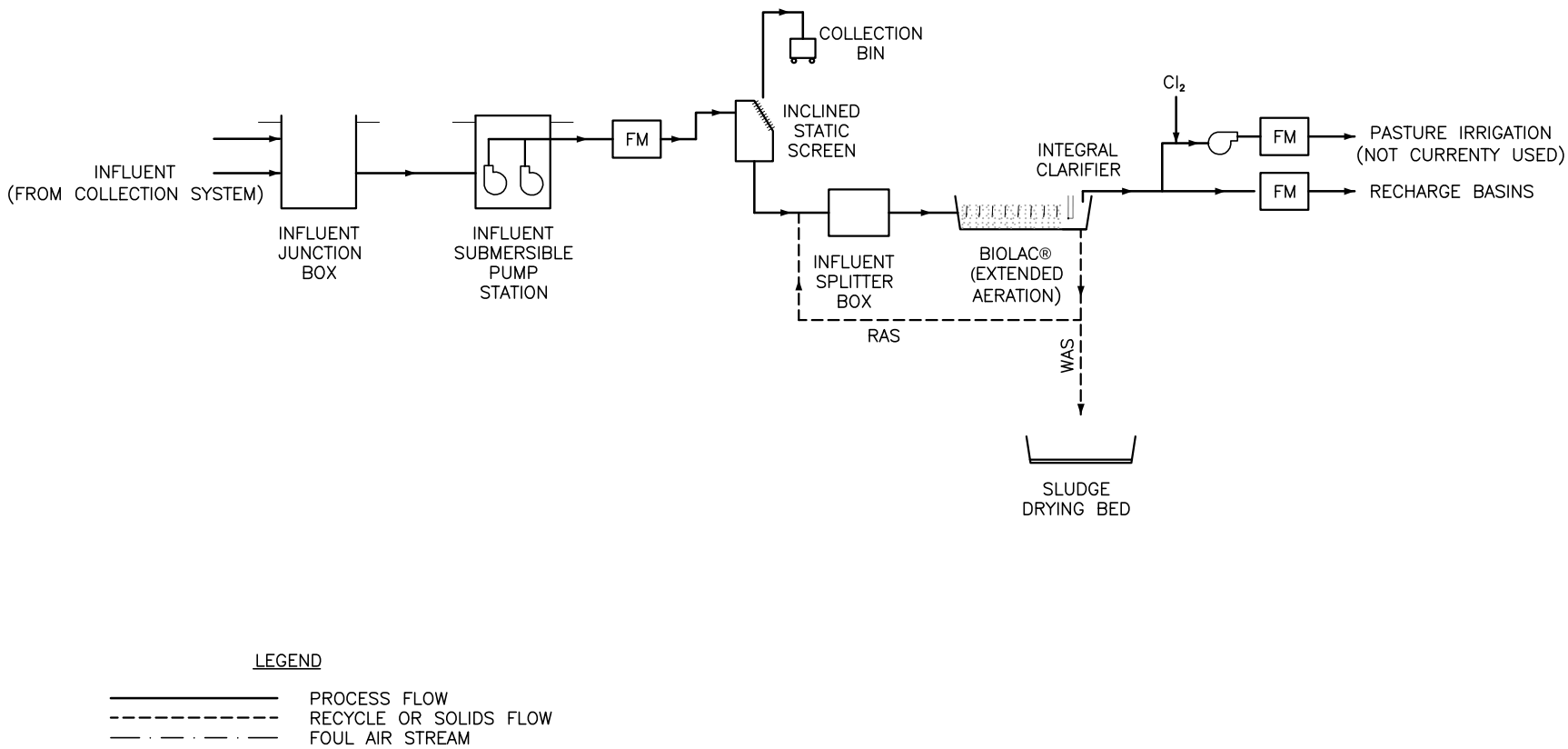


Figure 7

carollo
Engineers...Working Wonders With Water ™

City of Eloy – Wastewater Master Plan, September 2007

H:\Client\ELOY PHXC\726800\TASK004\MP FIG-7 9-18-07 03:30pm TTNguyen . MP-hdr-208

Some of the conclusions drawn from the WWTP analysis are:

- The plant expansion will likely be completed in three to four separate phases.
- The headworks will have to be replaced. The new headworks should contain an influent lift station, mechanically cleaned screens, grit removal (not required during initial expansion phase), and odor control.
- The Phase I Expansion may include a new headworks, adding one 2-mgd Biolac® unit with integral clarifiers, expanding and upgrading the existing disinfection system, and continuation with the present sludge treatment handling system.
- The Biolac® secondary treatment system should not be included in any expansion beyond 4.0 mgd. It is too land intensive and inefficient and as such, is generally not a suitable technology for larger treatment facilities.
- Expansion beyond 4.0 mgd should consider a more conventional secondary treatment process, with nitrogen removal. This will reduce the footprint of the plant. Another option is utilizing a membrane biological reactor (MBR) process, which has an even smaller footprint. However, MBR plants can be more expensive and more difficult to operate. When decisions are made for systems beyond the 4.0 mgd size, the MBR option should be revisited.
- Include external secondary clarifiers for expansion beyond 4.0 mgd.
- Build a new effluent pump station.
- Replace the existing chlorine disinfection system with ultraviolet light (UV) disinfection. This reduces the amount of hazardous materials on site as well as reducing the formation of disinfection byproducts. However, the use of bulk hypochlorite is a practical alternative that may be continued.
- Add tertiary filtration to meet Class A+ if this effluent quality is required in the future. Cloth media disk filtration was identified as a viable and cost-efficient filtration process for consideration.
- For sludge handling in the larger plant, it is recommended that the waste sludge be thickened prior to digestion.
- Aerobic digestion should be used at the site to minimize odor production and aid in the process of producing a quality solids end product.
- The digested sludge should be dewatered prior to landfill disposal, unless land application sites are identified.

4.3 WWTP PROJECT PHASES

For planning purposes, the WWTP expansion is identified as a three (3) phased expansion. It is possible that minor expansions will take place in between each of the major expansion phases in order to upgrade or expand minor facilities. For example, Phase 1A may include only the headworks expansion and Phase 1B may include an expansion of the secondary and tertiary processes.

4.3.1 Phase 1

The first expansion is the short-term expansion, bringing the total capacity to 4.0 mgd AADF. The expansion would add the following:

- Preliminary Treatment: New headworks facility, including two screen channels with one mechanically cleaned screen installed and one manually cleaned screen to serve as an emergency bypass. Odor control would be provided on the headspace in the screening channels. Construct a new influent lift station and piping to the aeration basin splitter structure. Designate areas for future grit removal, future third (and possibly fourth) screening channel, and a future Headworks Building (to enclose the screening channels and screening equipment).
- Secondary Treatment: Install one 2-mgd Biolac® aeration basin and integral clarifiers. Expand or construct a new aeration basin splitter structure. Expand and upgrade the existing blower facility.
- Tertiary Treatment: The existing disinfection system would be expanded to accommodate the expansion of the WWTP.
- Solids Handling: The existing sludge storage basin could continue to be used for sludge management. However, depending upon the needs of the City, improvements may be made to the solids handling facilities during Phase 1.

4.3.2 Phase 2

The second expansion would bring the facility to a total capacity of 7.0 mgd AADF, along with the conversion from the proprietary extended aeration process to a more conventional process. In addition, offsite recharge or reuse will be required in order to dispose of the effluent. This phase would mark a major expansion for the WWTP.

- Preliminary Treatment: A grit chamber would be added to the headworks facility. Additional pumps would be added to the lift station. A second mechanically cleaned screen would be added to replace the manually cleaned screen. A Headworks Building would be constructed over the screening area. Odor control would be expanded to accommodate the new Headworks Building. The existing static screens and unused primary clarifier structure would also be demolished.

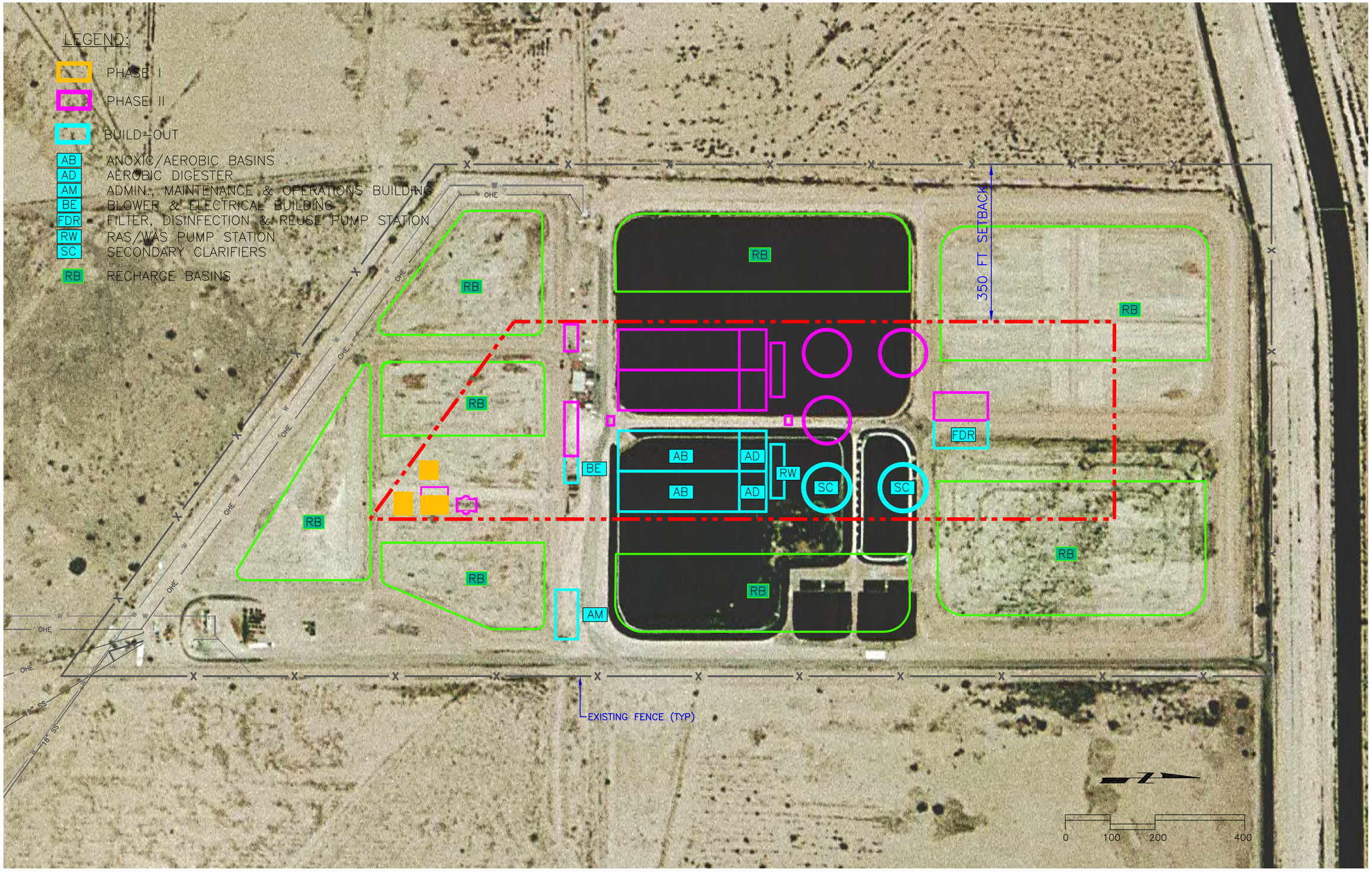
- Secondary Treatment: A 7.0 mgd conventional activated sludge process, with two equally sized trains and three external clarifiers would be constructed. A return activated sludge/waste activated sludge (RAS/WAS) pump station would also be constructed. After completion of the Phase 2 expansion, the Biolac® basins would be taken offline. A new Blower Building with climate control would be provided.
- Tertiary Treatment: Disinfection would be expanded as necessary to match the increase in capacity. If necessary, disk filters could be added to provide greater effluent disposal flexibility. The effluent pump station would be expanded to enable offsite recharge and reuse. The tertiary equipment would be constructed in a sequential and common wall arrangement, as much as practical, to provide a more compact footprint.
- Solids Handling: Aerobic digesters would be constructed (common wall with the aeration basins) along with a new RAS/WAS Building and a new Solids Handling Building. The existing sludge storage basin would be drained and decommissioned at the completion of Phase 2. These improvements may be completed as part of Phase 1.

4.3.3 Buildout

The third and possibly fourth phase(s) would bring the capacity of the WWTP to buildout at approximately 10.5 mgd AADF. The buildout facility is illustrated in Figure 7, followed by a process flow schematic presented in Figure 8. In addition, each phased expansion is summarized in Table 7.

- Preliminary Treatment: Two additional screen channels and two mechanically cleaned screens would be added. A second grit chamber would also be added. Additional pumps would be added to the influent lift station. The Headworks Building would be expanded to accommodate the additional screening equipment.
- Secondary Treatment: An additional 3.5 mgd activated sludge process would be constructed along with one additional external clarifier and blower. The additional biological basins would be common wall with the basins constructed under Phase 2, to provide a more compact footprint.
- Tertiary Treatment: Additional filtration and disinfection equipment would be added. The effluent disposal pump station would be expanded with additional pumps.
- Solids Handling: Additional aerobic digesters would be common wall constructed with the aeration basins. The solids handling equipment would be expanded to match the increase in the plant capacity.

Figure 9 also shows the expanded 10.5 mgd WWTP can be constructed on the existing site and still maintain the required 350-foot setback, assumed from the existing fence line.



City of Eloy – Wastewater Master Plan, September 2007

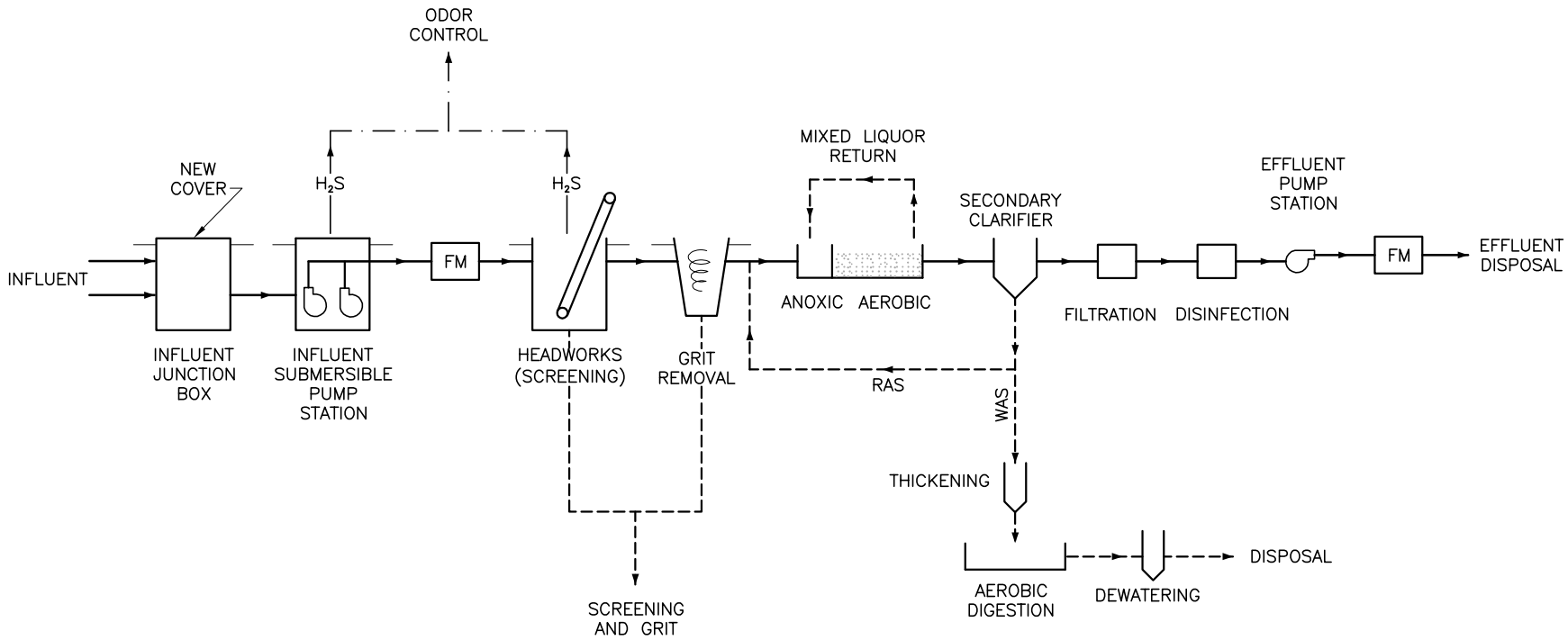
carollo Engineers...Working Wonders With Water™

BUILDOUT WATER RECLAMATION FACILITY LAYOUT (10.5 MGD, AADF)

Figure 8

H:\Client\ELOY_PHXC\7266B00\TASK004\MP.FIG-8 9-20-07 08:17am TTNguyen ; 1117-bdr.208 ;20060302085357.bmp;H:\CanonScans\CAD\1st Floor\20060302085357.tif;eloy_image.tif

BUILDOUT WATER RECLAMATION FACILITY
PROCESS SCHEMATIC



LEGEND

PROCESS FLOW
RECYCLE OR SOLIDS FLOW
FOUL AIR STREAM

ODOR CONTROL FOR SECONDARY TREATMENT PROCESS AND SOLIDS HANDLING NOT SHOWN, FOR CLARITY PURPOSES.

Figure 9

carollo
Engineers...Working Wonders With Water ™

City of Eloy – Wastewater Master Plan, September 2007

H:\Client\ELOY PHXC\726800\TASK004\MP FIG-9 9-18-07 03:31pm TTNguyen MP-hdr-208

4.4 EXISTING WWTP EFFLUENT REUSE AND DISPOSAL

Currently, the City recharges the effluent using three basins and is permitted to recharge up to 2.0 mgd of effluent. There are approximately 25 acres of land available for recharge at the existing WWTP. However, to recharge all of the buildout flow of 10.5 mgd, approximately 60 acres will be required.

To provide maximum use of the reclaimed water, the City also wants to consider other reuse options. These include:

- Urban Lakes
- Riparian Habitat
- Open Access Landscape Irrigation

The City currently owns 80 acres of land to the north of the Santa Rosa Canal. This property may be considered for recharge, riparian habitat, and/or a water conservation center. For the urban lakes, the City should coordinate with the developers to determine the size and best fit into the community.

To be able to use the plant effluent for uses other than recharge, the effluent quality of the plant will need to be increased from its current Class B+ to Class A+ classification.

4.5 SOLIDS DISPOSAL

The solids from the existing plant are initially stored in the onsite sludge storage ponds. Once they have dried, they are removed and disposed of in the City's landfill, located near the intersection of Allsdorf and Toltec Roads. This disposal plan will most likely continue in the future, although the sludge processing capability will improve as the plant is expanded.

Table 7 Expansion Plan Matrix - Existing WWTP Evaluation and Expansion Plan
Wastewater Master Plan
City of Eloy

	Existing WWTP	Phase 1 Expansion	Phase 2 Expansion	Buildout[1]
Annual Average Daily Flow (mgd AADF)	2	4	7	10.5
Average Day Max Month Flow (mgd ADMMF)	3[2]	6 [2]	9.5 [3]	14.2 [3]
Preliminary Treatment				
Screening	Static Screens	One Mechanically Cleaned Screen One Manually Cleaned Screen	Add one Mechanically Cleaned to replace manually cleaned screen	Four Mechanically Cleaned Screens
Grit Removal	None	None	One Mechanical Vortex Grit Chamber	Two Mechanical Vortex Grit Chambers
Lift Station	Wet Pit (10' diameter)	New Wet or Dry Well Lift Station	Add Pumps	Wet or Dry Well Lift Station
Odor Control	None	Wet Chemical Scrubber or In-Ground Biofilter to treat channel headspace and Lift Station	Expand to include Headworks Building	Wet Chemical Scrubber or In-Ground Biofilter
Secondary Treatment				
Biological	Two 1 mgd Biolac®	Add 2 mgd Biolac®	Add 7 mgd AADF MLE process (two 3.5 mgd AADF trains)	10.5 mgd AADF MLE process (three 3.5 mgd AADF trains)
Clarification	Four Integral	Six Integral	Three External 110' Diameter Circular Clarifiers	Four External 110' Diameter Circular Clarifiers

Table 7 Expansion Plan Matrix - Existing WWTP Evaluation and Expansion Plan
Wastewater Master Plan
City of Eloy

	Existing WWTP	Phase 1 Expansion	Phase 2 Expansion	Buildout[1]
RAS/WAS Pumping	Air Lift	Air Lift	Wet Pit Submersible Pump Station	Wet Pit Submersible Pump Station
Tertiary Treatment				
Disinfection	Bulk Hypochlorite (not used)	Bulk Hypochlorite or UV	Expand Disinfection	Bulk Hypochlorite or UV
Filtration	None	None	Option - Disk Filters	Option - Disk Filters
Effluent Disposal				
Effluent Disposal Pump Station	One pump (not used)	Same	New Vertical Turbine Pump Station	Vertical Turbine Pump Station
Required Recharge [4] Area (acres)	11.2	22.4	39.4	58.5
Max. Onsite Recharge Available (acres)	25.4	23.4	18.2	19.5
Offsite Recharge Required (acres) [5]	None	None	21.2	39.0
Solids Handling				
Thickening	None	None Option: Add Thickeners	Centrifuge, Gravity Belt Thickener, or Rotary Drum Thickener	Centrifuge, Gravity Belt Thickener, or Rotary Drum Thickener
Digestion	Sludge Drying Bed	Sludge Drying Bed Option: Add Two Aerobic Digesters	Two Aerobic Digesters	Four Aerobic Digesters
Dewatering	None	None Option: Add Dewatering	Centrifuge or Belt Filter Press	Centrifuge or Belt Filter Press

Table 7 Expansion Plan Matrix - Existing WWTP Evaluation and Expansion Plan
Wastewater Master Plan
City of Eloy

	Existing WWTP	Phase 1 Expansion	Phase 2 Expansion	Buildout(1)
Miscellaneous				
Admin., Maintenance, and Lab Building	Trailer	Same	Option - Add Building	Option - Add Building
Headworks Building	None	None	Add Building	Headworks Building
Solids Handling Building	None	None	Add Building	Solids Handling Building
Blower/Electrical Building	Three Sided Shed	Expand Existing, Enclose, add Noise Controls	New Building	Blower and Electrical Building with Climate Control

Notes:
(1) Buildout features shown represent the final quantity and type of each feature, while Phases 1 and 2 represent the additions to the facility.
(2) Assumed maximum month peaking factor of 1.5.
(3) Assumes peaking factor reduced to 1.35 as collection area expands.
(4) Required recharge area includes a 10 percent increase to account for containment berms and access roads. However, these features could require additional land. These quantities are to serve as an approximation with accurate land areas determined through site-specific hydrogeologic testing.
(5) Assumes recharge is the only method of effluent disposal. Offsite Recharge Required is the difference between the Max. Onsite Recharge Available and the Required Recharge Area. Required Recharge Area is based upon 0.6 acre-ft/acre/day design percolation rate used at the existing WWTP, rate taken from Westland (2004).Offsite recharge may be performed at the 80 acres of City owned land to the north of the existing WWTP. This would enable all recharge to be handled offsite and provide more space at the existing WTTP for treatment process and support facilities.

SUB-BASIN COLLECTION AND TREATMENT SYSTEM

5.1 SOFTWARE SELECTION

Part of the planning for the Wastewater Master Plan is the analysis of the existing collection system and the layout and sizing for the future collection systems to serve the Wastewater Sub-Basins. This type of planning and analysis is best accomplished using a wastewater collection system computer model. Carollo Engineers identified and then evaluated several of the commonly available models. This detailed analysis and evaluation is summarized below but described in detail in Technical Memorandum No. 4 – Software Selection (Appendix D).

Eight wastewater modeling software packages were evaluated: H_2OMAP Sewer by MWH Soft, InfoSewer by MWH Soft, Hydra by Pizer, Inc., Infoworks CS by Wallingford Software, Mouse by the Danish Hydraulic Institute, MIKE SWMM by the Danish Hydraulic Institute, XP-SWMM by XP Software, Inc., and SewerCAD by Haestad/Bentley, Inc.

These models were then technically evaluated relative to:

- Type of Hydraulic Calculation: Steady State, Quasi-Dynamic or Fully Dynamic.
- Type of Hydrology Calculation such as runoff flows, time of concentration, etc.
- Complex Hydraulic Calculation with multiple friction loss equations for multiple conduit shapes.
- Contaminant and Corrosion Potential modeling for hydrogen sulfide.
- GIS Interface capabilities.
- Customer Service and Support.

Other non-technical criteria used in the evaluation of the software included:

- Should be able to run on commonly available hardware and operating systems.
- Should have an open architecture and use standard formats.
- Must be designed to work with GIS.
- Vendor should be consistently profitable.
- Supported with responsive staff.
- Interface should be intuitive and easy to use.
- Best value for the money.

Table 8 shows a summary of features for sewer modeling software. Based on the evaluation, H_2OMAP Sewer was recommended for the City with the major reasons being:

- H_2OMAP Sewer has a load allocation module and data cleanup tools that Sewer CAD does not have.
- H_2OMAP Sewer has advantages over Sewer CAD such as an open database, lower price, more sophisticated hydraulic engine, good support, and industry leadership.

H_2OMAP Sewer is used by other Arizona communities including Chandler, Prescott Valley, Show Low, Casa Grande, Prescott, Gilbert, Mesa, Goodyear, Scottsdale, and Avondale.

5.2 COLLECTION SYSTEM DESIGN CRITERIA

This section of the report describes the performance and design criteria used in the evaluation, planning, and design of the City's sewer and reclaimed water system. Detailed descriptions are contained in Technical Memorandum No 3 (see Appendix C).

The basic "standards of measurement" used in the design of gravity sewers, force mains, and lifts stations include the following.

- Pipe Capacity, which is based on pipe diameter, slope, and Manning's coefficient of friction (n).
- Velocity, which has both a minimum and maximum number. The minimum velocity is 2.0 feet per second (fps) to minimize settlement of solids and the maximum velocity is approximately 7.0 fps to minimize erosion of the pipe material.
- Flow Depth in gravity sewers is the ratio of the maximum depth of flow in the pipe to the diameter of the pipe (d/D).
- Changes in Pipe Sizes occur when a smaller sewer joins a larger one. The adopted criteria is for the crowns of the pipes to match.
- Lift Station Capacity should be equal to approximately three times the average daily flow with the largest pump out of service.
- Lift Station well sizing should consider fill time, average flow, and minimum pump cycle.
- Lift Stations should have access to back-up generators.
- Force Mains should have a minimum diameter of 6 inches.
- Gravity Sewers should have a minimum cover of 5 feet, have 4 feet of separation from the flowline of irrigation ditches, and a minimum separation of 6 feet from potable water mains.

Table 8 Software Selection
Wastewater Master Plan
City of Eloy

	H_2OMAP Sewer, MWH Soft	InfoSewer by MWH Soft	SewerCAD, Haestad/ Bentley	Hydra, Pizer	XP-SWMM, XP Software	MIKE SWMM, DHI Software	Mouse, DHI Software	Infoworks, Wallingford Software
Company Characteristics								
Number of current software licenses of sewer modeling product with active support agreements in the U.S.	1,000+	Hundreds	~3,900	~1,000	~1,000	~1,000	~500	~150
Provides companion water modeling software	yes	Yes	yes	no	no	yes	yes	yes
Provides storm water drainage modeling capabilities or companion software	yes	Yes	yes, in a separate package	yes	yes	yes	yes	yes
Customer support	very good	very good	good	fair	good	good	good	fair
Price, assuming 5,000 pipes	$8,000	$8,000	$13,500	$4,500	$11,000	$5,000	$14,000	$32,000
Price of additional modules	$1,000	$1,000	$0	$0	$1,000	$4,400	$4,400	$0
Total M & S annual fee	$2,000	$2,000	$3,800	$1,250	$1,000	$450	$2,000	$5,000
Software training provided by the vendor, per person	$1,200	$1,200	$1,500 regular, $995 special	$1,200	$1,000	varies, $500 (web based)	varies, $500 (web based)	free if by June 30
Floating or network licenses	yes	Yes	yes	no	yes	yes	yes	yes
Company stability	good	Good	good	fair	fair	good	good	good
Additional modules required	load generation	load generation	none	included	GIS Interface	GIS Interface	GIS Interface	none

Table 8 Software Selection
Wastewater Master Plan
City of Eloy

	Usefulness to Eloy 3 = essential, 2 = useful, 1 = possible value, 0 = no value	H_2OMAP Sewer, MWH Soft	InfoSewer by MWH Soft	SewerCAD, Haestad/ Bentley	Hydra, Pizer	XP-SWMM, XP Software	MIKE SWMM, DHI Software	Mouse, DHI Software	Infoworks, Wallingford Software
Technical Characteristics									
Compatible with Windows 2000, MS Office 2000	3	Yes	yes	yes	yes	yes	yes	yes	Yes
Compatible with Arc View 9.1 (geodatabases)	2	Yes	yes	yes	no	no	no	no	No
Hydraulic engine source	n/a	Proprietary	proprietary	proprietary	proprietary	Modified SWMM	SWMM	proprietary	Proprietary
Steady state, normal depth hydraulic calculation	2	Yes	yes	yes	no	no	yes	yes	No
Quasi-dynamic hydraulic calculation	3	Yes	yes	yes	yes	yes	yes	yes	No
Fully dynamic	1	No	no	no	no	yes	yes	yes	Yes
Storm water runoff and time of concentration hydrology calculations	0	Yes	yes	no	yes	yes	yes	yes	Yes
Reads and writes to shape files directly	3	Yes	yes	no	no	no	no	no	No
Converts shape file data using an interface	2	No	no	yes	yes	yes	yes	yes	Yes
Tools to fix GIS data topology problems	2	Yes	yes	partial	no	no	yes	yes	Yes
Database driven	3	Yes	yes	yes, proprietary	no	no	yes	yes	Yes
Automatically sizes new mains	2	Yes	yes	yes	no	no	no	yes	No
Calculates pipe replacement costs	2	Yes	yes	yes	no	no	no	no	No
Calculates loads based on land use	3	Yes	yes	via Arc View	yes	no	yes	yes	Yes
Estimates elevations of intermediate manholes when missing	2	Yes	yes	no	no	no	yes	yes	Yes
Tracks source, age, or water quality parameters	1	Yes	yes	no	no	no	no	no	Yes
User Interface									
Scenario manager	3	Yes	yes	yes	no	no	no	yes	Yes
Customizable tabular reports	2	Yes	yes	yes	no	yes	yes	yes	Yes
Graphically compares the results of multiple simulations	2	Yes	yes	yes	no	no	yes	yes	Yes
Displays GIS data layers on screen	2	Yes	yes	no	no	no	yes	yes	Yes
Export tabular data to Excel	3	Yes	yes	yes	yes	yes	yes	yes	Yes
Update existing elements from GIS shapefiles	2	Yes	no	no	no	no	no	no	Yes
Information libraries	1	No	no	yes	no	no	no	no	Yes

Table 9 summarizes the performance and design criteria to design and evaluate wastewater systems.

Table 9 Wastewater System Criteria Summary
Wastewater Master Plan
City of Eloy

Description		Criteria	
		Pipe Capacity[3]	
Pipe Size (inches)	**Minimum Slope[1][2] (ft/ft)**	**(mgd)**	**(cfs)**
8	0.0034	0.45	0.70
10	0.0025	0.70	1.09
12	0.0020	1.02	1.57
14	0.0016	1.38	2.14
15	0.0015	1.59	2.45
16	0.0014	1.80	2.79
18	0.0012	2.28	3.53
20	0.0010	2.82	4.36
21	0.0010	3.11	4.81
24	0.0008	4.06	6.28

Note:

(1) Slopes are calculated using Manning's Equation for pipes flowing full with a minimum velocity of 2 fps.

(2) Sewers larger than 24 inches should have a slope ≥ 0.0008.

(3) Pipe Capacity based on full pipe flow.

Maximum Velocity	≤ 7 feet per second
Flow Depth, d/D	
d/D for New Sewer Pipes with Diameters less than 12 inches	= 0.5
d/D for Designing New Sewer Pipes 12 inches and Higher	= 0.75
d/D for Evaluating Existing Mains in Developed Areas	= 0.90
Headloss in Existing Pipes	
Gravity Pipes	Manning's n = 0.013
Pressure Pipes	Hazen William's C = 120
Changes in Pipe Size	
When a smaller sewer joins a larger one:	Sewer crowns will be matched.
Headloss at Manholes	
Manholes with pipelines intersecting at 90-degrees or greater	Provide 0.2' Invert Drop
Manholes with pipelines intersecting at less than 90-degrees	Provide 0.1' Invert Drop

Table 9	Wastewater System Criteria Summary Wastewater Master Plan City of Eloy
Description	**Criteria**
Clearances	
Minimum coverage	5 feet
Separation from irrigation ditch	4 feet
Separation from potable water lines	6 feet (Unless encased in concrete)

5.3 SUB-BASIN COLLECTION SYSTEM

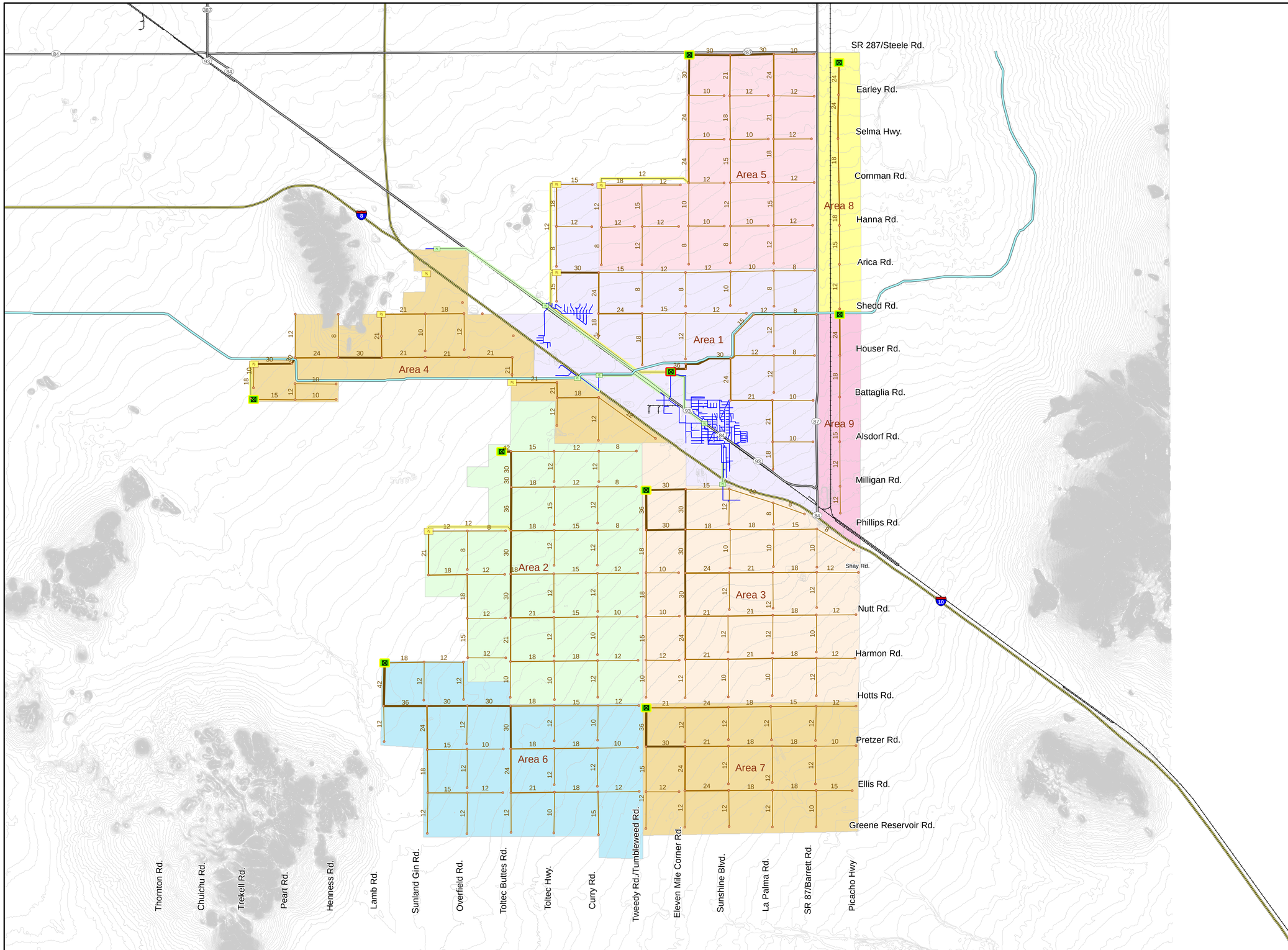
As shown in Figure 10, a wastewater collection system was developed for the entire DMA area at projected buildout. Layout and sizing of the collection system was based on the design criteria (Section 5.2) and on USGS contours. Flow projections generated from the GIS-based land use plan were input to the hydraulic model to define the preliminary system. Additional data and results from the collection system model are included on Figure 11 (pipe diameters and flow rates) and Figure 12 (manhole invert and rim elevations).

5.4 WRF DESIGN AND CONSTRUCTION GUIDELINES

This section describes the proposed design and construction guidelines for the Sub-Basin Water Reclamation Facilities. Detailed guidelines are contained in Technical Memorandum No. 3 (see Appendix C).

The development of the proposed Phased Regional WRFs require some initial assumptions regarding the WRFs, including the following:

1. Regional WRFs will only be considered within the service areas established by the City.
2. Each Regional WRF will be constructed by the developer as the initial phase of the permanent Regional WRF.
3. Each Regional WRF will be constructed at a location advantageous to water reclamation.
4. Adequate space will be provided to accommodate future expansion of each Regional WRF to serve planned buildout of its designated region. The initial phase shall be planned to accommodate future expansions to buildout at the designated site.
5. The initial phase of each Regional WRF must have the capability to meet all required effluent water quality standards as stated in the Arizona Administrative Code (A.A.C.). In addition, each WRF will not discharge to any waters of the U.S. (thereby requiring an NPDES permit).



N

Miles
0 0.5 1 2

- Existing Lift Station
- Future Lift Station
- Existing Force Main
- Future Force Main
- Existing Pipes
- Future Manhole

Future Pipes

Diameter

- 8
- 10
- 12
- 15
- 18
- 21
- 24
- 30
- 36
- 42

Water Reclamation Facility Locations

- Existing WRF
- Proposed WRF
- Interstate
- State Highway
- Railroad
- Canal
- 5-ft Contours

WRF Service Areas

- Area 1
- Area 2
- Area 3
- Area 4
- Area 5
- Area 6
- Area 7
- Area 8
- Area 9

Notes:

1. The Transportation layers are GIS data from ESRI Data & Maps (2004).

2. The planning boundary and developments are based on information obtained from the City of Eloy.

3. This GIS map is a limited representation of facilities, intended for planning purposes only. It is not intended for construction or other purposes requiring greater positional accuracy.

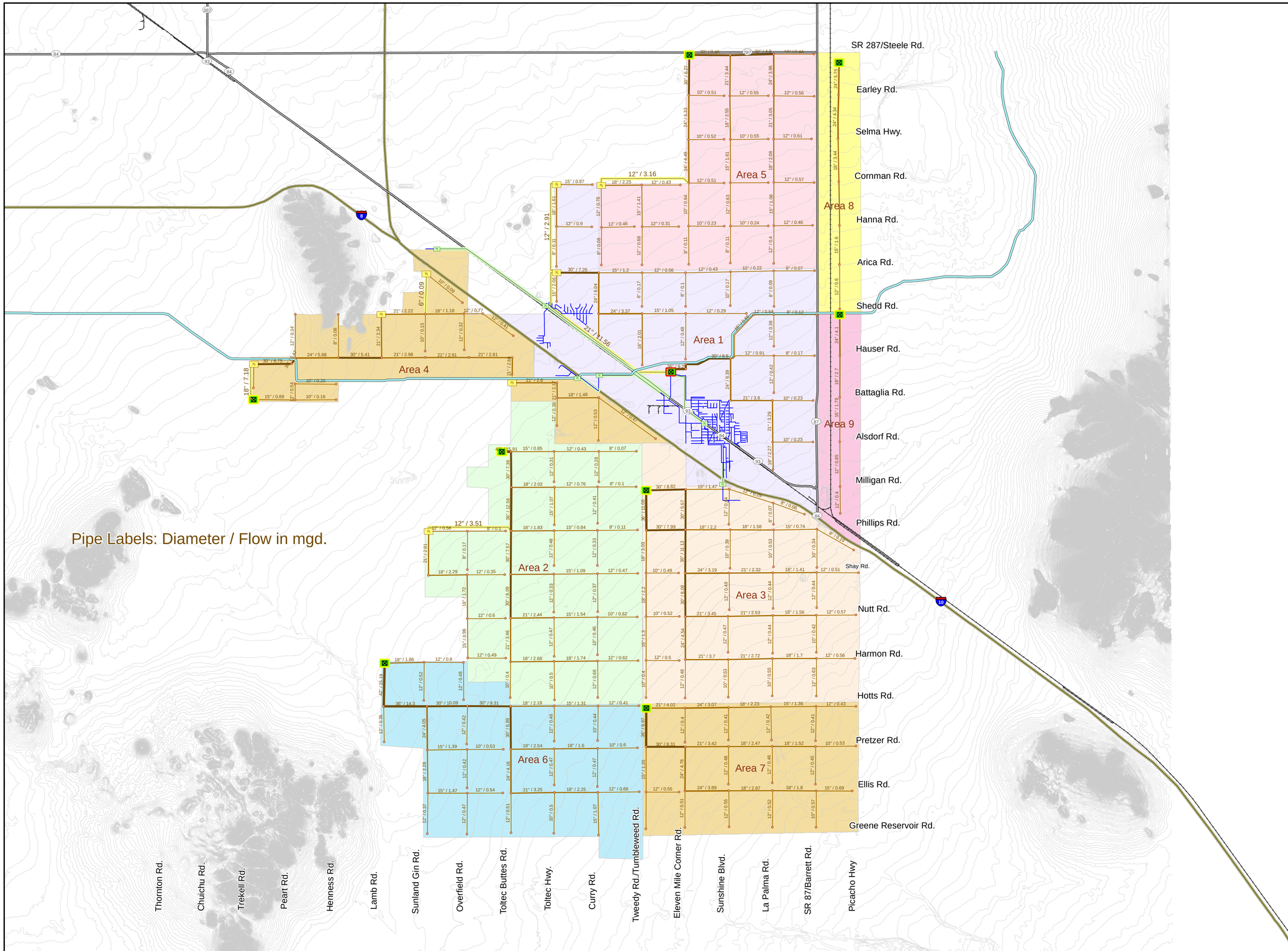
City of Eloy - Wastewater Master Plan, September 2007

carollo

PRELIMINARY SEWER SYSTEM LAYOUT AT BUILDOUT

Figure 10

M:\Client\Eloy_PHXMP\7266B00 Eloy Sewer Study-TO#3\Analysis\GIS Analysis\Maps\Sept 07\Fig10_Sub-Basin Collection System.mxd



N

Existing Lift Station
Future Lift Station
Existing Force Main
Future Force Main
Existing Pipes
Future Manhole

Future Pipes

Diameter

- 8
- 10
- 12
- 15
- 18
- 21
- 24
- 30
- 36
- 42

Water Reclamation Facility Locations

- Existing WRF
- Proposed WRF
- Interstate
- State Highway
- Railroad
- Canal
- 5-ft Contours

WRF Service Areas

- Area 1
- Area 2
- Area 3
- Area 4
- Area 5
- Area 6
- Area 7
- Area 8
- Area 9

Notes:

1. The Transportation layers are GIS data from ESRI Data & Maps (2004).

2. The planning boundary and developments are based on information obtained from the City of Eloy.

3. This GIS map is a limited representation of facilities, intended for planning purposes only. It is not intended for construction or other purposes requiring greater positional accuracy.

Miles
0 0.5 1 2

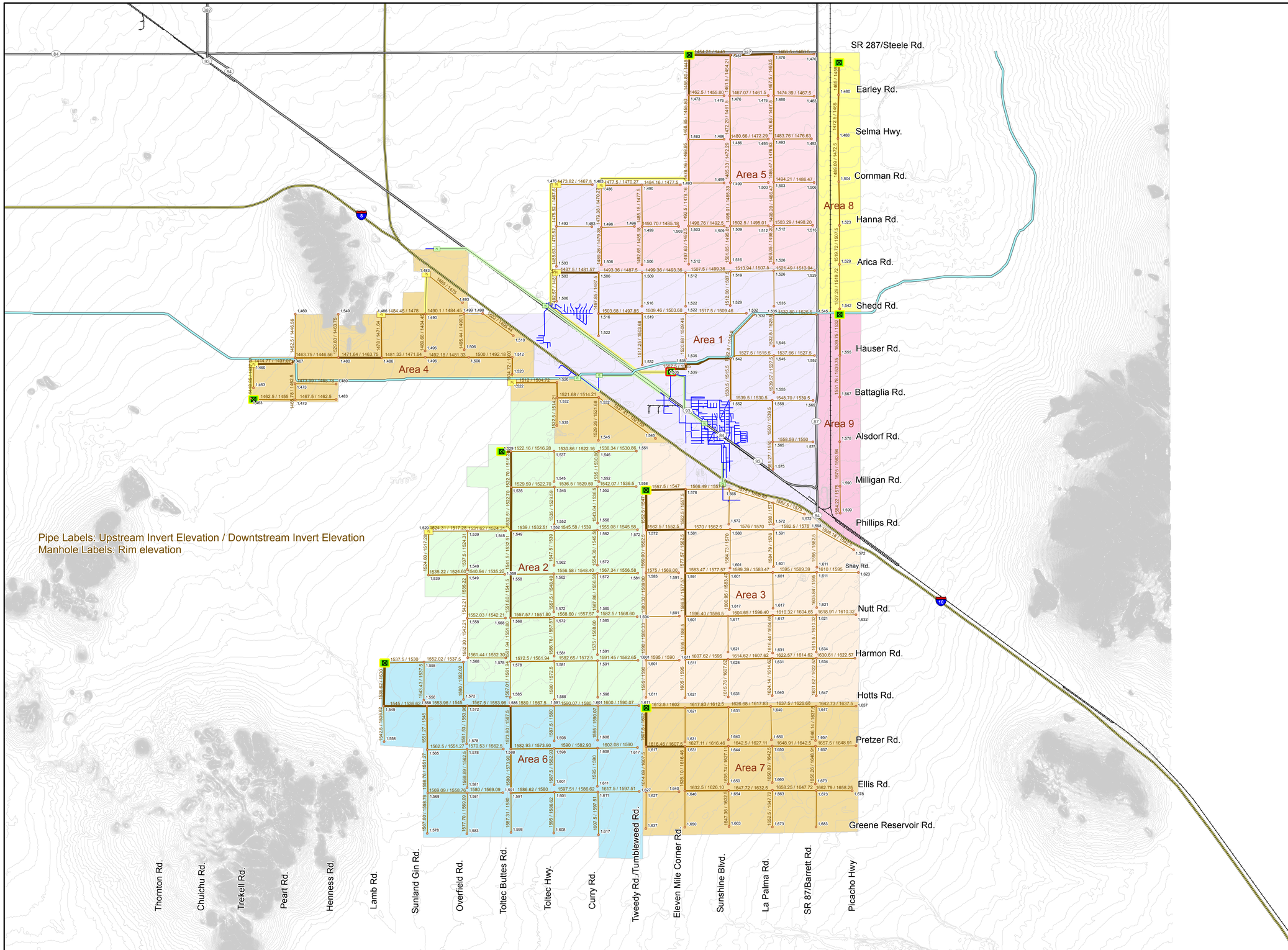
City of Eloy, Arizona - Wastewater Master Plan, September 2007

carollo

PIPE DIAMETERS AND FLOW RATES - SEWER SYSTEM AT BUILDOUT

Figure 11

M:\Client\Eloy_PHXMP\7266B00 Eloy Sewer Study-TO#3\Analysis\GIS Analysis\Maps\Sept 07\Fig11_Diameters and Flowrates.mxd



N

Existing Lift Station
Future Lift Station
Existing Force Main
Future Force Main
Existing Pipes
Future Manhole

Future Pipes

Diameter

8
10
12
15
18
21
24
30
36
42

Water Reclamation Facility Locations

Existing WRF
Proposed WRF
Interstate
State Highway
Railroad
Canal
5-ft Contours

WRF Service Areas

Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7
Area 8
Area 9

Notes:

1. The Transportation layers are GIS data from ESRI Data & Maps (2004).

2. The planning boundary and developments are based on information obtained from the City of Eloy.

3. This GIS map is a limited representation of facilities, intended for planning purposes only. It is not intended for construction or other purposes requiring greater positional accuracy.

Miles
0 0.5 1 2

City of Eloy, Arizona - Sewer Service Area Study

carollo

MANHOLE INVERTS AND RIM ELEVATIONS - SEWER SYSTEM AT BUILDOUT

Figure 12

M:\Client\Eloy_PHXMP\7266B00 Eloy Sewer Study-TO#3\Analysis\GIS Analysis\Maps\Sept 07\Fig12_Manhole Invert and Rim Elevations.mxd

6. Once built, each Regional WRF will be owned and operated by the City.
7. The effluent quality being promoted by the City is Class A+ to allow options and flexibility for water reclamation.
8. The effluent from the WRFs may be used for irrigation, groundwater recharge, wetland development, riparian preserves and urban lakes. Other uses may be proposed and decided on a case-by case basis.

Factors to be considered in the WRF Design and Construction, include:

- Peaking Factors
- Site Requirements
  - Access and security
  - Aesthetics
  - Future connections
  - Flood control
- Treatment Components
  - Influent pumping
  - Screening
  - Biological secondary treatment (capable of nutrient removal)
  - Secondary clarification
  - Tertiary filtration (or future accommodations for filtration)
  - Disinfection
  - Effluent pumping
  - Reclaimed water storage
  - Solids processing and disposal
- Other Design Factors
  - Odor control
  - Noise control
  - Utility and standby power
  - Instrumentation, controls and alarm telemetry
  - Utilities, Process and yard piping
  - Valves
  - Applicable codes and standards

- Construction and Start-Up
  - Approved contractor
  - Acceptable manufacturer
  - Local facilities and support
  - Equipment installation oversight
  - Training
  - Submittals
  - Operation and maintenance manual
  - Spare parts
  - Permits
  - Insurance
  - Warranties and guarantees

IMPLEMENTATION PLAN

6.1 INTRODUCTION

The overall concept for handling wastewater in the Eloy planning area is for the development of up to nine sub regional collection, treatment and reclamation systems. How these systems would be located, sized and designed are defined in this report and in the Technical Memoranda contained in the Appendices. The ultimate size of the WRFs and their associated collection system at buildout have been identified. The WRFs range in capacity from 3.2 mgd up to 10.4 mgd, and interceptors draining into the plants range in size from 15 inches up to 36 inches in diameter. Once development gets established in each of the sub-basins, the plants and major interceptors can be constructed. However, in the very early stages of development there may not be the flow or need for the "ultimate" system. Therefore, a sub-basin implementation plan needs to be developed to guide the City and developers in these early stages.

6.2 WATER RECLAMATION FACILITIES

6.2.1 Basic Requirements

No matter what size of WRF is going to be constructed there are some basic planning requirements that must be met. These include the following:

1. Regional WRFs will only be considered within the service areas established by the City.
2. Each Regional WRF will be constructed by the developer as the initial phase of the permanent Regional WRF.
3. Each Regional WRF will be constructed at a location advantageous to water reclamation. Site-specific investigations will be required to evaluate and size recharge facilities and to assess other effluent uses.
4. Adequate space will be provided to accommodate future expansion of each Regional WRF to serve its designated region. The initial phase shall be planned to accommodate future expansions to buildout at the designated site.
5. The initial phase of each Regional WRF must have the capability to meet all required effluent water quality standards as stated in the Arizona Administrative Code (A.A.C.). In addition, each WRF will not discharge to any waters of the U.S. (thereby requiring an NPDES permit).
6. Once built, each Regional WRF will be owned and operated by the City.
7. The effluent quality being promoted by the City is Class A+.

8. The effluent from the WRFs may be used for irrigation, groundwater recharge, wetland development, riparian preserves and urban lakes. Other uses may be proposed and decided on a case-by case basis.

For the approval of each system, the developer will also still have to go through a city review and approval process as defined below:

1. Developer meets with City to discuss the project and City requirements.
2. Developer submits phased Regional WRF Data Sheet to City (see Attachment A).
3. City reviews phased Regional WRF Data sheet, and approves or disapproves initial phase request based on the review criteria contained in Attachment B.
4. City sends a concept approval letter to developer.
5. If City approves the initial phased Regional WRF concept, the Developer will submit a phased Regional WRF Engineering Report to City.
6. City reviews Engineering Report.
7. Upon acceptance of the Engineering Report, the developer can proceed in obtaining the necessary Approval to Construct and APP permits from ADEQ. The developer shall provide copies of the ADEQ permitting submittals to the City.
8. Developer submits intermediate (approximately 60 percent completion stage) design drawings and specifications for City review and comment.
9. Upon City approval of the intermediate design submittal, the developer submits Final (100 percent completion stage) design drawings and specifications for final City comment and approval.
10. Upon acceptance of the Final design drawings and specifications the City will issue a Regional WRF Construction Permit.

6.2.2 Design Considerations

6.2.2.1 Small Plant Operation vs. Size

To successfully operate and maintain a biological wastewater treatment process requires a certain volume of wastewater. The "bugs" in the system live off the food in the wastewater and without the food the system dies. The quantity of waste flow a system needs depends on the size and type of system, which poses the dilemma of sizing the initial phase of a WRF. If the WRF is too big, then there could be a long-term problem of insufficient flow (food) and therefore poor plant performance and difficult operations. If the WRF is too small, then it will have to be expanded very quickly, which adds to the overall expense. Therefore, a balance needs to be achieved between the various plant demands.

6.2.2.2 Initial Sizing

Because of these WRF challenges, the initial phase of a WRF will most likely be a small plant in the capacity range of 250,000 gpd up to 1.0 mgd. The actual size will depend on the estimates by the developer as to the projected rate of growth in the service area.

If the initial plant is small (less than 0.75 mgd), consideration could be given to the feasibility of a package plant that could be removed from the site at a later date when flows dictate a larger more permanent plant. The second phase of the WRF could then initiate the concept of the final WRF layout.

If the initial plant is larger, e.g. 1.0 mgd, consideration could be given to it being the first phase of the ultimate plant. At this time there may also be consideration of more permanent process and administrative control buildings as well as standby power.

These size selection details must be worked out in advance with the City staff, as they will be operating the plant.

6.2.2.3 Initial Operation

Once the plant size has been selected and the plant constructed, there is the initial start-up and operation period when the flow to the plant is very low and insufficient to meet the needs of the plant. For this time frame, consideration should be given to store and haul the wastewater. In this scenario, the wastewater will flow to the plant, be stored at the plant in the wet well or in one of the plant tanks suitable for the task, and on regular intervals, be collected and hauled to the existing City WWTP for treatment.

6.2.2.4 Plant Expansion

Given the fact that an expansion to a plant could take up to three years for planning, design, construction and permitting, it is imperative that the initial phase flows to the WRF be closely monitored. For a fast growing service area, a WRF expansion plan should be developed when the flow to the WRF reaches about 50 percent of the plant capacity. In a slower growing service area, an expansion plan may be delayed until the flow reaches about 75 percent of existing plant capacity.

6.3 COLLECTION SYSTEM

Like a WRF, a collection system needs a minimal volume of flow to operate successfully. Too little flow in a large sewer line can cause slow rates of flow, solids deposition, odors and catastrophic pipeline corrosion. Too much flow in a system can cause sewage backups, and overflowing manholes.

6.3.1 Sewer Sizing

It will be unlikely that the initial interceptors connecting to the WRFs will be the final size identified in the buildout master plan. Some smaller interim size may be required. It also means that not all sewers will be constructed in the initial phases. In some instances, it may be preferable to construct a small interim lift station and force main that would be replaced at a later date with a permanent larger sewer.

6.3.2 Lift Stations

The proper sizing of lift stations and force mains in the early stages of a system is very important. This covers wet well size, pump size, and diameter of the force main.

The primary concerns with lift stations and small flows are the detention time in the wet well and force main, minimum scouring velocity in the force main, and the resultant odor problems. Careful consideration needs to be given to each of these factors and how the best approach to addressing them for each development. These details will need to be worked out with the developer and the City.

6.4 EXISTING WWTP EXPANSION

As presented in Section 4.0 and in TM No. 1 (Appendix A), the planned expansion of the existing WWTP will be accomplished in phases. The phased approach will allow the City to build treatment capacity to accommodate new development, and to continuously satisfy permit requirements and accomplish effluent recharge while expanding capacity and changing treatment processes. Although overall timing of the phased expansions will be driven by private development schedules, the length of time required to design, construct, and permit new treatment capacity dictates a proactive approach by the City. Preliminary options of costs for the phased plant expansion were developed and are summarized in Table 10. Supporting documentation for the summary costs is provided in Appendix E.

Table 10 Preliminary Opinion of Costs
Wastewater Master Plan
City of Eloy

Project Summary		**Estimate Class:**	Conceptual
Project:	City of Eloy - Wastewater Master Plan	**ENR Index at Estimate[1]**	7691
Job #:	7266B.00	**Date:**	06/29/06
Location:	City of Eloy	**By:**	ACG

Description	**Total Project Cost**
PHASE I	
IA - HEADWORKS EXPANSION	$3,742,000
IB -SECONDARY TREATMENT EXPANSION	$7,872,000
IC - SOLIDS HANDLING FACILITIES	$13,869,000
ID - TERTIARY TREATMENT[2]	$5,332,000
PHASE I - TOTAL PROJECT COST	$30,815,000
PHASE II	$71,660,000
BUILDOUT	$77,350,000

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

Notes:

(1) ENR Construction Cost Index (CCI) at the time of this estimate is based upon the 20 Cities Average Value for May 2006.

(2) Tertiary treatment expansion may not be required during the Phase 1 expansion if the current BADCT waiver, due to soil aquifer treatment, is continued by ADEQ.

(3) All costs listed herein are based upon May 2006 ENR dollars. Future costs should be escalated out to the mid-point of construction. Assume an annual infiltration rate of approximately 5% or City approved rate of escalation.

Appendix A

TECHNICAL MEMORANDUM NO. 1
EXISTING WASTEWATER TREATMENT PLANT EVALUATION AND EXPANSION PLAN, SEPTEMBER 2006

City of Eloy, Arizona

TECHNICAL MEMORANDUM NO. 1
EXISTING WASTEWATER TREATMENT PLANT EVALUATION AND EXPANSION PLAN

September 2006

3033 NORTH 44TH STREET, SUITE 101 • PHOENIX, ARIZONA 85018 • (602) 263-9500 • FAX (602) 265-1422

CITY OF ELOY, ARIZONA

TECHNICAL MEMORANDUM
NO. 1

EXISTING WASTEWATER TREATMENT PLANT
EVALUATION AND EXPANSION PLAN

TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION AND BACKGROUND 1-1
- 1.1 Purpose 1-1
- 1.2 Organization 1-1
- 1.3 Objectives 1-3
- 1.4 Background 1-3

2.0 EXISTING TREATMENT PLANT 1-4
- 2.1 History 1-4
- 2.2 Existing Facility Description 1-4
- 2.3 Permit Limits 1-10
- 2.4 Plant Operation 1-10
- 2.5 Plant Performance 1-11
  - 2.5.1 Influent Junction Structure 1-11
  - 2.5.2 Influent Lift Station 1-11
  - 2.5.3 Preliminary Screening 1-12
  - 2.5.4 Biolac® Aeration Basins 1-12
  - 2.5.5 Biolac® Integral Secondary Clarifiers 1-13
  - 2.5.6 Disinfection and Reuse Pump Station 1-13
  - 2.5.7 Recharge Basins 1-13
  - 2.5.8 Electrical, Instrumentation, and Controls 1-14

3.0 PROJECTED DESIGN CAPACITY 1-14

4.0 EFFLUENT DISPOSAL OPTIONS 1-15

5.0 EFFLUENT WATER QUALITY OBJECTIVES 1-17

6.0 OVERALL EXPANSION PLAN CONCEPT 1-19
- 6.1 Setback Requirements 1-20

7.0 LIQUID STREAM EVALUATION 1-22
- 7.1 Preliminary Treatment (Headworks) 1-22
  - 7.1.1 Influent Screening 1-22
  - 7.1.2 Influent Lift Station 1-23
  - 7.1.3 Grit Removal and Handling 1-23
  - 7.1.4 Odor Control 1-25
  - 7.1.5 Biofilters 1-28
  - 7.1.6 Headworks Recommendations 1-28
- 7.2 Secondary Treatment 1-29
  - 7.2.1 Selection Criteria 1-30
  - 7.2.2 Technology Review 1-30
  - 7.2.3 Comparison of Processes 1-34

7.2.4 Biological Process Recommendation: 1-34
7.2.5 Secondary Clarification 1-38
7.2.6 RAS Pump Station 1-39
7.2.7 Blower Building 1-39
7.3 Tertiary Alternatives 1-40
7.3.1 Disinfection 1-40
7.3.2 Filtration 1-41
7.3.3 Effluent Pumping 1-42
7.3.4 Tertiary Recommendations 1-43

8.0 SOLIDS STREAM EVALUATION 1-43
8.1 Solids Thickening 1-44
8.1.1 Gravity Belt Thickeners 1-44
8.1.2 Rotary Drum Thickeners 1-44
8.1.3 Centrifuge Thickeners 1-45
8.2 Digestion 1-45
8.3 Solids Dewatering 1-45
8.4 Solids Handling Recommendations 1-46

9.0 PLANT EXPANSION ALTERNATIVES 1-46
9.1 Preliminary Treatment (Headworks) Alternatives 1-46
9.1.1 Common Headworks Alternatives Features 1-47
9.1.2 Alternative A 1-47
9.1.3 Alternative B 1-47
9.1.4 Alternative C 1-50
9.1.5 Recommended Headworks Alternative 1-50
9.2 Expansion Alternatives 1-50
9.2.1 Short Term Alternatives 1-50
9.2.2 Buildout Alternatives 1-53
9.2.3 Long Term Expansion Recommendation 1-54

10.0 PLANT PHASED EXPANSION PLAN 1-54
10.1 Phase 1 1-55
10.2 Phase 2 1-55
10.3 Buildout 1-58

Appendix A Aquifer Protection Permit No. 101689
Appendix B Underground Storage Permit No. 71-591932

LIST OF TABLES

Table 1.1 Existing WWTP Design Parameters and Equipment 1-7
Table 1.2 Existing Permit Requirements 1-10
Table 1.3 WWTP Effluent Summary Data for 2005 1-11
Table 1.4 Existing Biolac® Design Parameters 1-12
Table 1.5 Minimum Reclaimed Water Requirements for Direct Reuse 1-15
Table 1.6 BADCT Effluent Requirements 1-18
Table 1.7 Reclaimed Water Quality Standards 1-18
Table 1.8 Recommended Effluent Design Criteria 1-19
Table 1.9 Facility Setback Requirements 1-20
Table 1.10 Comparison of Extended Aeration Processes 1-35
Table 1.11 Numerical Weighting Factors 1-36
Table 1.12 Comparison and Ranking of Biological Process Alternatives 1-37
Table 1.13 Expansion Plan Matrix 1-61

LIST OF FIGURES

Figure 1.1 Existing Wastewater Treatment Plant Site Map 1-2
Figure 1.2 Existing WWTP Site Layout 1-5
Figure 1.3 Existing WWTP Process Schematic 1-6
Figure 1.4 Setback Limits 1-21
Figure 1.5 Headworks Alternative A 1-48
Figure 1.6 Headworks Alternative B 1-49
Figure 1.7 Headworks Alternative C 1-51
Figure 1.8 Phase 1 Expansion Layout 1-56
Figure 1.9 Phase 2 Expansion Layout 1-57
Figure 1.10 Buildout Water Reclamation Facility Layout 1-59
Figure 1.11 Buildout Water Reclamation Facility Process Schematic 1-60

EXISTING WWTP EVALUATION AND EXPANSION PLAN

1.0 INTRODUCTION AND BACKGROUND

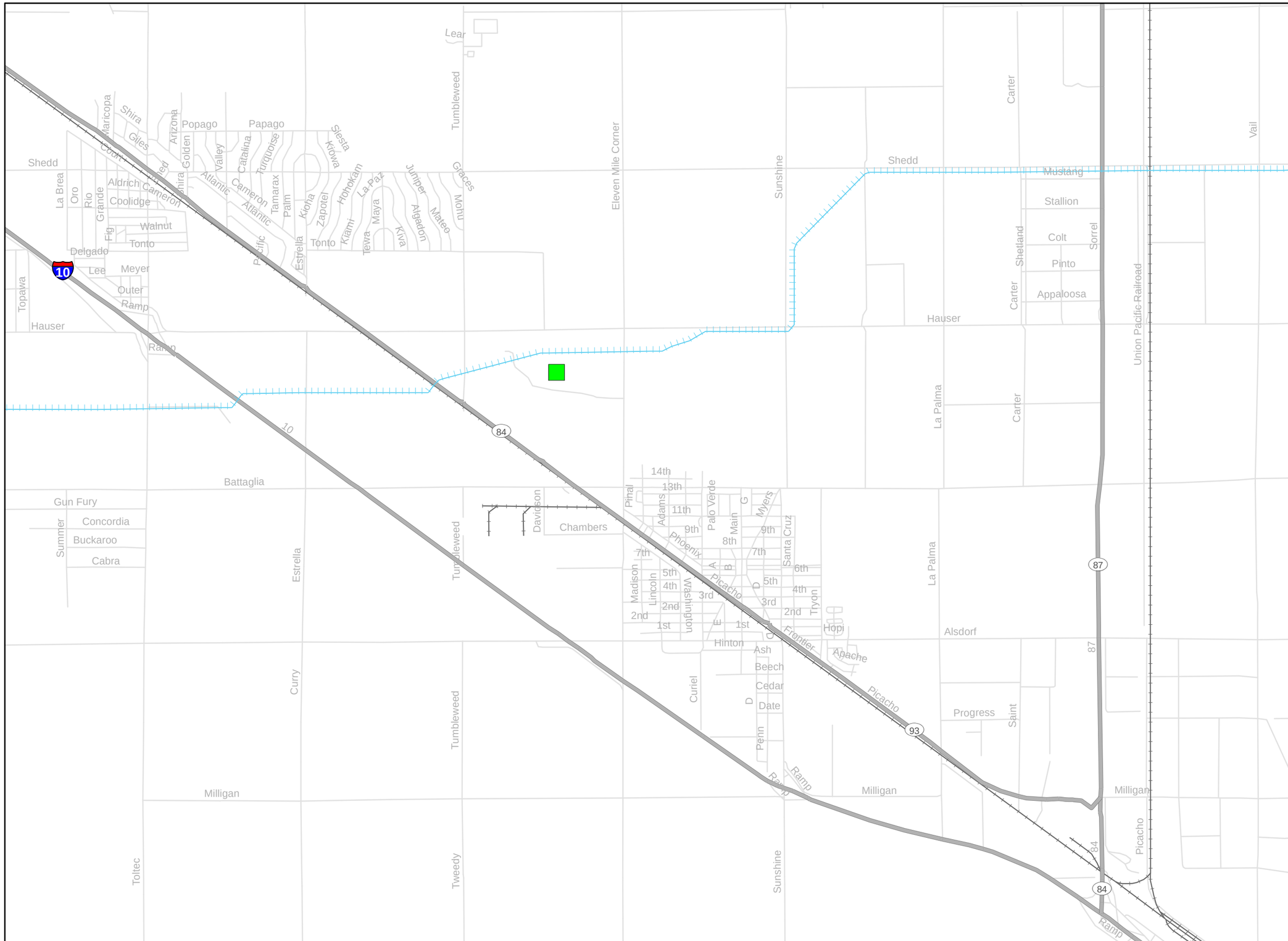
1.1 Purpose

The purpose of this technical memorandum is to evaluate the existing facility, to identify treatment process alternatives, and to present a conceptual expansion plan for the City of Eloy's existing Wastewater Treatment Plant (WWTP). The WWTP is located between Tumbleweed Road and North Eleven Mile Corner Road, immediately south of the Santa Rosa Canal, as shown on Figure 1.1. The existing WWTP is located on two parcels of land totaling approximately 51.6 acres, assessor parcel numbers (APN) 404-12-002A5 and 001D0. The site is bordered to the north by the Santa Rosa Canal and to east, west, and south by property owned by Tes Farms, APN 404-12-00504.

1.2 Organization

This technical memorandum is organized into the following sections:

- **Section 1.0 – Introduction and Background:** The purpose, objectives, and organization of this technical memorandum.
- **Section 2.0 – Existing Treatment Plant:** The existing process concept, plant layout, equipment, a review of the original design criteria, and the performance to date.
- **Section 3.0 – Projected Design Capacity:** Wastewater Master Plan and projected wastewater flows.
- **Section 4.0 – Effluent Disposal Options:** Options for disposal of the treated wastewater and the classes of reuse water.
- **Section 5.0 – Effluent Water Quality Requirements:** Water quality required for each of the options presented in Section 4.0.
- **Section 6.0 – Liquid Stream Evaluation:** Evaluation of the options for each unit process in the liquid stream, along with recommendations for each of these processes.
- **Section 7.0 – Solids Stream Evaluation:** Evaluation of the options for each unit process in the solids stream, along with recommendations for each of these processes.



N

Legend

- Existing WWTP
- Highways
- Streets
- Railroad
- Canal

Notes:

1. The Transportation layers are GIS data from ESRI Data & Maps (2004).

2. This GIS map is a limited representation of facilities, intended for planning purposes only. It is not intended for construction or other purposes requiring greater positional accuracy.

0 0.25 0.5 1 Miles

May 2006

City of Eloy, Arizona - Sewer Service Area Study, Technical Memorandum No. 1 DRAFT

carollo engineers

M:\Client\Eloy_PH\MP\7266A.00 Eloy Sewer Service Area Study\Analysis\GIS Analysis\MXD's\City of Eloy_Existing_WRF_TM1117.mxd

Existing WWTP Location Map

Figure 1.1

- **Section 8.0 – Plant Expansion Alternatives:** Recommendations from the liquid and solids stream evaluations are compiled into alternatives and further discussed for their fit into the short and long-term phasing.
- **Section 9.0 – Plant Phased Expansion Plan:** A phased approach is presented for the expansion of the existing WWTP from its current capacity of 2 mgd to buildout, currently estimated at 14 mgd annual average daily flow (AADF).

1.3 Objectives

The objectives of this technical memorandum include:

- Review the existing treatment plant operation and equipment.
- Define criteria to evaluate treatment alternatives.
- Identify alternative treatment processes.
- Evaluate the appropriate treatment alternatives where necessary.
- Provide treatment process recommendations and summarize the basis for selection.
- Develop a conceptual expansion plan for the existing treatment plant.
- Provide process recommendations that can serve as a "model" for the future Regional Water Reclamation Facilities.

1.4 Background

The City of Eloy, Arizona (City) is located approximately 55 miles north of Tucson and 65 miles south of Phoenix. The City owns and operates a wastewater treatment plant located at 1750 North Eleven Mile Corner Road. The City is currently planning for new developments and significant growth within its City limits. This will require an expansion of the existing WWTP to service the anticipated growth within its service area. New Regional Water Reclamation Facilities (WRFs) are being master-planned to serve growth in the remaining City wastewater service areas.

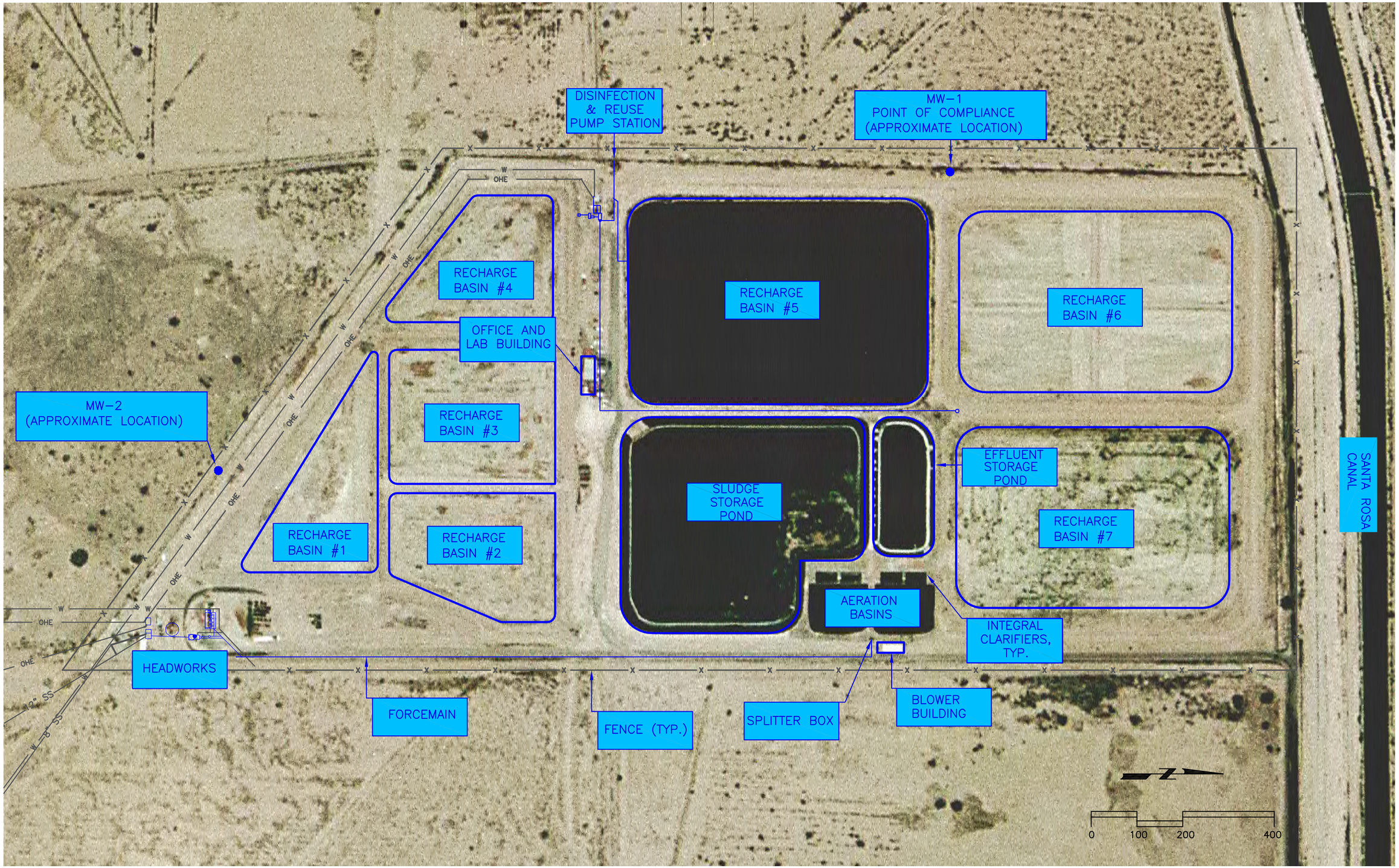
2.0 EXISTING TREATMENT PLANT

2.1 History

Before the current facility was constructed, wastewater was treated, at the existing site, through four aerated lagoons and discharged to four recharge basins. The aerated lagoons were located at approximately the location of the future Recharge Basins 1, 2, 3, and 4. The construction date of the original facility is unknown. The facility was upgraded in 1998 with new preliminary treatment facilities (influent pump station and static screens), extended aeration biological process (Biolac®), and integral secondary clarifiers. The re-grading of the recharge ponds to create sub-cells was performed in 2002. The most recent expansion also planned for the addition of an aerobic sludge digestion pond fitted with surface aerators. Future plans included additional Biolac® basins and vacuum assisted sludge drying beds. Due to budgetary constraints, the aerobic digester, and vacuum assisted sludge drying beds were not constructed.

2.2 Existing Facility Description

The existing WWTP is a secondary treatment plant with a proprietary extended aeration activated sludge process called Biolac® (as manufactured by Parkson). Wastewater is collected at the influent junction box from two gravity influent pipes and then directed to the influent lift station. From the lift station the wastewater is pumped to the inclined static screens. The pumped flow is measured through a magnetic flowmeter. Screenings are collected in a trough and conveyed by a screw auger to a collection bin. Screened wastewater flows, via gravity, to the splitter box located near the aeration basins. Wastewater is mixed with return activated sludge at the splitter box and then directed to the aeration basins for biological treatment. The aeration basins include fine bubble membrane diffusers, suspended approximately one foot from the basin bottom. The aeration diffusers provide mixing and aeration. In addition, the aeration system is cycled with timers to allow for both nitrification and denitrification within an individual basin. Air is provided by positive displacement blowers. Mixed liquor from the basins flows into an integral clarifier, where the solids are settled. Return activated sludge (RAS) is air lifted from the clarifier to the splitter box, while waste activated sludge (WAS) is air lifted to the lined solids drying pond. Treated effluent flows over the clarifier weir and to the evaporation/percolation basins for disposal. Treated effluent can also be disinfected with chlorine and disposed by irrigation onto adjacent agricultural or pasture lands. Flow to the recharge basins is metered with a velocity area meter mounted in a monitoring manhole before the recharge basins. Currently three recharge basins are used with an additional four basins available for recharge. The facility also includes a chlorine contact chamber, bulk hypochlorite storage tank, and a single effluent disposal pump. The disinfection and effluent pumping facilities are not used since disposal via pasture irrigation is no longer a disposal method and the reuse permit has lapsed. The layout of the existing treatment plant is presented in Figure 1.2 and the process schematic is illustrated in Figure 1.3.



EXISTING WASTEWATER TREATMENT PLANT LAYOUT

Figure 1.2

CITY OF ELOY, ARIZONA SEWER SERVICE AREA STUDY
Technical Memorandum No. 1
DRAFT
May 2006

carollo

J:\Client\ELOY_PHXC\7266B00\TASK004\FIG-1-2 5-24-06 10:09am AGilmore ; 1117-bdr ;20060302085357.bmp;H:\CanonScans\CAD\1st Floor\20060302085357.tif;eloy_image.tif

EXISTING WWTP PROCESS SCHEMATIC

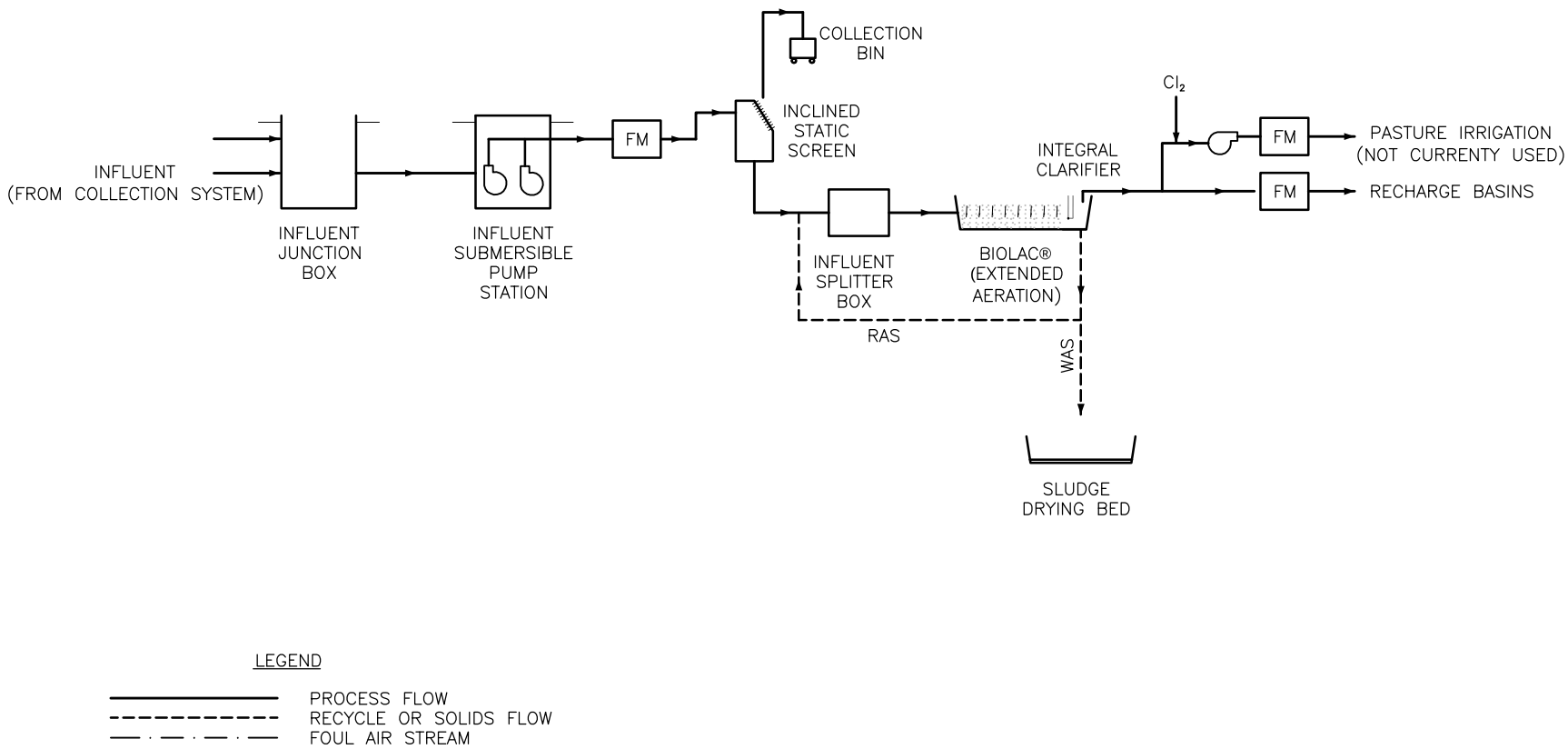


Figure 1.3

carollo engineers

City of ELOY, Arizona – Sewer Servive Area Study
Technical Memorandum No. 1 DRAFT

May 2006

J:\Client\ELOY PHX\796800\TASK004\FIG_1_3 5-24-06 10:15am AGilmore : 811-bdr

The major plant features and equipment are summarized in Table 1.1 along with the manufacturer, number of units, and design capacities.

Table 1.1 Existing WWTP Design Parameters and Equipment
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

Design Parameter	Value	Unit
Influent Pumps		
Manufacturer	Fairbank Morse	--
Type of Pump	Submersible Wet Pit	--
Number of Pumps	2	--
Horsepower, each	25	HP
Design Capacity	2,800	gpm
Type of Pump Station	Wet Well	- -
Controls	Mechanical Floats	- -
Flow Metering	Magnetic Flow Meter	
Screens		
Manufacturer	Vulcan	--
Type	Inclined Static Screens	--
Number of Screens	4	--
Screen Size	1.524	mm
Design Capacity	4,680	gpm
Activated Sludge System		
Manufacturer	Parkson	--
Process	Extended Aeration - Biolac®	--
Number of Basins	2	--
Total Volume	1.82	MG
Side Water Depth	12	ft
MLSS	3,000	mg/L
F/M	0.068	lbs BOD_5 /lbs MLVSS day
Diffused Aeration		
Manufacturer	Parkson	--
Type	Fine Bubble - Biofuser®	--
Number of Units		--
Aeration Chains	7	--
Total Assemblies	63	--
Process Air Requirements		
Without WOX(1)(2)	1,573	scfm
With WOX	1,102	scfm
Per diffuser, max	5.17	scfm
Oxygen Transfer Efficiency		
Without WOX	4.52	percent
With WOX	4.33	percent

Table 1.1 Existing WWTP Design Parameters and Equipment Existing WWTP Evaluation and Expansion Plan City of Eloy, Arizona		
Design Parameter	**Value**	**Unit**
Aeration Blowers		
Manufacturer	Denver Gardner	--
Type of Blower	Positive Displacement	--
Number of Blowers	4	
Blower Capacity	1,722	scfm
Horsepower	195	HP
Blower Controller	Constant	--
Secondary Clarification		
Manufacturer	Parkson	--
Type	Integral - Rectangular	--
Number	4	--
Dimensions		
Length	50	ft
Width	24.92	ft
Side Water Depth	12	ft
Surface Area		
Each Clarifier	1,246	sf
2 of 4 clarifiers out of service	2,492	sf
Volume		
Each Clarifier	112,210	gal
2 of 4 clarifiers out of service	224,420	gal
Total	448,840	gal
Weir Type	Rectangular Trough	--
Weir Length		ft
Each Clarifier	66	ft
2 of 4 clarifiers out of service	132	ft
Total	264	ft
Type of sludge removal	Air Lift	--
Type of scum removal	Floating Skimmer	--
Hydraulic Retention Time		
At Average Day		
All Basins in Service	5.4	hrs
2 of 4 clarifiers out of service	2.7	hrs
At Maximum Month(3)		
All Basins in Service	4.0	hrs
2 of 4 clarifiers out of service	2.0	hrs

Table 1.1 Existing WWTP Design Parameters and Equipment
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

Design Parameter	Value	Unit
Surface Overflow Rate		
At Average Day		
All Basins in Service	401	gpd/sf
2 of 4 clarifiers out of service	802	gpd/sf
At Maximum Month		
All Basins in Service	541	gpd/sf
2 of 4 clarifiers out of service	1,983	gpd/sf
Weir Loading		
At Average Day		
All Basins in Service	7,575	gpd/ft
2 of 4 clarifiers out of service	15,151	gpd/ft
At Maximum Month		
All Basins in Service	10,227	gpd/ft
2 of 4 clarifiers out of service (4)	20,455	gpd/ft
RAS / WAS Pumping		
Type	Air Lift	--
Disinfection		
Type	Bulk Hypochlorite	
Concentration	12.5	percent
Storage Volume	150	gallons
Effluent Disposal		
Type	Recharge Basins	--
Basins in Operation	3	--
Total Basin	7	--
Percolation Rate(5)	0.6	acre-feet/acre/day
Wet-Dry Cycling	50	percent
Current Operation Surface Area	15.45	Acres
Total Available Surface Area	25.4	Acres
Total Available Disposal Capacity	4.97	mgd

Notes:

(1) WOX: Wave Oxidation™, for denitrification.

(2) WOX is cycled on and off, values provided are for periods when aeration basins are running in WOX mode and running without WOX.

(3) Max month peaking factor assumed at 1.35.

(4) Secondary Clarifiers: one basin out of service is equal to having one clarifier out of service in a basin with both basins operating, since there are two basins and four clarifiers.

(5) The reported recharge basin percolation rate includes an adjusted for the wet-dry cycling. Unadjusted the rate is 1.2 acre-feet/acre/day, Westland Resource, Inc. (2004).

2.3 Permit Limits

The WWTP operates under Aquifer Protection Permit (APP) No. 101689, dated March 21, 2005, as issued by the Arizona Department of Environmental Quality (ADEQ). The existing point of compliance (POC) is a downstream monitoring well, designated as MW No. 1, located at a latitude of 32° 46' 07" N and a longitude of 111° 34' 26" W. An upgradient monitoring well, designated as MW No. 2, is used in conjunction with MW No. 1 to monitor the groundwater quality. These wells have also been used to justify further treatment through the unsaturated zone, thereby eliminating the need for disinfection prior to disposal to the existing recharge basins. The monitoring wells are shown on Figure 1.2. The existing APP requirements are summarized in the Table 1.2.

Table 1.2 Existing Permit Requirements
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

	Alert Level	Maximum Discharge Level
Percolation Pond Discharge		
Average Monthly Flow	1.9 mgd	2.0 mgd
Total Nitrogen	8.0 mg/L	10.0 mg/L
Class C Reclaimed Water (1) (2)		
Average Monthly Flow	0.49875 mgd	0.525 mgd
Fecal Coliform Single Sample	No Limit	4,000 MPN
Fecal Coliform Seven Sample Median	No Limit	1,000 MPN

Notes:
(1) Class C Reclaimed Water to be used for pasture and farm field irrigation
(2) Class C Reclaimed Water not a currently used disposal method, permit expired on 12/30/04

This existing WWTP has performed satisfactorily to date, and the City has expressed interest in investigating the feasibility of further expanding the treatment plant with the Biolac® system.

2.4 Plant Operation

The plant is currently operated with minimal operator intervention. Operator intervention is required to set the splitter box gate valves, aeration cycle frequency and duration, RAS flow rate and duration, WAS flow rate and duration, and effluent disposal location. Operators have been pleased with the system to date, citing the ease of operation and stable process as major benefits.

2.5 Plant Performance

The existing secondary treatment system has been operating satisfactorily to meet the facility's permitted effluent limitations summarized in Table 1.2 previously. The long solids retention time, low organic loading rate, and subsequently large aeration volume (typical with extended aeration), provides for a stable and flexible process since flow and load equalization can typically be "absorbed" within the aeration basin. This provides the operators with flexibility and forgiveness in the operation of the plant. Self-monitoring reports for the existing WWTP have been reviewed for the period from January through December 2005. A summary of the data from these reports is provided in Table 1.3.

Table 1.3 WWTP Effluent Summary Data for 2005
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

Parameter	Value	Unit
Annual Average Daily Flow (AADF) (1)	0.735	mgd
Average Day Max Month Flow (ADMMF) (1)	0.887 (November)	mgd
Total Nitrogen - Average (2)	3.4	mg/L
Total Nitrogen - Maximum (2)	4.2	mg/L

Notes:
(1) Flow is measured and reported from the effluent flow monitoring manhole
(2) Total Nitrogen results taken from percolation basins, three sampling events in 2005

2.5.1 Influent Junction Structure

Two influent gravity sewer pipes (12 and 18 inches) enter the WWTP and combine flow at the influent junction structure. The inverts of the pipes are at approximately 1,531.2 feet above mean sea level (ft msl) with ground elevations at around 1,545.5 ft msl, resulting in an influent invert pipe depth of approximately 14 feet. Inspection of the structure noted that it is open to the environment and odorous.

2.5.2 Influent Lift Station

The existing influent lift station contains two 25-horsepower submersible non-clog pumps in a 10-foot inside diameter wet well. The maximum capacity of the lift station is approximately 4 mgd. The combination of relatively deep influent sewers and aboveground static screens warranted an influent lift station. The lift station is approximately 27 feet deep and is controlled using mechanical floats and a pump control panel located at the wet well. The 1998 construction drawings specified the installation of two 60-horsepower submersible pumps.

2.5.3 Preliminary Screening

As previously reported, four existing inclined static screens provide preliminary screening before the aeration basins. The original design provided three screens for duty service and one screen designated as a backup. Inclined screens are typically prone to blinding. Blinding occurs when screenings build up on the outside of the screen allowing wastewater to cascade over the screen, often carrying some of the screenings with this overflow. Visual inspection of the screens confirmed that some blinding was occurring and that the screenings were not being effectively collected in the screw conveyor. Operators use a squeegee to clean the wastewater and screenings from the concrete pad beneath the screw conveyor that overflow due to blinding. The screenings that are collected in the screw conveyor are transferred to a dumpster and disposed off-site. The four inclined screens have a combined maximum throughput of approximately 6 mgd, with all four screens operating (no back up screen scenario).

2.5.4 Biolac® Aeration Basins

The existing secondary treatment system includes two Biolac® aeration basins. Each aeration basin is fitted with aeration chains with isolation valves. Timing of the valve opening and closing allows for zones of oxic and anoxic conditions within a single basin. This process is known as the Wave-Oxidation® (WOX) process. This enables nitrification and denitrification within the same basin. During a site visit, only one aeration basin (along with its associated two clarifiers) was in operation.

The existing Biolac® system was designed with the following design parameters and criteria.

Table 1.4 Existing Biolac® Design Parameters
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

Parameter	Influent	Effluent
Design Flow Rate (mgd)	2	- -
Peak Flow Rate (mgd)	4	- -
BOD_5 (mg/L)	200	10
TSS (mg/L)	200	15
NH_3 (mg/L)	25	1
TKN (mg/L)	30	1

According to operation logs, the two basins are currently operated with a MLSS concentration ranging from 3,000 to 5,000 mg/L, with RAS return for approximately 3 hours per day. Dissolved oxygen (D.O.) probes are installed in each basin.

The existing system is typically operating from 37 percent to 44 percent of rated capacity. In addition, it should be noted that the existing APP only limits nitrogen concentrations in the effluent. Achieving nitrogen levels below 10 mg/L is typically indicative of adequate BOD_5 and COD reduction. Daily logs have shown COD reductions to be 86 percent on average. Assuming this can be similarly correlated to the BOD reduction, the anticipated effluent BOD_5 concentrations would be approximately 28 mg/L on average, which is within a typical discharge permit level of 30 mg/L. In addition, non-compliance sampling has shown BOD_5 levels in the effluent to be from 4 to 11 mg/L; however, only seven sampling events were provided.

2.5.5 Biolac® Integral Secondary Clarifiers

The existing secondary clarifiers are integral to the biological process with two clarifiers associated with each aeration basin.. Mixed liquor flows through wall openings at the end of the aeration basin into the secondary clarifiers, where the mixed liquor is then settled. Clarified effluent flows over a V-notch weir. The V-notch weir is approximately 33 feet long, with two weirs installed on each side of the effluent trough. Each clarifier includes one trough. Design criteria for the clarifiers are summarized in Table 1.1.

According to operation logs, the sludge volume index (SVI) has typically been approximately 132 mg/L. SVI results under 100 mg/L are typical of a good settling sludge, while 150 mg/L or more is often contributed to filamentous growth (poor settling). However, because the data in the logs was consistently reported at 131.8 mg/L, the validity of the data is suspect and may not be indicative of the actual settling performance. Additional testing may be warranted prior to design of future secondary clarifiers.

2.5.6 Disinfection and Reuse Pump Station

The facility has the capability to disinfect wastewater in an existing chlorine contact chamber located between Recharge Basins 5 and 6. Bulk 12-percent hypochlorite is delivered to the WWTP and stored in a 150-gallon tank. The existing WWTP also contains one effluent disposal pump used to pump effluent for Class C Reuse.

However, chlorination has not been used in some time since the facility demonstrated soil aquifer treatment. In addition, the facility no longer disposes of effluent via agricultural Class C Reuse, thereby eliminating the need to disinfect and pump the effluent.

2.5.7 Recharge Basins

After clarification, effluent can be directed, via gravity, to three equally sized recharge basins (Recharge Basins 5, 6, and 7) with a total surface area of approximately 15 acres. The discharge is cycled to allow for wet and dry cycles. There have been no reports of plugging or inability to percolate the effluent at the recharge basins. The plant site contains an additional four recharge basins (Recharge Basins 1, 2, 3, and 4) on the south end of the facility. The combined surface area for all seven basins is approximately 25 acres. The

recharge basins are noted to have a percolation rate of 1.2 acre-feet/acre/day, per the Eloy Reclaimed Water Recharge Project, April 2004, Westland Resource, Inc. The basins were designed using a percolation rate of 0.6 acre-feet/acre/day to account for a 50 percent reduction common with wet/dry cycling. This design rate results in the ability to recharge a maximum of approximately 5 mgd.

The facility has an underground storage permit from the Arizona Department of Water Resources (ADWR), Application No. 71-591932, for groundwater recharged from the recharge basins.

2.5.8 Electrical, Instrumentation, and Controls

Two APS transformers provide power to the existing WWTP. A 75-kVA pad mounted transfer located just south of the existing influent junction box provides 480 volt, 3-phase power to the existing headworks. A 300-kVA pad mounted transformer provides power to the aeration basins, clarifiers, and blowers. Backup power is provided by a 125-kW generator (Generac), located just north of the existing influent junction box.

The existing WWTP does not have a Supervisory Control and Data Acquisition (SCADA) System, instead the operation and controls are simple mechanical controls (float switches) or are manual (manually operated valves).

3.0 PROJECTED DESIGN CAPACITY

A land use plan was developed for the City of Eloy to classify the type of current and future developments. The purpose of the land use plan is to quantify existing and future developments, and identify the location of developments. The classifications of land uses were specifically developed as part of the Wastewater Service Area Study (Carollo 2006) and are consistent with the City's General Plan wherever possible. In undeveloped and undefined areas, a "typical" square mile of development was used in the land use plan.

The land use plan allows the creation of a planning level sewer collection system layout to serve the existing and future developments. The geographic and political boundaries of the City resulted in the creation of five (5) Wastewater Service Areas, with the existing WWTP located in Wastewater Service Area 1. The land use within each Wastewater Service Area is then combined with wastewater generation (unit flow) rates per land use type to produce the total wastewater flow to be generated with the given Wastewater Service Area. Wastewater Service Area 1 is estimated to generate a total of 14 AADF at buildout; therefore, the buildout capacity of the existing WWTP will be defined as 14 mgd AADF. The anticipated timing of the growth and expansion from the current 2 mgd capacity to the anticipated buildout capacity was not evaluated as part of this study.

4.0 EFFLUENT DISPOSAL OPTIONS

The level of treatment (effluent quality) required at the treatment plant will be dependent upon the future effluent disposal method(s) and the best available demonstrated control technology (BADCT) treatment performance requirements as defined by ADEQ. The effluent disposal methods to be considered by the City include:

- Urban Lakes
- Riparian Habitat
- Recharge Basins
- Open access landscape irrigation

If pursued, urban lakes would be coordinated with the developers and the homeowner's association (HOA) to determine the maximum size maintainable by the HOA. Recharge basins are the preferred effluent disposal method at the existing WWTP.

The minimum reclaimed water requirements for different reuse options are provided in the following table.

Table 1.5 Minimum Reclaimed Water Requirements for Direct Reuse Existing WWTP Evaluation and Expansion Plan City of Eloy, Arizona

Type of Direct Reuse	Minimum Class of Reclaimed Water Required
Irrigation of food crops	A
Recreational impoundments	A
Residential landscape irrigation	A
School ground landscape irrigation	A
Open access landscape irrigation	A
Toilet and urinal flushing	A
Fire protection systems	A
Spray irrigation of an orchard or vineyard	A
Commercial closed loop air conditioning systems	A
Vehicle and equipment washing (does not include self-service vehicle washes)	A
Snowmaking	A
Surface irrigation of an orchard or vineyard	B
Golf course irrigation	B
Restricted access landscape irrigation	B
Landscape impoundment	B
Dust control	B

Table 1.5 Minimum Reclaimed Water Requirements for Direct Reuse Existing WWTP Evaluation and Expansion Plan City of Eloy, Arizona	
Type of Direct Reuse	**Minimum Class of Reclaimed Water Required**
Soil compaction and similar construction activities	B
Pasture for milking animals	B
Livestock watering (dairy animals)	B
Concrete and cement mixing	B
Materials washing and sieving	B
Street cleaning	B
Pasture for non-dairy animals	C
Livestock watering (non-dairy animals)	C
Irrigation of sod farms	C
Irrigation of fiber, seed, forage, and similar crops	C
Silviculture	C

Notes:
1. Reference: A.A.C. R18-11-309 Table A
2. Denitrification is designated by adding a "+" to the Class, for example A+.

Currently the existing WWTP site has approximately 25 acres of area designated for recharge. Assuming the design recharge rate of 0.6 acre-feet/acre/day is consistent throughout the site, approximately 72 acres of recharge (not including berms, access roads, etc.) is required at 14 mgd AADF assuming no other disposal methods are pursued. Therefore, the current area set aside for recharge is insufficient. In addition, future expansion of the WWTP will further reduce the available area for recharge. It is recommended that the City pursue other reuse options (such as urban lakes, injection wells, aquifer storage and recovery, etc.) and additional land for recharge. The use of offsite effluent disposal will likely require an expansion to the existing reuse pump station or construction of a new effluent pump station. Also to be considered is the impact of recharging effluent on land within close proximity to wastewater infrastructure, specifically the impacts upon existing and future structures. Geotechnical investigations will be necessary to assess the ability to construct structures upon land used for recharge and to assess the potential impacts upon structures from the recharge of effluent in close proximity to structures. Hydrogeologic investigations are also recommended to further evaluate impacts upon the aquifer, including groundwater "mounding" and migration.

The City currently owns approximately 81.5 acres of land to the north of the existing WWTP and north of the Santa Rosa Canal (APN 404-27-01500). These 81.5 acres would be a prime location for a future site dedicated to recharge, and possibly riparian habitat to serve as a water conservation education center. It would be prudent of the City to earmark this land for these purposes and possibly recharge a majority of the effluent from the existing

WWTP at this 81.5-acre site. This will benefit the City since additional major land purchase may not be required and this would provide the maximum use of the land at the existing WWTP. Site specific recharge rates and recharge basin layouts including containment berms and access roads will be required to determine the maximum amount of recharge that could be performed at this site.

5.0 EFFLUENT WATER QUALITY OBJECTIVES

Treated effluent must (at a minimum) meet or exceed the current standards set forth in the Arizona Administrative Code (A.A.C.), specifically as defined in R18-9 and R18-11. The specific effluent limits, sampling parameters, and sampling frequency will be determined by the various permits required for expansions to the existing wastewater treatment plant.

Typically, ADEQ requires Class B+ for effluent disposal via recharge basins, while open access methods, also promoted by the City, require Class A+. Since the land requirement for disposal via recharge basins is substantial, it is anticipated that the existing WWTP and each Regional WRF will use multiple effluent disposal methods. Therefore, the existing WWTP and each Regional WRF may include the flexibility to produce Class A+ or Class B+ depending upon the disposal method and dependent upon soil aquifer treatment thereby waiving the need for disinfection. While effluent disposal methods requiring a Class C level of treatment may be available, it should be noted that the effluent would still be required to meet the BADCT standards, which requires denitrification and more stringent disinfection requirements, resulting in the need to provide nitrogen removal and disinfection at Class A standards. It should also be noted that while no specific Reuse type requires Class A+ or B+ (the "+" refers to nitrogen removal) quality water, the BADCT standards require nitrogen removal and therefore treatment to Class A+ or B+ instead of Class A or B.

Currently, the existing wastewater plant is able to discharge effluent to recharge basins without disinfection. This is allowable since the BADCT standards provide for a deviation from the disinfection requirements if soil treatment can be proved at the site. Despite the allowable deviation from the disinfection requirement, ADEQ could discontinue the credit for treatment through the unsaturated zone when the facility expands. Therefore, continued monitoring and reporting (as part of a design report or hydrogeologic report) of the soil treatment and proactive discussions with ADEQ are essential to protecting this current practice. In addition, major updates to the APP will include a public hearing process, public opinion may be negative towards the recharging of groundwater with effluent that has not undergone disinfection. To accommodate the potential of ADEQ requiring disinfection for future expansion, sufficient footprint should be set aside for disinfection and possibly filtration. The BADCT treatment performance requirements, reclaimed water quality standards, and recommended effluent design criteria are provided in Tables 1.6, 1.7, and 1.8, respectively.

Table 1.6 BADCT Effluent Requirements
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

	Average Daily Flow < 250,000 gpd	Average Daily Flow > 250,000 gpd
Parameter	**Effluent Limits(1)**	**Effluent Limits(1)**
pH	6.0 - 9.0	6.0 - 9.0
BOD (30 day average)	< 30 mg/L	< 30 mg/L
BOD (7 day average)	< 45 mg/L	< 45 mg/L
TSS (30 day average)	< 30 mg/L	< 30 mg/L
TSS (7 day average)	< 45 mg/L	< 45 mg/L
Removal Efficiency for BOD, CBOD, TSS	85%	85%
Total Nitrogen (as N) (2)(3)	< 10 mg/L	< 10 mg/L
Fecal Coliform (3)		
Single sample maximum	800 cfu/100 mL	23 cfu/100 mL
Seven sample median	200 cfu/100 mL	2.2 cfu/100 mL

Notes:
(1) Reference: A.A.C. R18-9-B204
(2) Five month rolling geometric mean
(3) BADCT standards allow for soil aquifer treatment if it can be proved that the level of treatment is reached in the wastewater that percolates to the groundwater. In this case, the limit would not be at the outfall, but rather prior to the groundwater interface.

Table 1.7 Reclaimed Water Quality Standards
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

	Class A+ (1)	Class B+ (2)	Class C (3)
Parameter	**Effluent Limits**	**Effluent Limits**	**Effluent Limits**
Total Nitrogen (as N) (4)	< 10 mg/L	< 10 mg/L	N/A
Turbidity			
Daily (24-hour) average	2 NTU	N/A	N/A
Single sample maximum	5 NTU	N/A	N/A
Fecal Coliform			
Single sample maximum	23 cfu/100 mL	800 cfu/100 mL	4,000 cfu/100 mL
Four out of last seven daily samples	Non Detect	200 cfu/100 mL	1,000 cfu/100 mL

Notes:
(1) Reference: A.A.C. R18-11-303
(2) Reference: A.A.C. R18-11-305
(3) Reference: A.A.C. R18-11-307
(4) Five sample geometric mean
(5) Class A, B, C, etc uses are listed in R18-11 Table A

Table 1.8 Recommended Effluent Design Criteria Existing WWTP Evaluation and Expansion Plan City of Eloy, Arizona	
Parameter	**Effluent Limits**
pH	6.0 - 9.0
BOD	< 10 mg/L
TSS	< 10 mg/L
Total Nitrogen (as N)	< 8 mg/L
Turbidity (1) (2)	
Daily (24-hour) average	2 NTU
Single sample maximum	5 NTU
Fecal Coliform (2) (3)	
Single sample maximum	23 cfu/100 mL
Seven sample median	2.2 cfu/100 mL

Notes:
(1) Turbidity monitoring only required if Class A+ reclaimed water is being produced.
(2) Turbidity and coliform limits will not be required if limits are continued to be waived by ADEQ due to the large groundwater separation and the proven soil aquifer treatment.
(3) Fecal Coliform for four out of last seven days must be non detect if Class A+ reclaimed water is being produced.

In order to meet these effluent water quality recommendations, expansions of the existing WWTP will be required to include nitrogen removal, disinfection, and possibly filtration (filtration would be required if a Class A Reuse method is pursued or if ultraviolet light (UV) disinfection is the preferred disinfection technology). In addition, if during the next major APP amendment process ADEQ does not accept soil aquifer treatment the future expansion will require disinfection.

6.0 OVERALL EXPANSION PLAN CONCEPT

The existing WWTP expansions and future Regional WRFs (covered under a separate technical memorandum) are proposed to be developed under a water reclamation facility (WRF) concept. Under the WRF concept, the WRFs would be planned and expanded with the overall goal of recharging and/or reclaiming water for beneficial uses within the City limits. This concept could be realized with a treatment facility producing either Class B+ or Class A+ reclaimed water (as defined by A.A.C. R18-11-303 and 305). Class B+ reclaimed water is defined as wastewater that has undergone secondary treatment, nitrogen removal, and disinfection, and could be utilized for golf course irrigation and restricted access landscape irrigation. Class A+ reclaimed water is defined as wastewater that has undergone secondary treatment, nitrogen removal, filtration (with provisions for coagulant addition if required), nitrogen removal, and disinfection and could be utilized for irrigation of food crops, recreational impoundments, residential landscape irrigation, toilet and urinal flushing, and urban lakes. Direct injection wells and/or aquifer storage and recovery (ASR) wells could be implemented as a supplement to or as an alternative disposal via recharge

basins. Direction injection and/or ASR wells could be used to gain groundwater credits without the expansive land area requirements of surface recharge, or to provide location specific groundwater recharge (e.g., strategic mounding or injection into a lower aquifer unit). The recharge option could also be expanded to a riparian preserve-type facility, which could include both recharge basins and open water impoundments (ponds).

Sections 7 and 8, Liquid Stream Evaluation and Solids Stream Evaluation, discuss the unit process options that are available to meet the long-term planning goal of reclamation (i.e. ability to produce either Class B+ or Class A+ reclaimed water reliably and consistently). Each unit process is followed by a recommendation on the specific technology best suited to fit the future needs at the WWTP.

6.1 Setback Requirements

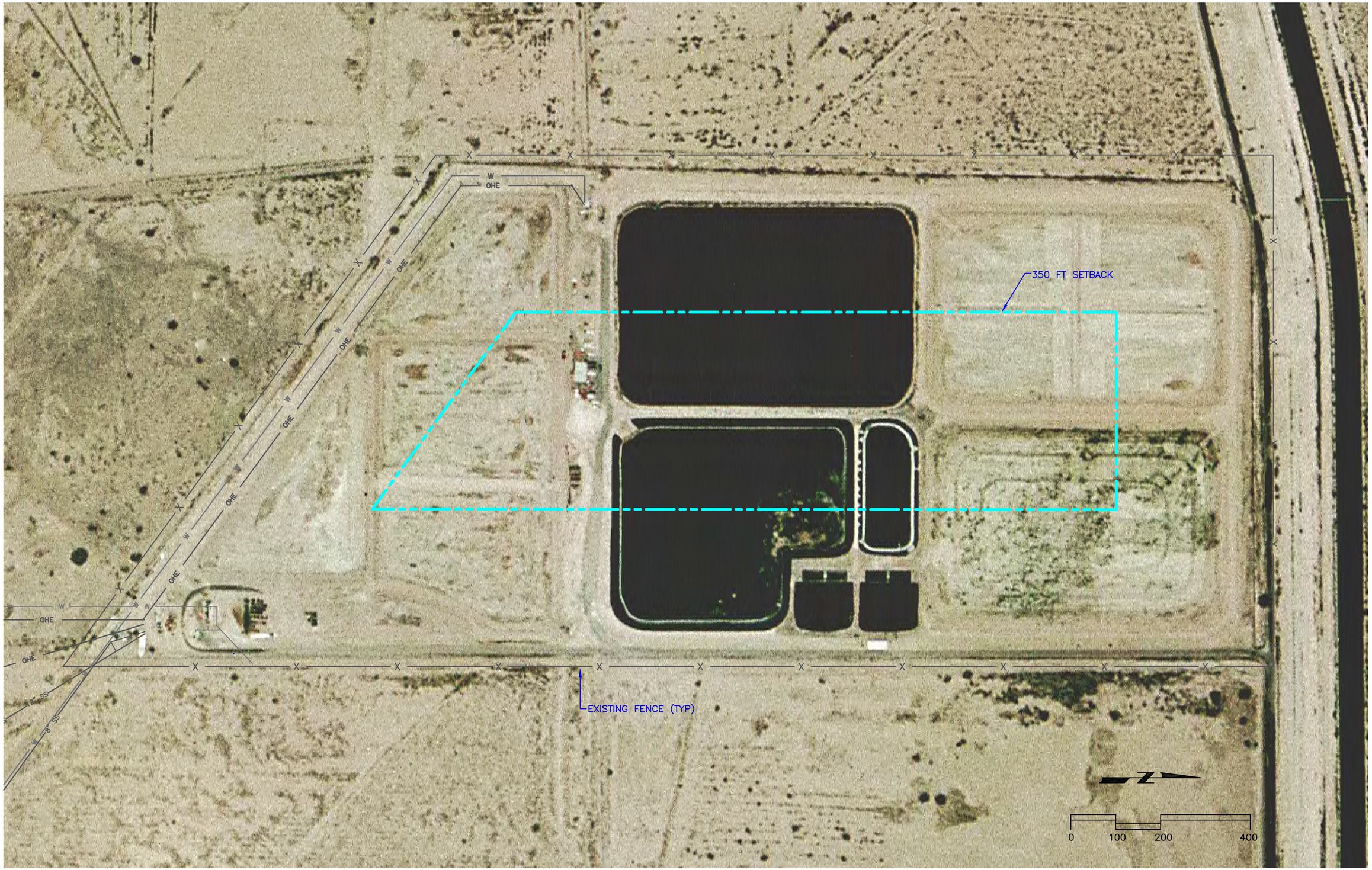
The future expansions at the existing WWTP must also meet the setback requirements set forth in A.A.C. R18-9-B201, as summarized in Table 1.9. A setback is defined as the distance from a feature that has the potential to produce odor or noise to the nearest adjacent property line. Since the existing WWTP capacity is greater than 1 mgd, the setback distances are 350 and 1,000 feet depending upon odor, noise and aesthetic controls. The 350-foot setback limit has been placed upon the existing WWTP layout for illustration purposes and to define the limits for future unit process expansions. The 350-foot setback line has been offset from the existing fence, for illustration purposes; the actual property line should be defined to further define the setback implications. Facilities that have the potential to produce noise and/or odor will need to be constructed within this setback and be provided with measures to minimize their effect. These facilities and features include headworks, blowers, solids handling equipment, aeration basins, and digesters. The 350-foot setback line superimposed over the exiting WWTP site is presented as Figure 1.4.

Table 1.9 Facility Setback Requirements
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

Sewage Treatment Facility Design Flow (gpd)	No Noise, Odor, or Aesthetic Controls (feet)	Full Noise, Odor, and Aesthetic Controls (feet)
24,000 to less than 100,000	350	50
100,000 to less than 500,000	500	100
500,000 to less than 1,000,000	750	250
1,000,000 or greater	1,000	350

Source: Arizona Administrative Code (A.A.C.) R18-9-B201

Support facilities that can be located outside the setback limits include administration / maintenance facilities and recharge basins. Odor control features may be required to be located within the setback limits, however this should be coordinated with ADEQ as these features might be allowable outside the setback limits.



CITY OF ELOY, ARIZONA SEWER SERVICE AREA STUDY
Technical Memorandum No. 1
DRAFT
May 2006

carollo ENGINEERS

350-FOOT SETBACK LIMITS

Figure 1.4

J:\Client\ELOY_PHXC\7266B00\TASK004\FIG-1-4 5-24-06 10:02am AGilmore ; 1117-bdr ;20060302085357.bmp;H:\CanonScans\CAD\1st Floor\20060302085357.tif;eloy_image.tif

7.0 LIQUID STREAM EVALUATION

7.1 Preliminary Treatment (Headworks)

A new preliminary treatment system consisting of mechanical screening and grit removal is proposed, with the screenings operations located in a new Headworks Building that includes odor control. The headworks facilities would be sized to treat the short-term expansion goal of 4 mgd AADF, with accommodations for further expansions to the anticipated buildout capacity of 14 mgd AADF.

7.1.1 Influent Screening

As the initial plant preliminary treatment process, influent screening is used to remove large items such as rags and debris to protect downstream treatment processes and equipment. Hydraulic losses through bar screens are a function of approach velocity and the velocity through the bars. As such, headloss increases with the degree of clogging. Mechanical-cleaning mechanisms are used to reduce potential overflows and flooding due to screen clogging, similar to what occurs with the existing static units. Proposed influent screening alternatives include either a grinder auger or a step screen. The grinder auger and step screens are further discussed as follows.

7.1.1.1 Grinder Auger

The grinder auger is an in-channel screen that consists of a dual or single-shafted grinder and a lift screw. Many manufacturers can include an optional screenings washer/compactor unit. Wastewater first enters through the grinder, where coarse solids are ground and then separated from the wastewater through a perforated screen. Typically, a 1/4-inch perforated screen is recommended. The coarse solids are carried up a helical shaft conveyer before dispensing into a dumpster or the screenings washer/compactor. The grinder augers can provide additional protection of downstream equipment by grinding incoming solids; however, the grinders can fail and require periodic rebuilding by the manufacturer. Examples of commonly used grinder augers are JWC's Auger Monster and grinder augers produced by Franklin Miller.

7.1.1.2 Step Screen

This self-cleaning mechanical screen adds a bottom "step" to improve the removal of grit and debris that can settle at the bottom of the screen. Step screens have moving lamellas to improve screening removal and allow for unassisted cleaning (no brushes or water sprays needed). These screens can be installed in deep channels with screenings discharge heights of over 22 feet. In addition, step screens can be installed with 3 to 8 mm openings, providing a fine level of screening. Huber and Vulcan are two recommended step screen manufacturers.

7.1.2 Influent Lift Station

The existing influent pump station currently pumps raw wastewater to the existing inclined static screens. The influent pump station would require an expansion to handle the increased flows and piping modifications to bypass the inclined static screens (to be removed). However, the existing wet well inside diameter dimension of 10 feet, is too restrictive for installing new larger submersible pumps capable of meeting the ADEQ requirement of providing adequate pumping capacity at the peak hour flow with one pump out of service.

A practical option is to construct a new influent lift station with expandability to provide buildout capacity. A new influent lift station could be constructed without impacting operation of the existing facility. The new lift station could be constructed as a wet well (submersible pumps in wet well) or wet-dry well (submersible or self-priming pumps in a dry well) configuration. The wet well configuration (such as the current lift station) is less expensive to construct but can be problematic to maintain. A wet-dry well configuration allows for easier maintenance since the pumps are in a dry well out of the wastewater wet well. The downside of a wet-dry well configuration is the increased capital cost, larger footprint, ventilation requirements, and lighting requirements.

Any lift station alternative should include one standby pump of equal capacity to the largest pump. In addition, foul air from the lift station should be withdrawn and sent to the odor control system.

7.1.3 Grit Removal and Handling

The objective of a grit removal process is to physically remove heavy, abrasive, and inorganic solids from the flow stream. The removal of such grit, including sand, gravel, and other large particles, is important because it eliminates excessive wear on a plant's mechanical equipment, reduces the formation of deposits in the pipelines and process units, and reduces the frequency of digester cleaning.

It should be noted that the replacement of the existing inclined static screens with finer mechanical screening devices may defer the need for grit removal to a future plant expansion. While grit removal is recommended, the capital costs of these facilities may preclude its inclusion until later phases. Regardless, the new headworks facilities will be planned to include the additional headloss through a grit removal system and allow gravity flow through the remainder of the plant.

Proposed grit removal alternatives include aerated, vortex, or tube settling grit removal methods. Vortex grit removal, including both mechanical vortex and free vortex, has proven to be an effective and practical method for grit removal and is typically recommended over other technologies. Grit from the vortex would be washed, drained and collected into a bin for off-site disposal.

Grit is typically removed using an airlift pump, a turbo suction lift pump, or a torque flow (recessed impeller) pump. The objective of grit pumping is to move the grit to a grit washer while preventing the grit from clogging the pipes. For these types of pumps, careful consideration must be given to the material of construction, overpressure protection, and types of lubrication and seal systems. Lots of organics are typically removed with vortex grit systems. As such, grit washing and dewatering is often used to further separate organics from the grit, in order to reduce odor and vector problems.

The grit removal technologies are briefly discussed as follows.

7.1.3.1 Aerated Grit Removal

Aerated grit chambers use a specific velocity of roll or agitation to keep organics in suspension while settling out the grit. If the velocity is properly adjusted, roll can produce a very low percentage of organic material in the grit. The aerated grit removal process typically consists of a rectangular tank with coarse bubble diffusers along one wall, and a bottom floor sloped to a collection trough under the diffusers. Aerated grit removal is typically more expensive than vortex grit removal because of the structure and supplemental equipment.

The reputation of aerated grit removal as an effective process has suffered somewhat over the years due to some faults in the typical design criteria. The traditional width-to-depth ratio of aerated grit basins has increased to accommodate the coarse bubble swing-out type diffusers. This creates a large area down the middle of the basin that is not affected by the roll pattern and often results in short-circuiting of grit through the process. Attempts to remedy this have been made by installing vertical baffles across the width of the basin. Another reason for poor aerated grit removal performance is often due to shallow floor slopes along the bottom of the basin, which results in grit becoming resuspended before it reaches the collection trough under the diffusers.

7.1.3.2 Vortex Grit Removal

The vortex grit removal process provides a simpler, less mechanically intensive method of grit removal on a smaller footprint than aerated grit removal. Vortex grit removal works on the principles of gravity and centrifugal action. Upon entering the circular, conical-shaped chamber, the grit is moved to the outside of the chamber because of the centrifugal forces created by the spiraling action of the chamber. Tangential velocities increase as they move from the outside wall to the center of the unit. Therefore, the flow path on the outer part of the chamber has a longer travel time, allowing the grit to settle. The benefits of vortex grit removal are that it is lower in cost than an aerated system and typically does not require odor control. However, the short detention time of vortex grit removal decreases the efficiency of fine grit removal in comparison to that of an aerated process.

Vortex systems are generally classified as free vortex or mechanically-induced vortex. In a mechanically-induced vortex system, a rotating turbine controls the velocity inside the circular chamber. The turbine impeller is located at the center of the chamber, above the grit collection hopper, which causes a lifting action, which suspends the lighter organic material, which exits the basin through the effluent channel. One manufacturer has a basin with a flat bottom, while other manufacturers use a sloped, conical bottom. Smith & Loveless's Pista® Grit Chamber and US Filter's Mectan Grit System are examples of a mechanically induced vortex systems. However, the Mectan Grit System is preferable since its cone shaped bottom has an advantage over the Pista® Grit's flat bottom, which in some facilities has resulted in build-up of grit.

A free vortex system takes advantage of the centrifugal and gravitational forces created by the orientation of the inlet piping into the circular basin without the use of a mechanical turbine. The rotating flow creates a free vortex accelerated boundary layer for grit collection and classification. The primary advantages of the free vortex system are that it is an all hydraulic, non-mechanical design with no moving parts. The primary disadvantage of a free vortex system is that operational flexibility for adequately handling variable flow rates is minimized, as compared to mechanically-induced vortex systems. Additionally, there are only two manufacturers of free vortex grit systems (Eutek System's TeaCup™ and Hydro International's Grit King®).

7.1.3.3 Tube Settling Grit Removal

Tube settling is a proprietary technology for grit removal consisting of a circular basin, similar to a free vortex grit removal basin, inside of which is a bank of settling tubes. The concept of settling tubes is fundamental to sedimentation theory. Many settling basins have been retrofitted with settling tubes or settling plates (i.e., Lamella plates) for years as a means of expanding the design capacity of a basin. The settling tubes are designed to impart a high velocity on the wastewater entering the tube in order to prevent plugging. The wastewater flow then experiences a decrease in velocity until the optimum rate for grit removal is achieved. The primary benefit to this type of system is a smaller footprint compared to the vortex system. The primary disadvantages include a single proprietor (Eutek Systems HeadCell™) and minimal installations in the U.S. to date. Again, the operational flexibility for adequately handling variable flow rates is minimized.

7.1.4 <u>Odor Control</u>

The proposed Headworks Building would be constructed to provide odor control of the preliminary treatment process. An odor control system would be installed to treat the odorous air (primarily hydrogen sulfide, or H_2S) from the Headworks Building as well as the headspace from the influent channels and influent pump station. In addition, the secondary process and solids handling facilities will likely also require odor control measures due to the setback requirements. The odor causing constituents from these processes vary and may result in multiple odor control methods throughout the site, for example carbon

adsorption is better suited to treating odors from aeration tanks and secondary clarifiers, while wet-chemical scrubbers are suited to odors at Headworks facilities.

Several different methods are available to control odors at the future headworks. Odors generated at wastewater facilities have historically been controlled using either liquid stream or air stream treatment technology. Liquid stream treatments add chemicals to the wastewater stream to minimize odors before they can be emitted. Air stream (vapor phase) treatments use an enclosure surrounding the odorous area to capture the affected air, and then ventilate the collected gases to an odor control unit for treatment. For this application, an air stream treatment technology is recommended. Generally the three primary air stream odor control technologies are:

- Wet Chemical Scrubber
- Carbon Adsorption
- Biofiltration

7.1.4.1 Wet Chemical Scrubber

Vapor phase treatments rely on transferring odorants to the liquid or solid phase via absorption, condensation, and/or adsorption. The most popular absorption technology is wet chemical scrubbing using either packed towers or mist chambers. Packed towers are the predominant technology employed in the U.S.

The primary advantages to packed-tower wet chemical scrubbers are that they can treat high inlet concentrations, and they respond well to variable inlet concentrations. The primary disadvantages include high chemical requirements, high electrical consumption, and high noise potential. Multi-stage systems often have pressure drops of 8 to 12 inches of water column, depending on the number of stages. There is also a high corrosion potential and safety concerns with the handling of hazardous chemicals.

7.1.4.2 Carbon Adsorption

Although several different types of media are often used to adsorb odorous compounds, the most widely used is granular activated carbon (GAC). The carbon is thermally treated to create tiny pores, which substantially increases the surface area and creates active sites for bonding locations. Odorous compounds bond to the adsorptive surfaces. GAC effectiveness decreases as adsorptive sites are taken up by the contaminants. This eventually requires regeneration or replacement of the media. There are two general types of carbon adsorption systems - caustic-regenerated impregnated carbon and water-regenerated catalytic carbon.

Caustic-Regenerated Impregnated Carbon

Traditionally, air streams containing high levels of H_2S have been treated with alkali-impregnated carbon. Impregnated carbon employs chemical additives to increase contaminant capacity. The most common additive is an alkaline or caustic reagent, primarily sodium hydroxide (NaOH) or potassium hydroxide (KOH). The reagent reacts with H_2S, the product of which remains fixed on the carbon. As the chemical impregnant is consumed, sulfur will clog the pores in the activated carbon, reducing the effectiveness as the adsorption sites become saturated. The carbon then has to be replaced or regenerated. Soaking the vessel with caustic solutions will regenerate the carbon's capacity to remove H_2S. This method of regeneration restores the adsorptive capacity of the carbon to approximately 80 percent of its former capacity. As the adsorption capacity decreases, the time between regenerations also decreases. Generally, after three of four regenerations, replacing the carbon is required. For replacement-type carbon systems, the adsorber unit is taken offline to remove the exhausted carbon, which results in facility downtime.

Another concern associated with chemical regeneration is that it creates heat, posing a potential fire danger. Caustic-impregnated carbon can reduce the kindling temperature from around 500 degrees C to about 250-300 degrees C. Onsite regeneration of impregnated activated carbon also has other drawbacks. Disposal of the spent caustic solution can become a handling problem. However, since the caustic solution is a high pH stream, it could potentially help keep sulfides in solution if bled back into the waste stream appropriately.

Water-Regenerated Catalytic Carbon

One carbon manufacturer, Calgon Carbon Corporation, has developed a proprietary vapor-phase virgin activated compound called *Centaur HSV*™, which is specifically intended for wastewater facilities. The *Centaur HSV*™ carbon is a bituminous coal-based product that catalytically oxidizes H_2S and converts it to water-soluble sulfur compounds. Unlike the impregnated carbon, this catalytic carbon does not require a caustic reagent for an acid-base neutralization and regeneration. As a result, it can be restored for H_2S uptake through simple water washing. This method of regeneration restores the adsorptive capacity of the carbon to approximately 85 percent of its original capacity, with an approximate 5 percent decrease each subsequent regeneration, down to about 60 percent of the original capacity. Again, as the adsorption capacity decreases, the time between regeneration also decreases. After approximately six regenerations, replacing the carbon is generally recommended.

Carbon adsorption systems typically are easy to operate and reliable. The effectiveness of carbon is directly related to the number and size of the active sites available for adsorption. When the influent odorous air streams contain high concentrations, the carbon sites will be consumed rapidly. Since wastewater air streams often contain a mixture of odorous compounds, it is difficult to predict carbon breakthrough without some type of pilot testing.

Isotherms are available to estimate carbon breakthrough for single components, but not for multi-component mixtures. Electrical consumption can also be high, primarily due to the pressure drop through the carbon bed, which increase markedly with higher face velocities through the beds.

7.1.5 Biofilters

Biofiltration (or a Biofilter) is a natural media bed process that contains bacteria and microorganisms. This process removes odor from foul air streams by both adsorption and absorption of the odor-causing compounds onto the media where microorganisms oxidize the compounds. The media can be wood chips, yard waste, compost, or proprietary media. The microorganisms that grow on the media are sufficient to provide for odor removal, no additional chemicals and/or bacteria is required. With any Biofilter a mist spray is required to provide the necessary moisture to the Biofilter. The major benefit of using biofilters is there are no chemical requirements. The downside of a Biofilter is they typically require a greater footprint than wet chemical scrubbers.

A biofilter can be constructed either as an aboveground stack configuration or as an in-ground system. Typically, the aboveground configurations use proprietary media as a site for microorganism growth, while in-ground systems have been constructed with proprietary media or more "natural" medias. Belowground systems are typically constructed in a belowground concrete tank with influent foul air header piping in order to provide an even distribution of foul air to the Biofilter.

In the past Biofilters were used primarily at relatively smaller facilities (under 6 mgd AADF); however, recent advances have resulted in the ability to treat odor at very large facilities. These recent advances make the in-ground proprietary media Biofilters and attractive option for the Existing WWTP, future WRFs, and future lift stations throughout the wastewater collections system.

7.1.6 Headworks Recommendations

The recommendations for the preliminary treatment system is provided below, with the arrangement alternatives (such as screening proceeding the lift station, etc.) further discussed and illustrated under Section 9.0, Plant Expansion Alternatives. In addition, due to site features, such as the deep influent sewer lines and setback issues, these recommendations and the alternatives discussed later in Section 9.0 will require further investigation during a preliminary design effort.

Lift Station: Due to the physical constraints of the existing wet well, it is recommended that a new submersible lift station be constructed within the 350-foot setback. At the direction of the City, a new wet well configuration is proposed in order to reduce the capital costs associated with a dry well approach. The lift station should include at least two pumps and possibly three or more pumps in order to provide flexibility and coverage over the possible flow ranges. The lift station should be designed with expandability to serve buildout

conditions. The trough style wet well could be constructed to further reduce the capital costs and promote self cleaning. Upon construction of the new lift station, the existing wet well should be abandoned.

Screening: A step screen is recommended for the headworks project. Step screens are efficient, can handle high flows, provide fine screening, can be fully enclosed, and are self-cleaning, thereby reducing the need for operator intervention and making this a perfect fit for the City. In addition, the wide operating flow range of these screens allows for greater flexibility as the plant expands. Upon construction of the new screening facility, the existing static screens should be removed.

It is recommended that any screen be coupled with a conveyor, washer, and compactor typically provided as a single unit available from the screen manufacturer.

Grit Removal: It is recommended that the headworks include grit removal by the mechanically induced vortex grit removal method due to its low capital cost, good grit removal performance, low headloss, success at similar facilities, and ease of adding this process after a gravity screen arrangement. Alternatively, if gravity flow cannot be maintained through the Headworks, a free vortex system could be installed above grade. However, if capital costs are an issue for the headworks expansion it may be possible to postpone the installation of the grit removal and provided the necessary footprint for future addition of grit removal.

Odor Control: A wet chemical scrubber is recommended for the Headworks Building. This system has a cost benefit over a biofilter as the plant capacity and necessary headworks scrubbing needs increase. A packed tower configuration is recommended due to its ability to handle variations in the odor concentration and flow rate; this provides increased flexibility as the plant expands. However, if chemical handling is an issue and footprint is not a major issue, a belowground pre-engineered biofilter is recommended, which will likely have lower capital and O&M costs compared to a wet-chemical scrubber. In addition, if ADEQ allows the construction of an odor control system outside the setback limits, the Biofilter will become a more attractive option since footprint will likely not be an issue. The City has expressed an interest in using a biofilter alternative; odor control options will be furthered during a preliminary design phase.

7.2 Secondary Treatment

The secondary treatment process includes the biological process and secondary clarification. The options for these processes are discussed in this subsection with the biological process discussed first, followed by a discussion on clarification.

7.2.1 Selection Criteria

The biological process selection criteria for this project are as follows:

- Effluent Quality: How well does the treatment process perform to meet water quality requirements?
- Footprint: How much room is required for the treatment basins and associated equipment?
- "Good Neighbor" Features: What is the odor and noise potential of the process and associated equipment?
- Maintenance Attention: How much time does the operators need to spend (daily, monthly, or yearly) to keep the process equipment working properly?
- Site Aesthetics: How aesthetically pleasing will the finished structures and equipment be to the public?
- Process Reliability: Will the process consistently meet or exceed the water quality requirements?
- Operational Flexibility: How easily can the operation of the treatment process be changed to meet changing loading conditions?
- Expandability: How easy is it to expand the treatment process or convert the process to another technology?
- Public Acceptance: How favorably will the public view the treatment process?
- Energy Cost: How much energy does the process consume per volume of wastewater treated?
- Capital Cost: How much does the system cost?

7.2.2 Technology Review

The following suspended growth activated sludge technologies are discussed herein:

- Conventional activated sludge - Modified Ludzack-Ettinger (MLE)
- Membrane bioreactor (MBR)
- Extended aeration
  - Biolac®
  - Oxidation ditch

7.2.2.1 Conventional Activated Sludge (MLE)

A conventional activated sludge process that includes nitrogen removal, such as the modified Ludzack-Ettinger (MLE) process, has been well documented and successfully implemented since the 1960s. This process is also known as biological nutrient removal (BNR), since nutrients (in this case nitrogen) are reduced during the biological process. The process includes two "zones" - an anoxic zone and an aerobic (oxic) zone. Two recycle streams are provided in this process - return activated sludge (from a secondary clarifier) and a separate internal mixed liquor recycle (from aerobic to anoxic zone). The addition of the mixed liquor recycle enables increased denitrification. The process requires control of the mixed liquor recycle in order to achieve excellent nitrogen removal. There are many modifications to this process to allow for different benefits, with many of these being proprietary processes. There are numerous successful MLE facilities in operation in the size range of the Eloy WWTP, such as those in Phoenix (Cave Creek WRP), Peoria (Beardsley Road WRF), and Yuma (Desert Dunes WPCF), just to name a few.

The benefits of this process are the reduced footprint (as compared to extended aeration), expandability, operation flexibility, effluent quality, and practicality for large treatment facilities. This would require an engineered system (as opposed to a proprietary pre-engineered system) and an experienced operator. At minimum, a moderate level of automation is recommended to further simplify the operation of this process.

7.2.2.2 Membrane Bioreactor (MBR)

A membrane bioreactor (MBR) process is an activated sludge process with micro- or ultra-filters (membranes) submerged into the activated sludge process. This reduces the necessary footprint due to the following: separate clarifiers and tertiary filters are eliminated; mixed liquor concentrations can be increased (thereby increasing the biological kinetics); and filters are included into the process tanks. An MBR can be incorporated into a BNR process. The MBR process requires a high level of operator training; however, this process can be highly automated and coupled with a well-planned SCADA system to monitor the process, thereby reducing the demand upon the operator. MBR facilities have been constructed to accommodate remote daily operation.

An MBR process is mentioned herein as a possible option for future expansions. Since the current practice is disposal of the treated effluent to recharge basins and footprint has not been identified as a major issue, an MBR is not viewed as a practical initial phase treatment process. However, as the City growth encroaches upon the existing and future WRFs, expansion within the existing footprint may become attractive. In addition, future opportunities for reusing treated wastewater and increased competition in the membrane market (resulting in reduced costs) could make this technology more attractive. Therefore, the alternatives are also compared by the ease of expansion/conversion to an MBR process.

7.2.2.3 Extended Aeration Processes

The following technologies are categorized as extended aeration activated sludge processes. Extended aeration is typically used for small proprietary pre-engineered wastewater treatment plants due to the relatively simple design and operation. Extended aeration is typically used for facilities up to 4 or 5 mgd AADF. Extended aeration wastewater facilities are in operation that successfully treat flows in excess of 4 to 5 mgd; however, this is at the expense of energy efficiency and footprint. Typically, facilities are physically constrained and are sensitive to energy costs, resulting in the selection of a conventional treatment approach.

The two technologies presented can be further categorized as low-rate cyclic activated sludge processes, since they are designed with a low organic loading concept, high detention times, cyclic aeration, and with lower clarifier loading rates. The combination of these criteria yields a stable, flexible, and easy to operate process. On the downside, these design parameters result in a larger footprint and more aeration energy as compared to conventional processes. This process can be operated with a low-level of automation (e.g. aeration set to run off timers).

Biolac®

Biolac® is a proprietary extended aeration activated sludge process (as manufactured by Parkson Corporation) which can also include denitrification (Wave Oxidation© process). The process incorporates a long solids retention time with submerged aeration, typically in earthen (lined or unlined) basins. Suspended aeration diffusers are set at approximately one foot from the bottom of the aerated basin. The aerators provide a dual function of mixing and aerating. The Wave Oxidation© process involves individually controlling the aeration chains to allow for oxic and anoxic conditions within a single basin, enabling nitrification and denitrification. An integral clarifier can be incorporated to reduce the overall footprint.

The Biolac® process is a very stable and flexible operation, as is typical with extended aeration. Future expansions with Biolac® would follow the existing configuration with earthen basins lined with a geo-synthetic liner (ADEQ requires a minimum 30-mil liner for earthen aeration basins). Due to limitations in side slopes, the earthen basin design increases the overall footprint of the facility as compared to extended aeration processes constructed with concrete tanks. The use of a synthetic liner also raises issues of leakage and potential replacement costs. In addition, the expandability and/or conversion of this configuration for future phases is limited due to the earthen/lined configuration, requiring demolition and construction of concrete tanks to accommodate membranes, conventional activated sludge, etc. The lack of a physical barrier between the oxic and anoxic zones can also result in decreased denitrification since control of the oxygen level in the anoxic zone is difficult.

Biolac® is a proven process, both in Arizona and within the City. For short-term solutions and for facilities with small flows (less than 2 to 5 mgd), this is an attractive solution from both an operation and cost approach. The inherent process flexibility of an extended aeration process to operate at flows much lower than design is a key benefit of the technology to new and expanding communities. However, as the facility expands beyond the 4-mgd capacity, other alternatives should be considered to provide treatment that is more efficient and for a reduced footprint. As community growth encroaches upon the treatment facility, odor control will become an attractive method to maintain a "good neighbor" status. If the aeration basins were required to have odor control, the footprint requirements of an earthen aeration basin design coupled with extended aeration would greatly increase the costs of odor control and would deem earthen basins cost prohibitive.

The aeration strategy of this process can be costly from an operation and maintenance (O&M) basis. Typical operator complaints (of other Biolac® facilities) include the difficulty of retrieving the aerator chains and the number of parts requiring maintenance. The current aeration configuration includes 63 aerator assemblies per basin, for a 4-mgd facility this equates to 252 assemblies, and projecting this further out to 14 mgd would result in 882 assemblies requiring periodic servicing and spare parts.

Oxidation Ditch

The oxidation ditch process is compared herein to the Biolac® since it is also an extended aeration process with some similarities and differences. The oxidation ditch process consists of a ring or oval shaped channel equipped with mechanical aeration and mixing devices. Aeration and mixing devices are sized to provide plug flow along the channels and complete mix at the influent zone. Oxidation ditches can also be designed for denitrification, by allowing the end run of the channel to go anoxic or by adding additional volume at the end of the run. The geometry of the oxidation ditch can be modified to provide greater biological treatment within a given footprint (e.g. by deepening the ditch). Oxidation ditch facilities are typically treating flows up to 6 mgd AADF. However, oxidation ditches have been modified to provide treatment at much larger facilities by reducing the solids retention time and thereby operating outside the extended aeration mode and more like conventional process. There are several proprietary oxidation ditch systems available, with successful operations at locations such as Casa Grande, Sahuarita, and Surprise. The proprietary Carrousel® oxidation ditch (as manufactured by Eimco) is considered herein, due to its simple and flexible operation, proven success, and historical experience in the region. Other successful oxidation ditch designs include the Orbal® multi-channel oxidation ditch process by US Filter/Siemens and the Phased Isolation Ditch by Krüger.

Oxidation ditches are constructed in a concrete tank; this allows for space savings, as compared to the Biolac®, and future upgrade/conversion flexibility. Oxidation ditches are also a more efficient treatment process, as compared to Biolac®, since the energy added for aeration is sufficient to provide the velocity needed for plug flow around the oxidation ditch. Oxidation ditches can also operate with shorter hydraulic retention times, as

compared to other extended aeration processes, resulting in a smaller footprint. In addition, the ditch can be modified to increase the biological capabilities within a given footprint (e.g. adding a second aerator impeller allows for deepening of the ditch).

The Carrousel® oxidation ditch operation is comparable to the operation of the Biolac® and actually has less equipment (no blowers or aeration chains, instead has one or two surface aerators). While the capital costs of an oxidation ditch (such as Carrousel®) would be greater than the Biolac® process, the O&M costs would be less and would likely offset the costs over the 20-year life. In addition, the concrete tanks constructed for the oxidation ditch can be readily retrofitted to accommodate a conventional activated sludge process or membrane bioreactor process in the future, if desired (for example the City of Avondale converted oxidation ditches to an MLE process).

7.2.3 Comparison of Processes

The alternatives for biological process (extended aeration only) are briefly juxtaposed for an initial expansion of an additional 2 mgd, for total WWTP capacity of 4 mgd, in Table 1.10. Table 1.11 provides a numerical ranking of the selection criteria, defined earlier. The numerical weighting factors are based upon the perceived importance of each of the selection criteria. Finally, the comparison of suspended growth alternatives is provided in Table 1.12.

7.2.4 Biological Process Recommendation:

In the long-term, a conventional activated sludge process (MLE or an MBR) would benefit the City by reducing the overall plant footprint, improve flexibility, is practical to cover (for odor control), and provides a readily expandable process concept. However, the operator requirements and the necessary capital investment for these two approaches may warrant that a less operator intensive process be pursued in the short-term.

For the short-term expansion to 4 mgd, it is recommended that the facility be expanded with an additional Biolac® basin. This is based upon the City's experience with this technology, to maintain a consistent biological process concept, and to reduce capital costs. While an oxidation ditch may be a better-suited process for this application, the use of two different technologies at the same facility is not recommended. Expansions beyond 4 mgd could use all or some the existing Biolac® basins for flow equalization (recommended if an MBR is pursued). If the City wishes to continue the use of an extended aeration technology until the buildout capacity of the plant is reached, it is recommended that the next expansion and future expansions include oxidation ditch technology in order to reduce the footprint, reduce energy costs, and reduce operator maintenance requirements. However, extended aeration technology is not recommended for the long-term expansion needs of the WWTP, particularly given the existing WWTP boundary and setback limits.

Table 1.10	Comparison of Extended Aeration Processes Existing WWTP Evaluation and Expansion Plan City of Eloy, Arizona	
Process	**Advantages**	**Disadvantages**
Biolac®	• Stable process • Easy to operate • Reduced quantities of sludge generated • Nitrification and denitrification in single basin	• Proprietary design • Large biological basin volume (as compared to conventional processes and processes installed in concrete tanks) • Accurate control of RAS/WAS • O&M of air diffuser and valves • Increased oxygen and mixing requirements • Not easily retrofitted to MBR process or conventional processes • Difficult to remove grit and solids without damaging liner • Requires a geosynthetic liner, failure risks and replacement costs
Oxidation Ditch (Carrousel®)	• High degree of process control • Less equipment to maintain • Easy basin cleaning (removal of grit, etc.) • Concrete basins can be modified for future expansions/conversions • Small footprint (as compared to Biolac®) • Nitrification and denitrification in a single basin	• Concrete costs • Proprietary design • Large biological basin volume (as compared to conventional processes)

Table 1.11 Numerical Weighting Factors Existing WWTP Evaluation and Expansion Plan City of Eloy, Arizona	
Criteria	**Numerical Weighting Factor**
Effluent Quality	4
Footprint	4
"Good Neighbor" Features	5
Maintenance Attention	5
Site Aesthetics	2
Process Reliability	5
Operational Flexibility	3
Expandability	4
Public Acceptance	5
Energy Costs	2
Capital Costs	4

Notes:

1. Numerical Weighting Factors 1 through 5, with 5 being the most important.

Table 1.12 Comparison and Ranking of Biological Process Alternatives
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

	Numerical Weighting Factor	Biolac®	Oxidation Ditch	MLE	MBR
Effluent Quality	4	4	4	4	5
Footprint	4	1	2	4	5
"Good Neighbor" Features	5	1	2	3	5
Maintenance Attention	5	4	5	3	2
Site Aesthetics	2	2	2	3	5
Process Reliability	5	5	5	4	3
Operational Flexibility	3	2	3	4	4
Expandability	4	1	3	4	5
Public Acceptance	5	3	4	4	5
Energy Costs	2	1	3	5	2
Capital Costs	4	5	3	4	2
Total Score		**121**	**147**	**162**	**169**

Notes:

1. Ranking 1 through 5, with 5 being the best.
2. Capital Costs do not include costs for land.
3. Total Scores are calculated as the summation of all the products of the rankings and numerical weighting factors for each criteria.

The ranking of the biological process alternatives results in a close ranking of the MLE and MBR systems. While the MBR achieved the highest rank of the all the alternatives the current effluent disposal practices do not warrant the increased capital investment, however changes in effluent disposal practices and/or changes in effluent permit requirements could result in an MBR process selection. All of the biological process alternatives will be discussed as potential buildout alternatives with the MLE and MBR options being most favorable due to the advantages of these processes.

As the existing WWTP facility expands, it is recommended that selector boxes be added to the aeration basins. The selector box aids in the control of filamentous organisms and allows for thorough mixing of the influent and RAS flows before the aeration zone. Selector boxes are typically sized with a hydraulic retention time of 20 to 60 minutes and generally include a mechanical mixing device. Selector boxes can be retrofitted into the existing aeration basins and designed into future expansions.

7.2.5 Secondary Clarification

The primary function of the secondary clarifier is to separate the activated sludge solids from the mixed liquor. Solids separation is the final step in the production of a well-clarified, stable effluent low in BOD and TSS, and as such, represents a critical link in the operation of an activated sludge treatment process. Typically, the goal is to achieve a total suspended solids concentration of less than 30 mg/L, although for a well-operated nitrification-denitrification process, BOD and TSS effluent concentrations less than 10 mg/L are typical. Return activated sludge (RAS) is directed from the clarifiers to the inlet of the biological process, while waste activated sludge (WAS) is directed to the solids handling facilities, or solids drying ponds at the existing WWTP, for further treatment and/or off-site disposal.

Currently, clarification is achieved by an integral rectangular clarifier. Alternatives include the continuation of the use of integral clarifiers or the use of external circular clarifiers.

While the integral clarifiers have performed well to date, this should be considered with respect to the lack of current permit limits in regards to TSS. The current configuration of integral clarifiers limits the flexibility between the unit operations. For example, if aeration is offline in a basin and a clarifier is offline in a different clarifier, two process trains would be taken out of service. To avoid such a scenario and thereby improve operational flexibility and performance, it is recommended that external circular clarifiers be incorporated into future expansions. Separating the unit processes in this manner will allow for increased process flexibility and reliability. In addition, future removal of the existing integral clarifiers and minor modifications to the existing aeration basins would enable increased biological treatment within the existing basins. The use of external clarifiers also eliminates the space constraints of the integral design, allowing for more conservative clarifier design, which can be a benefit to the biological process performance.

With the existing configuration, if one clarifier or basin is out of service during the maximum month flow period, the surface overflow and weir loading rates will exceed ADEQ standards. Comparing the values provided in Table 1.1 with clarifier design standards provided in Engineering Bulletin No.11, Minimum Requirements for Design, Submission of Plans and Specifications of Sewage Works, ADEQ, 1978 (Bulletin No. 11) shows that the clarifiers will operated beyond the 1,000 gpd/sf surface overflow rate standards when one clarifier or basin is out of service. In addition, Bulletin No. 11 sets the weir loading rate for extended aeration plants at a maximum of 7,000 gpd/ft, which is also exceeded when one clarifier or basin is out of service during maximum month flow period. If the short-term expansion does incorporate and additional Biolac® basin, the clarifiers should be sized to remedy this situation and provide additional flexibility.

7.2.5.1 Secondary Clarifier Recommendation

An analysis of the existing clarifier performance is recommended to assess the existing integral clarifier performance and to determine if external clarifiers are warranted. A State Point Analysis (SPA) technique utilizing the operational MLSS, solids overflow rate (SOR), sludge volume index (SVI), RAS, and initial settling velocity (ISV) would provide further insight into performance and capability of the existing clarifiers. These field-collected parameters can then be modeled using a desktop process simulator such as *Clariflux*™ to develop plant specific ISV curves.

It is recommended that expansion beyond the short-term include external circular clarifiers in order to increase the control and efficiency of the secondary process. The clarification process is crucial to the performance of downstream processes such as filtration and disinfection and ultimate effluent quality, adding to the importance of adequate clarification.

7.2.6 RAS Pump Station

The use of an air lift pump for return activated sludge (RAS) pumping can be problematic on larger installations, since air lift pumping can be difficult to meter and control. A centralized and positive method of providing return activated sludge is recommended for larger installations, particularly if external clarifiers are implemented. This would improve the process control and reduce the O&M requirements as opposed to air lift mechanisms at each clarifier.

7.2.7 Blower Building

An expansion to the WWTP will require additional aeration capacity, and therefore additional or larger blowers. This is an opportunity to consider enclosing the blowers in a sound-attenuated building and for enclosing the electrical equipment (PLCs, etc.) in a climate-controlled environment. It is therefore recommended that future expansions include a centralized and expandable Blower and Electrical Building.

7.3 Tertiary Alternatives

As discussed previously, the level of tertiary treatment will be based upon the effluent disposal option(s) selected. At a minimum, it is anticipated that Class B+ treatment, and depending upon the effluent disposal options pursued, Class A+ may be required. At a minimum, the BADCT standards require that the tertiary facilities include disinfection, with filtration being optional depending upon the effluent disposal method (for Class A uses). However, as previously stated, a waiver from the BADCT disinfection requirement may be granted if soil aquifer treatment is proven, as is the current practice at the WWTP.

7.3.1 Disinfection

BADCT standards require sufficient disinfection such that total coliform organism do not exceed 2.2 MPN per 100 mL as a seven sample median and that they do not exceed 23 MPN per 100 mL at any time. Class A (or A+) reclaimed water requires sufficient disinfection such that total coliform organisms are non-detect in four out of seven daily samples, and do not exceed 23 MPN per 100 mL at any time. Two feasible disinfection alternatives are chlorination with liquid sodium hypochlorite and ultraviolet light (UV) disinfection.

7.3.1.1 Sodium Hypochlorite

Liquid sodium hypochlorite is an effective disinfectant to reduce total coliform in the effluent. Hypochlorite disinfection systems typically include a bulk storage tank for the liquid sodium hypochlorite (12.5 percent concentration), chemical feed pumps, injection and mixing equipment, and a chlorine contact tank to provide retention time for disinfection.

As an alternative to concentrated sodium hypochlorite, low strength (0.8 percent) sodium hypochlorite can be generated on-site by electrolytic means from concentrated brine solution for use as needed. This approach would avoid the need for storing large volumes of concentrated hypochlorite on site, and reduce risks associated with handling a high strength chemical. The units typically require elevated operating and maintenance attention to operate properly.

Hypochlorite is a proven, low cost method for disinfection. In addition, this is a common compound, often used for odor control, biological foam control, etc. On the downside, it requires a larger footprint and hazardous chemical handling. A chlorine contact tank sized to provide 30 minutes of contact time (per ADEQ regulations), at peak hour flow, would require a substantial footprint at the future buildout condition.

ADEQ typically requires dechlorination before disposal of chlorinated effluent, due to concerns over disinfection byproducts such as trihalomethanes (THMs). Dechlorination is typically achieved by using sodium bisulfite.

Currently, ADEQ has waived the chlorination requirement for the existing wastewater facility due to the large separation distance of groundwater from the recharge basins. However, as the WWTP expands and other methods of effluent disposal are pursued, these requirements will likely be reinforced and efforts should be made to maintain the disinfection waiver.

7.3.1.2 Ultraviolet (UV) Light

As effluent is passed through modules of lamps emitting a spectrum of ultraviolet (UV) light, microorganisms are effectively inactivated from contact with the correct intensity and exposure to the UV light. UV disinfection could be achieved by using a closed vessel or open channel method. UV disinfection provides numerous advantages over hypochlorite disinfection, such as smaller footprint, public perception, no chlorine byproducts, reduced chemical handling, no need to dechlorinate, etc. On the downside, the life-cycle costs are higher and filtration is required to improve the efficiency of the UV system. UV disinfection can be achieved by three different methods: low-pressure, low intensity; medium-pressure, high output (MP/HO); and low-pressure, high output (LP/HO). Since UV disinfection is only a potential future expansion item, and may not be required if the current practice of soil aquifer treatment is maintained, UV disinfection methods are not being further evaluated at this time.

7.3.2 Filtration

The purpose of tertiary filtration is to remove suspended solids that carry over from the secondary clarifiers, and to provide a high-quality filtrate to optimize the efficiency of the disinfection process, particularly if UV lamps are used for producing an essentially pathogen-free final effluent. In short, tertiary filtration is a vital component in producing Class A+ for future water reclamation. ADEQ regulations for Class A+ reclaimed water (*A.C.C. R18-11-303*) specify turbidity requirements of 2 NTUs or less based on a 24-hour average, not to exceed 5 NTUs maximum at any time.

7.3.2.1 Traveling Bridge

Traveling bridge filters are commonly used at water reclamation plants in Arizona, particularly in small capacity plants. The filters are low head (typically one foot of head loss), shallow media depth (16-24 inches), gravity filters. Filter media can be mono (sand) or dual (sand and anthracite), although mono-media sand filters are generally recommended for wastewater applications.

7.3.2.2 Continuous Backwash Filters

Continuous backwash filters are gaining popularity for large filter installations. Continuous backwash filters are deep-bed granular media filters. As the name implies, these filters backwash while in operation, and involve the movement of the media in the cleaning process. There have been issues with the backwash mechanisms (air-lift), on these filters; however, most manufacturers have modified their designs in attempt to remedy this issue.

7.3.2.3 Cloth Media (Disk) Filters

Cloth media filters or more commonly termed disk filters are a recent advance in wastewater treatment. The cloth disk filters require less space than sand filters and often can be installed inside existing sand filter tanks, thereby increasing the filtration capability within the same footprint.

Advantages of disk filtration includes: compact design and small footprint, operational flexibility, automatic operation, easily expandable, low operating headloss (approximately 8 to 10 inches), low maintenance, and it is an economical approach. On the downside, there are fewer installations than other filtration technologies, the "life span" of the cloth media is unknown, manufacturer serviceability is unknown, susceptibility to biogrowth, susceptibility to pin floc breakthrough, more mechanical equipment, and possibly a lack of operator familiarity.

Currently there are two major manufacturers of disk filters, Aqua Aerobics and Krüger. The major differences between these two manufacturers is the Aqua Aerobics' Aqua Diamond®, Aqua Disk®, Aqua Drum®, Aqua Minidisk®, include a continuous or nearly continuous backwash with filtered effluent exiting from inside the cloth filter (outside-in flow). On the other hand the Hydrotech Diskfilter by US Filter/Krüger, is an inside-out flow configuration with unfiltered effluent entering the inside of the cloth filter and the backwash cycle is an automated process based upon pressure differential. Aqua Aerobic disk filters have been successfully implemented at Litchfield Park, El Mirage, and Fountain Hills, while US Filter/Krüger disk filters are being installed at the new Greenfield Water Reclamation Plant in Gilbert and are in operation at the Verrado WRF.

7.3.3 Effluent Pumping

As the existing WWTP expands and the need to convey effluent to offsite locations for disposal increases, the effluent pumping will need to be upgraded to accommodate. Effluent pumping can be achieved by using centrifugal, submersible or vertical turbine pumps.

Commonly, effluent pumping is achieved by using vertical turbine pumps since they are efficient, and suitable to low-head high-flow situations that are typical to effluent pumping. Vertical turbine pumps would likely require noise control; this could be achieved by adding soundproof shrouds. Vertical turbines could be placed in a clear well or installed as pump-can configuration. A clear well provides the benefit of additional equalization, thereby enabling more flexibility. A vertical turbine pump station situated in a clear well would be a good fit with the potential future effluent disposal method of recharge at the City-owned 80-acre site to the north of the existing WWTP. The 80-acre site is at relatively the same elevation is within close proximity, thereby reducing the need for high-head pumps.

7.3.4 Tertiary Recommendations

Disinfection: Ultraviolet light (UV) disinfection is recommended as a long-term expansion item, since there is no chemical handling and hazardous material issues, eliminates the formation of disinfection byproducts and subsequent dechlorination requirements, and requires a smaller footprint than chlorine contact chambers. Chlorine will still be required to provide chlorine residual for reclamation disposal and odor control; however, the quantity of chlorine to be stored at the WWTP would be minimal and dependent upon the disposal method and extent of odor control and therefore could be hauled onsite as a bulk liquid. Other options to avoid hazardous material issues (and if UV disinfection is not attractive from the City's standpoint) is onsite generation of 0.8 percent hypochlorite or using 12.5 percent hypochlorite hauled from an outside source. The use of bulk hypochlorite can be attractive from a capital standpoint since the capital expenditure is minor (holding tank, metering pumps, piping, etc.).

Filtration: Disk filtration is recommended since this technology has a small footprint, provides good filtration, and allows for disposal flexibility. Competition within the disk filtration market has resulted in more competitive pricing, and is cost competitive with media filters. However, this recommendation is optional unless Class A Reuse options and/or UV disinfection is pursued. Additionally, since continuation of the current practice of soil aquifer treatment will be pursued as the WWTP expands, it is not recommended that filtration be added unless required by ADEQ.

Effluent Pump Station: It is recommended that a new effluent pump station be constructed in order to meet the future needs of sending effluent to additional offsite recharge basins. The potential for effluent disposal for reuse furthers the need for an effluent pump station at the existing WWTP. The pump station could be fitted with variable frequency drive motors in order to meet the pressure needs of a reuse distribution system. Since effluent disposal options other than reuse will be pursued, the facility will not be required to construct an effluent disposal storage reservoir. However, the use of an existing recharge basin for a dual purpose of recharge and storage will provide further effluent disposal flexibility. It is recommended that a vertical turbine pump station with a clear well be constructed when offsite effluent disposal is pursued.

8.0 SOLIDS STREAM EVALUATION

Currently, the solids wasted from the biological process are directed to a sludge drying bed. As the WWTP expands, this practice will require an upgrade to a more conventional process. This section will discuss options for solids thickening, digestion, and dewatering.

8.1 Solids Thickening

Thickening is generally accomplished by a number of mechanical process alternatives, the most feasible being centrifuge, gravity belt thickener, or rotary drum thickener. These mechanical thickening processes typically require a minimum of 0.5 percent solids feed concentration, preferably around 1.0 percent concentration for better performance. When feed sludge is of lower concentration, the ability of mechanical thickeners to perform will be reduced, requiring much lower feed rates and high polymer use, resulting in less than optimum thickened sludge concentration. In turn, this will compromise digester performance and stress the sludge dewatering process following digestion. The target concentration for thickened sludge is 5 to 6 percent.

The issue of odor potential is a major factor in the decision as to which thickening process equipment to select. Centrifuges and rotary drum thickeners, by their nature, are somewhat contained. A gravity belt thickener is open to the atmosphere in the room in which it is installed. Therefore, to contain odor and create an acceptable working environment for the operators, the entire thickener space must be aggressively scrubbed. Hoods are frequently used over the thickeners to improve the extraction of air from the space directly over the sludge, however much of the odorous air escapes into the room. Thus, a very large volume of air must be handled and treated. It may be possible to surround each thickener with an enclosure to minimize the amount of foul air to be treated. This has the disadvantage of requiring confined-space entry procedures by the operators when entering to check the process, and interference with access for maintenance and repair.

8.1.1 Gravity Belt Thickeners

Gravity belt thickeners (GBTs) consist of a gravity belt that moves over rollers driven by a variable-speed drive. After polymer conditioning, the sludge is distributed evenly across the belt. Water then drains away, allowing the concentrated sludge to be collected at the discharge end of the belt. After the thickened sludge is removed, the belt then travels through a washing mechanism before returning to the collection end to repeat the process. GBTs are a modification of the upper gravity zone of the belt filter process. GBTs have the benefit of a compact footprint, low power usage, high solids capture with minimal polymer, and low capital costs. Disadvantages include odor potential if not enclosed and secondary process scum can clog the belts.

8.1.2 Rotary Drum Thickeners

A rotary drum thickener (RDT), also called a rotary screen thickener, is an internally feed drum screen with a screw for transporting thickened solids out of the drum. The advantages of this technology are the recycle flow is low as compared to GBTs, low initial capital cost, and minimal power usage. Disadvantages include sensitivity to polymer type, odor potential if not enclosed, and the low loading rates result in numerous units for larger facilities thereby negating the low capital costs.

8.1.3 Centrifuge Thickeners

Centrifuges are widely used in the industry for a variety of applications, including thickening and dewatering. Sludge is fed into the centrifuge at a constant flow rate, and due to the centrifugal force acting upon the constituents of varying densities, the sludge is separated into thickened sludge and centrate. The centrate is then drained and recycled, while the thickened sludge is discharged by the screw feeder. Advantages of this technology include minimal polymer usage, odor containment, and effectiveness for WAS thickening. Disadvantages include high maintenance requirements, high capital costs, and high power costs,

8.2 Digestion

There are two main types of solids digestion: aerobic and anaerobic. Generally, smaller plants use aerobic processes to digest solids, while larger facilities use anaerobic processes. In order to increase the efficiency of digestion and reduced tank volume, the pre-digestion solids are often thickened; see above discussion on solids thickening.

Aerobic digestion can be achieved in tanks fitted with coarse or fine bubble membrane diffusers with air supplied by dedicated blowers. Depending on the location of the digester and the proximity to the nearest potential neighbor, covers and odor control may not be required. An aerobic digester could be constructed with common walls to the biological process to reduce construction costs or they could be constructed in separate basins.

8.3 Solids Dewatering

Solids from the digester would be pumped to a location for dewatering and, depending upon the final use, hauled offsite to a landfill or hauled for land application. The most feasible solids dewatering options to be considered include belt filter presses and centrifuges. Vacuum-assisted sludge drying beds, as previously proposed by others, have not been considered due to the odor issues, operator requirements, and footprint requirement.

Centrifuges can produce a drier and less odorous cake than belt filter presses; however, the cost for centrifuges can be higher. A benefit of using centrifuges is that one technology can be used for both thickening and dewatering, reducing the need to operate different technologies, common spare parts, and one vendor interaction. In addition, centrifuges provide good odor containment and have a clean appearance.

Belt filter presses are also commonly used to dewater due to low capital and operating costs. Belt filter presses are also relatively less mechanically complex than other dewatering technologies. However, this technology has a high odor potential and automatic operation is not advisable.

Alternately, the adequately digested solids could forego dewatering and an outside contractor could be procured to accept digested liquid sludge for land application.

8.4 Solids Handling Recommendations

Thickening: Centrifuges, gravity belt thickeners, or rotary drum thickeners could be successfully added as the facility's solids handling capabilities expand. Centrifuges may be more attractive from the ability to use a common technology for thickening and dewatering and to reduce odor control requirements at the solids handling area. However, the less complicated gravity belt thickeners or rotary drum thickeners may be a more reasonable option if maintenance is an issue.

Digestion: Aerobic digestion is recommended for future expansions of the existing WWTP. It is recommended that the digesters be common walled with the biological process (common walled with aerobic basins) in order to reduce construction costs. However, separate digester basins could be constructed if preferred by the City.

Dewatering: Similar to the thickening recommendation, the use of centrifuge or belt filter press could be successfully implemented as the facility's solids handling capabilities expand. If a common technology is a goal for the facility, then centrifuges should be implemented. However, if maintenance is an issue then the facility should expand with belt filter presses.

Solids Handling Building: The thickeners, future dewatering equipment, solids pumps, and controls are recommended to be located in a new building near the future aerobic digesters. The building should be maintained under a vacuum to reduce the potential for odors escaping to the atmosphere and will require odor control of foul air removed from the thickening and dewatering equipment.

9.0 PLANT EXPANSION ALTERNATIVES

The recommendations made under the Liquid and Solids Evaluation sections can be compiled into plant expansion alternatives, which are presented in this section. Expansion alternatives are organized into three categories: headworks, short-term expansion, and buildout. The alternatives have been organized in this manner since the first expansion at the WWTP will likely include an upgrade to the headworks followed by the short-term expansion. The buildout alternatives are provided as a long-term vision of the WWTP and set the stage for developing a phasing strategy to bring the WWTP from its current capacity to buildout. The next section (Section 10 - Plant Phased Expansion Plan) will address the sequencing of the selected alternatives in greater detail.

9.1 Preliminary Treatment (Headworks) Alternatives

As previously mentioned, the preliminary treatment system is proposed to include a new Headworks Building, screens, grit removal, odor control, and a lift station. The Headworks facilities are recommended to be sized to treat the short-term expansion design capacity of 4.0-mgd AADF (with the appropriate peaking requirements) and provide accommodations for future expansions. In this subsection; common features to all three alternatives are

discussed; followed by a description of the three headworks alternatives, and finally a recommended headworks alternative is provided. It should be noted that these recommendations are contingent upon sizing, layout, and cost implications to be further developed during a preliminary design stage.

9.1.1 Common Headworks Alternatives Features

Demolition: The existing static screens and unused primary clarifier would be removed during the headworks project or during a future expansion phase. The existing lift station would be abandoned after a new lift station has been constructed.

Headworks Building: A new Headworks Building would enclose the screening process along with its associated equipment, such as conveyor, washer, and compactor. Grit removal can be located outside the building since a majority of the foul air will be released in the open channel screening environment. The building can be constructed of masonry block with elements to match the architectural scheme of the future expansions and/or a City approved architectural themes.

Odor Control: A chemical wet scrubber is recommended for the Headworks Building. This system has a cost benefit over a biofilter as the plant capacity and necessary headworks scrubbing needs increase. A packed tower configuration is recommended due to its ability to handle variations in the odor concentration and flow rate; this provides increased flexibility as the plant expands. However, if space is not of concern, an in-ground biofilter could be constructed for odor control, thereby reducing the need for chemicals. If the State (ADEQ) would allow construction of a biofilter outside the setback limits, this would be a cost-effective alternative for the City to consider.

9.1.2 Alternative A

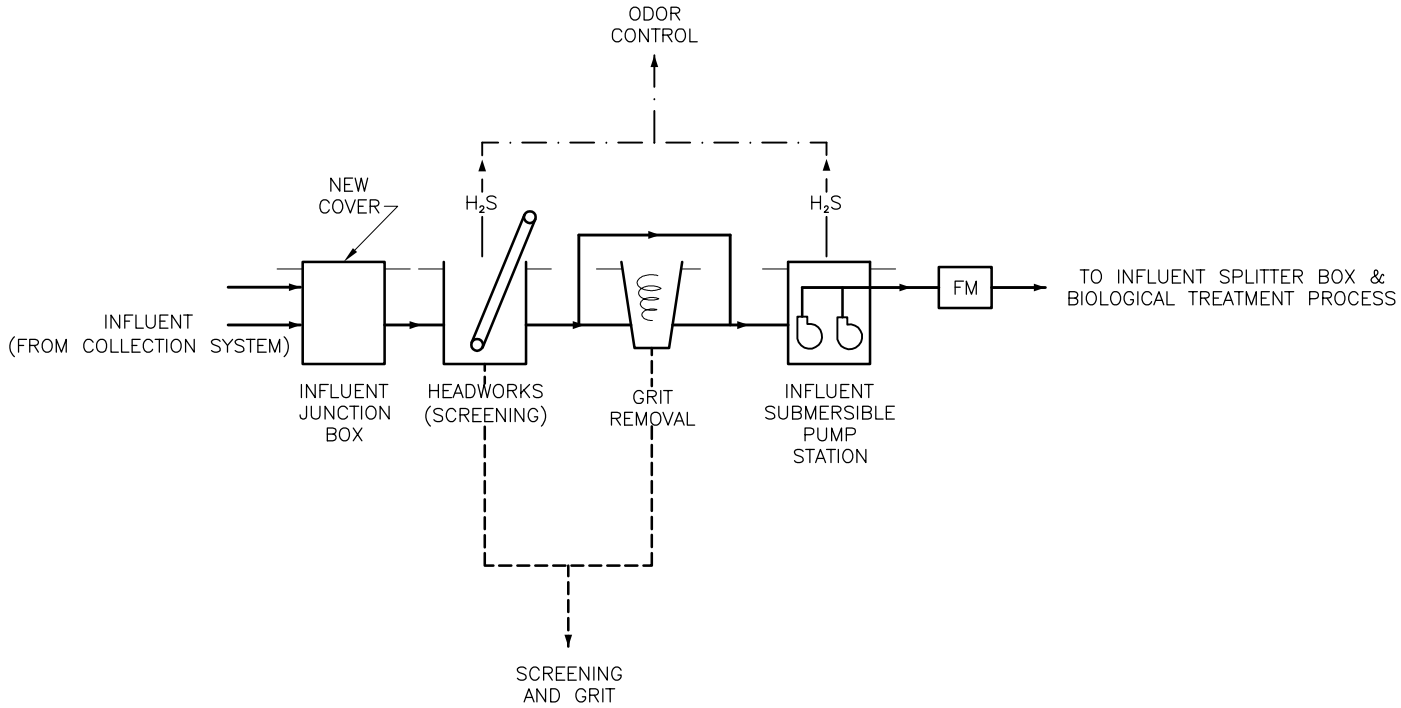
Alternative A is representative of a typical gravity preliminary treatment system, as illustrated in Figure 1.5. This system is not practical since the influent sewer inverts are approximately 14 feet below land surface, which is too deep for typical grit chambers, which are at most 9.5 feet deep.

9.1.3 Alternative B

Alternative B addresses the influent sewer depth issue by moving the lift station before grit removal. Step screens can be installed into deeper channels with the ability to lift screens up to 22 feet, making this a feasible alternative if the headworks is constructed near the existing influent junction box. This option would also be feasible if the influent sewer lines are extended to the new headworks area with a nearly flat slope.

The grit chamber can be built at-grade in order to provide the appropriate water level needed to flow the wastewater over the weir at the aeration basin splitter structure. Another benefit to this option is screening prior to the lift station will aid in protecting the pumps and thereby reduce pump failure due to clogging. Alternative B is illustrated in Figure 1.6.

HEADWORKS ALTERNATIVE A



LEGEND

PROCESS FLOW
RECYCLE OR SOLIDS FLOW
FOUL AIR STREAM

NOTES

GRIT REMOVAL COULD BE PLANNED FOR INSTALLATION DURING A FUTURE PHASE.

Figure 1.5

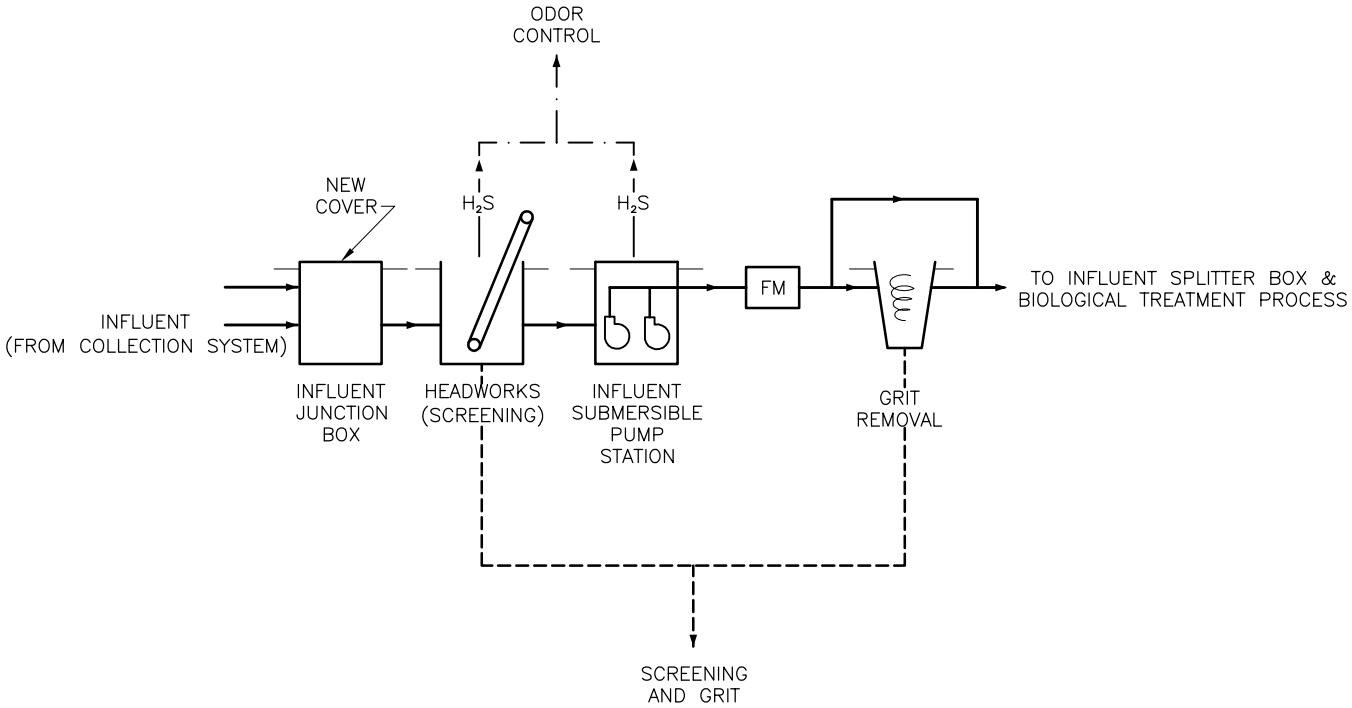
carollo engineers

City of ELOY, Arizona – Sewer Servive Area Study
Technical Memorandum No. 1 DRAFT

May 2006

J:\Client\ELOY PHX\726800\TASK004\FIG_1_5 5-24-06 10:13am AGilmore : 811-hdr

HEADWORKS ALTERNATIVE B



LEGEND

PROCESS FLOW
RECYCLE OR SOLIDS FLOW
FOUL AIR STREAM

NOTES

GRIT REMOVAL COULD BE PLANNED FOR INSTALLATION DURING A FUTURE PHASE.

Figure 1.6

carollo engineers

City of ELOY, Arizona – Sewer Servive Area Study
Technical Memorandum No. 1 DRAFT

May 2006

J:\Client\ELOY PHX\766800\TASK004\FIG_1_6 5_24_06 10:12am AGilmore : 811_hdr

9.1.4 Alternative C

Alternative C allows for influent pumping at the front of the headworks process. Wastewater entering the plant would be lifted to the screening channel and conveyed via gravity to the grit removal chamber. Wastewater would continue to the aeration basin splitter box via gravity flow. In order for the wastewater to flow over the weir at the aeration basin splitter box, both the screening channel and grit chamber would have to be constructed at or above grade. This could result in a taller headworks building structure. Another iteration of this alternative is to install a second pump station after the grit chamber. This is not recommended since double pumping increases the operation costs of the facility. If the headworks are to be constructed within the 350-foot setback limits (refer to Figure 1.3) the depth of the influent sewer extension (with a conservative gravity line slope) may result in the need for a lift station at the beginning of the headworks. Alternative C is illustrated in Figure 1.7.

9.1.5 Recommended Headworks Alternative

Alternatives B and C are feasible options for the Headworks process. The benefits of screening prior to pumping favors Alternative B, while the potentially deep screening channel would favor Alternative C instead of Alternative B. It is proposed that these two alternatives be evaluated during a preliminary design phase in which the details and cost implications can be furthered in order to provided a more thorough basis for selection.

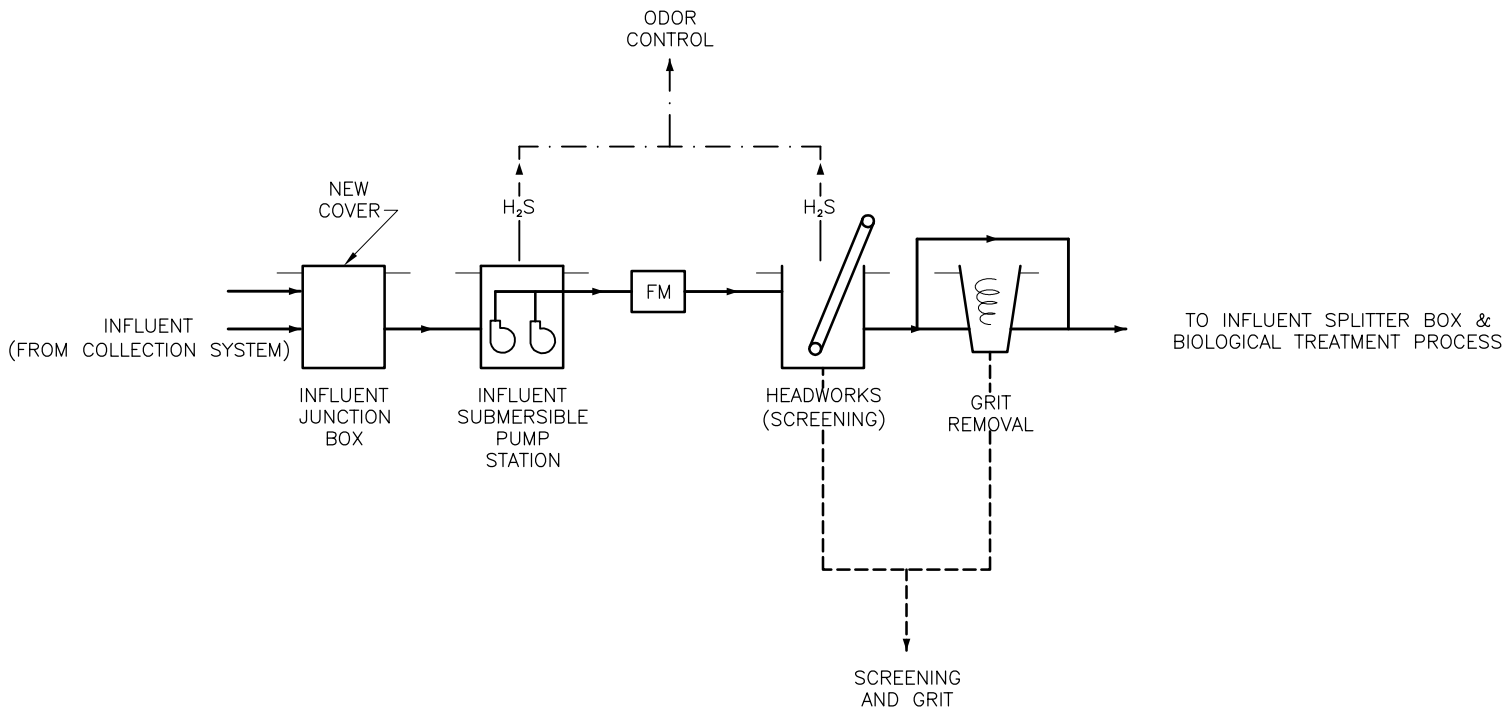
9.2 Expansion Alternatives

All the plant expansion alternatives contained herein include Headworks Alternative C, however, Alternative B may be selected upon further evaluation during a preliminary design phase. A short-term WWTP expansion alternative is discussed followed by three buildout alternatives.

9.2.1 Short Term Alternatives

The short-term is defined as increasing the plant capacity from 2 to 4 mgd AADF, thereby doubling the plant capacity. However, the long-term expansion needs of the plant should be taken into consideration when planning the short-term expansion. A major aspect of the long-term plant expansion requirements is the footprint required for effluent disposal via recharge basins and meeting setback requirements.

HEADWORKS ALTERNATIVE C



LEGEND

PROCESS FLOW
RECYCLE OR SOLIDS FLOW
FOUL AIR STREAM

NOTES

GRIT REMOVAL COULD BE PLANNED FOR INSTALLATION DURING A FUTURE PHASE.

Figure 1.7

carollo engineers

City of ELOY, Arizona – Sewer Servive Area Study
Technical Memorandum No. 1 DRAFT

May 2006

J:\Client\ELOY PHX\726800\TASK004\FIG_1_7 5_24_06 10:11am AGilmore . 811_hdr

Secondary Treatment: It is recommended that the short-term expansion incorporate one additional Biolac® basin with a 2 mgd AADF capacity. This recommendation is based upon the City's familiarity with the Biolac® system, its relatively low capital costs, and ease of operation. However, due to the intensive land requirements for the Biolac® process, it is recommended that a more efficient process be used in future expansions. The 4 mgd AADF, of Biolac® basins could be converted to equalization basins or the land reclaimed for other purposes such as new buildings or recharge. This is further discussed in the Buildout Alternatives subsection.

In the long-term, it is recommended that the plant move from integral clarification to external circular clarifiers. However, if the City prefers an additional short-term Biolac® expansion, the integral clarifiers could be pursued with the understanding that it is recommended that this method be abandoned in the long-term. In addition, air lift activated sludge (a common feature of the Biolac® process) could be continued for the short-term expansion; however, should be replaced with a positive pumping scheme during future expansions.

Other secondary treatment process improvements should include:

- Expand or Add an Additional Aeration Splitter Box: In order to accommodate the additional aeration basin and allow for process control, modify the existing splitter box to allow for splitting to the new aeration basin and to handle the increased hydraulic load.
- Install Selector Boxes: To provide control of filamentous organisms and to promote adequate mixing of RAS and influent wastewater, selector boxes could be constructed in the influent portion of the existing aeration basins and designed into the proposed aeration basins. Mixers would be incorporated into the selector boxes. However, if foaming has not been an operational issue, selector boxes could be an optional expansion item to be incorporated into future expansion phases.

Tertiary Treatment: In order to meet BADCT standards and to provide effluent disposal flexibility, it is recommended that the plant be upgraded to include disinfection (either by using UV disinfection or bulk hypochlorite). The disinfection facility would be sized for the short-term expansion and provide for future expansions. An optional tertiary upgrade is the addition of disk filtration, if Class A Reuse is pursued. If filtration is not pursued, UV disinfection will not be recommended since this technology requires adequate upstream filtration for efficient disinfection.

Solids Handling: In the short-term, the facility could continue with the current practice of solids storage and disposal via the sludge storage pond. However, in the long-term this practice should be abandoned for a more conventional approach. If the current practice is to be pursued in the short-term, a solids balance is recommended to determine if the existing solids holding basin will provide adequate storage at 4 mgd AADF.

Effluent Disposal: In the short-term, adequate disposal capacity is provided by the existing recharge basins, but will require additional piping and a change in the effluent monitoring location in order to incorporate the remaining recharge basins into the recharge program. It is recommended that one effluent flow monitoring location be established at a new effluent flow splitter structure, in order to simplify the monitoring and reporting process.

Electrical and Controls: It is recommended that a Supervisory Control and Data Acquisition System (SCADA) be installed to improve process control and remote control capabilities. In addition, this new SCADA system should be expandable to include future regional treatment plants and expansion of the existing WWTP. The main SCADA CPU would be best located in the City's new Engineering Building, with a local CPU at each future WRF. The SCADA system should allow remote monitoring and control of any WRF from any location. The SCADA system would incorporate data from the influent and effluent flowmeters, MLSS sensors, water level sensors, dissolved oxygen sensors, etc.

Blower and Electrical Building: The existing blower area should be upgraded to include additional blowers and an insulated enclosure to control noise from the blowers.

9.2.2 Buildout Alternatives

Given that the existing plant may eventually expand to approximately 14 mgd AADF, adequate planning should be provided to successfully take the existing WWTP from its current 2 mgd capacity to buildout capacity. The following alternatives incorporate the Headworks Alternative C (with flexibility for Alternative B if selected during a preliminary design phase) and the unit process recommendations made in the liquids and solids stream evaluations. The alternatives differ in their approach of addressing the most land intensive feature of the WWTP, the biological process.

Alternative 1: Alternative 1 is an extended aeration expansion with the continued expansion of the Biolac® process to buildout and the addition of external circular clarifiers. The feasibility of this approach lies in the land requirements inherent to the Biolac® process. The reduction of the available recharge area at the existing WWTP is a negative to this alternative. The modular nature of the expansion results in multiple activated sludge processes requiring operator attention, thereby increasing maintenance and process issues. A Biolac® expansion, to buildout, would also include new external clarifiers to improve the process flexibility and performance at higher flows. Additionally, the cost to cover and provide odor control would be excessive. Biolac® expansion beyond 4 mgd AADF is not recommended for this plant.

Alternative 2: Alternative 2 is an extended aeration expansion using oxidation ditch technology along with external circular clarifiers. This alternative assumes that the short-term expansion includes oxidation ditch technology. If oxidation ditch technology were chosen for the long-term expansion, it would be prudent to begin this process during the short-term expansion phase. This option has the benefit, over Alternative 1, in having a smaller footprint

and less equipment (no blowers and only a few surface aerators). However, if odor control were required, the cost to cover and provide odor control would be excessive. Oxidation ditches could later be converted to a conventional process or to an MBR.

Alternative 3: Alternative 3 takes a more conventional approach in order to further reduce the footprint and maximize the space available for recharge. This alternative includes an MLE process constructed with concrete tanks that are common walled with aerobic digesters in order to provide capital cost savings and further reduce the footprint. This system has the advantage over extended aeration in that it yields a smaller footprint and is a more efficient process.

Alternative 4: Alternative 4 further reduces the footprint by pursuing an MBR approach. This approach yields the smallest footprint by eliminating the need for secondary clarifiers and separate filters. In addition, the quality of effluent produced from an MBR, coupled with disinfection, provides the greatest effluent disposal flexibility of all the alternatives. This approach would allow the largest area for onsite recharge, due to its small footprint. However, the capital costs for this approach would be the highest.

9.2.3 Long Term Expansion Recommendation

Alternative 3 is recommended for the long-term expansion of the existing WWTP. Since a buildout flow of 14 mgd AADF is anticipated for the existing WWTP and recharge at the existing WWTP site is to be maximized (thereby reducing land costs for additional recharge locations) the small footprint and efficiency of a conventional activated sludge process is recommended. However, since expansions beyond 4 mgd AADF are not likely for several years, an MBR alternative may become more attractive as the market matures and cost competition increases in this market. Therefore, the selected option may shift to Alternative 4 in the future and should be revisited prior to commencing with expansions beyond 4 mgd AADF.

10.0 PLANT PHASED EXPANSION PLAN

Successful expansion of the existing WWTP from its current capacity of 2 mgd AADF to a buildout capacity of 14 mgd AADF requires that a conceptual expansion framework be in place. The goal of this section is to bring together the recommendations into a phased expansion approach. For planning purposes, the expansion is shown as three (3) phased expansions. It is possible that minor expansions will take place in between each of the major expansion phases in order to upgrade or expand minor facilities. For example, Phase 1A may include only the headworks expansion and Phase 1B may include an expansion of the secondary and tertiary processes.

It is also recommended that the process and equipment selections for the expansions of the existing WWTP be mirrored at the future Regional Water Reclamation Facilities (WRFs). The goal would be to have all of the buildout facilities using common equipment and processes. This will result in common operation, maintenance, parts, etc., for all of the WRFs within the City.

10.1 Phase 1

The first expansion is the short-term expansion, as described previously bringing the total capacity to 4 mgd AADF and consisting of a new headworks facility. This phase is illustrated in Figure 1.8. The facility would add the following:

Preliminary Treatment: New headworks facility including: two screen channels with one mechanically cleaned screen installed and one manually cleaned screen to serve as an emergency bypass. Odor control would be provided on the headspace in the screening channels. Construct a new influent lift station and piping to the aeration basin splitter structure. Designate area for future grit removal, future third (and possibly fourth) screening channel, and a future Headworks Building (to enclose the screening channels and screening equipment).

Secondary Treatment: Install one 2-mgd Biolac® aeration basin and integral clarifiers. Expand or construct a new aeration basin splitter structure. Expand and upgrade the existing blower area.

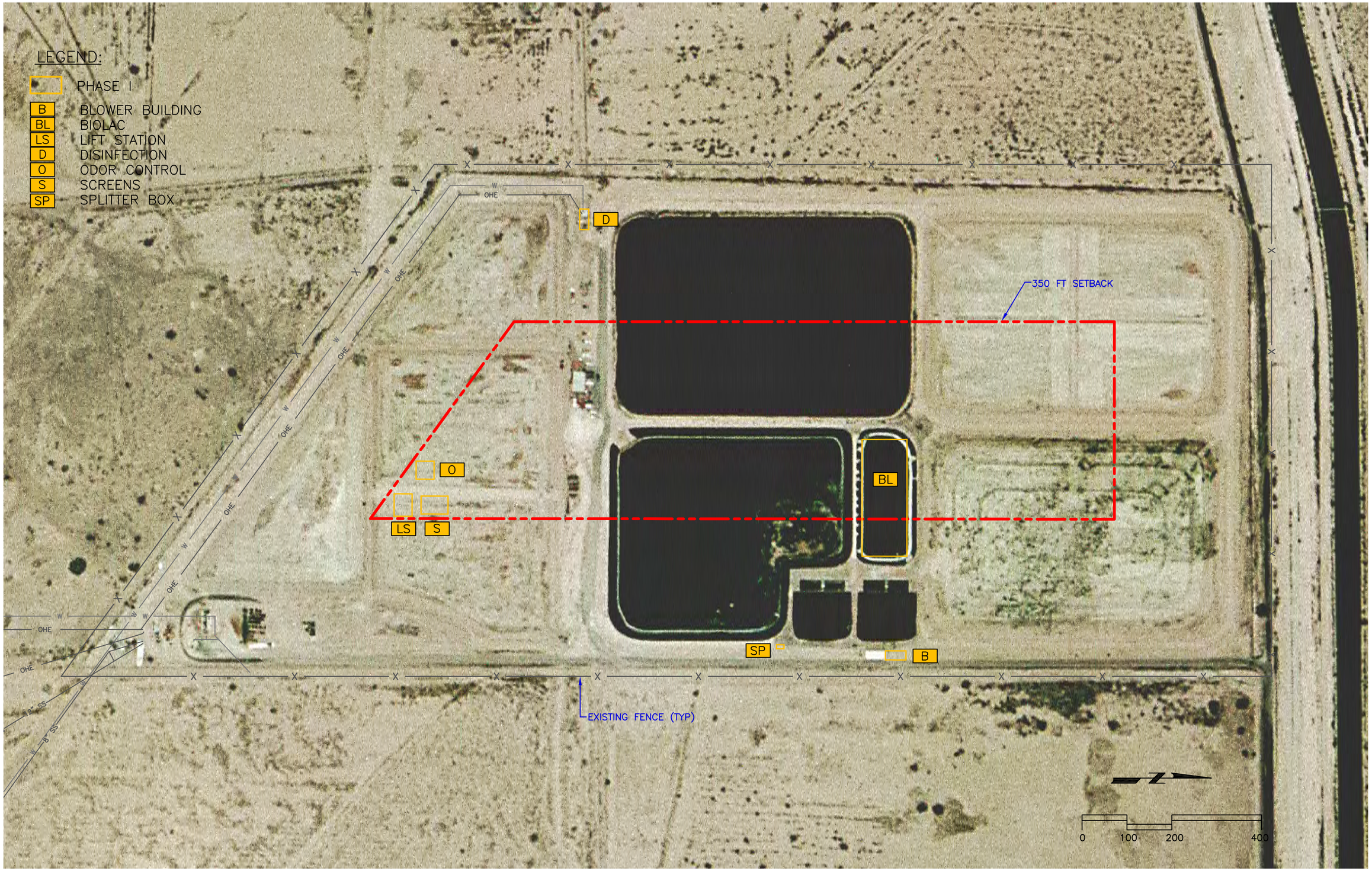
Tertiary Treatment: The existing disinfection system would be expanded to accommodate the expansion of the WWTP.

Solids Handling: The existing sludge storage basin could continue to be used for sludge management. However, depending upon the results of a solids balance and the needs of the City, solids handling improvements may be pursued during Phase I.

10.2 Phase 2

The second expansion would bring the facility to a total capacity of 7 mgd AADF, along with the conversion from the proprietary extended aeration process to a more conventional process. In addition, offsite recharge or reuse will be required in order to dispose of the effluent. This phase is illustrated in Figure 1.9. This phase would mark a major expansion for the WWTP.

Preliminary Treatment: A grit chamber would be added to the Headworks facility. Additional pumps would be added to the influent lift station. A second mechanically cleaned screen would be added to replace the manually cleaned screen. A Headworks Building would be constructed over the screening area. Odor control would be expanded to accommodate the new Headworks Building. The existing static screens and unused primary clarifier structure would also be demolished.



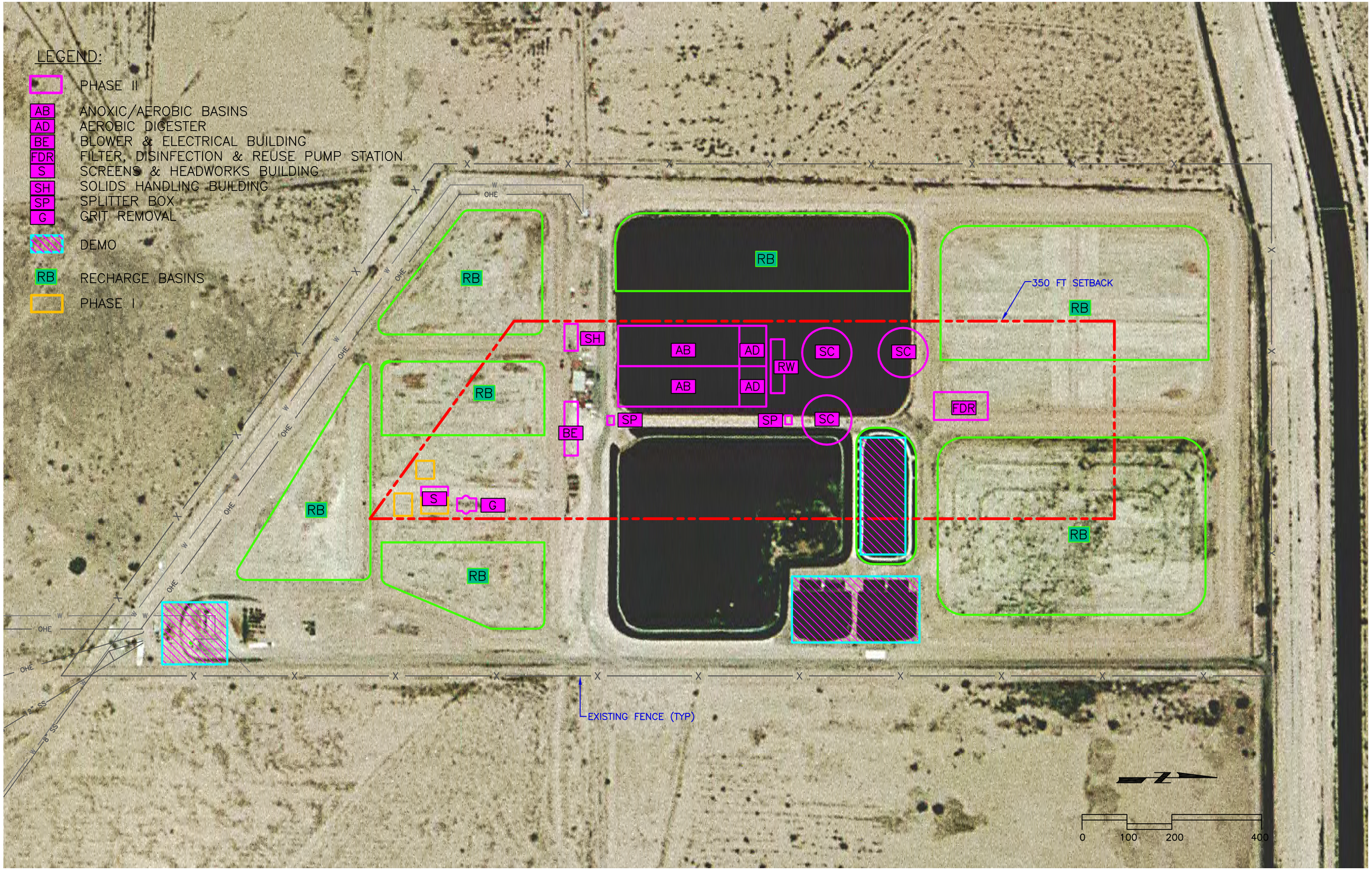
PHASE 1 EXPANSION (4 MGD, AADF)

Figure 1.8

CITY OF ELOY, ARIZONA SEWER SERVICE AREA STUDY
Technical Memorandum No. 1
DRAFT
May 2006

carollo

J:\Client\ELOY_PHXC\7266B00\TASK004\FIG-1-8 5-24-06 10:07am AGilmore ; 1117-bdr ;20060302085357.bmp;H:\CanonScans\CAD\1st Floor\20060302085357.tif;eloy_image.tif



CITY OF ELOY, ARIZONA SEWER SERVICE AREA STUDY
Technical Memorandum No. 1
DRAFT
May 2006

carollo ENGINEERS

PHASE 2 EXPANSION (7 MGD, AADF)

Figure 1.9

J:\Client\ELOY_PHXC\7266B00\TASK004\FIG-1-9 5-23-06 04:11pm AGilmore ; 1117-bdr ;20060302085357.bmp;H:\CanonScans\CAD\1st Floor\20060302085357.tif;eloy_image.tif

Secondary Treatment: A 7 mgd AADF MLE process, with two equally-sized trains, and three external clarifiers would be constructed. A RAS/WAS pump station would also be constructed. After completion of the Phase 2 expansion, the Biolac® basins would be taken offline. A new blower building with climate control would be provided.

Tertiary Treatment: Disinfection would be expanded as necessary to match the increase in capacity. If necessary, disk filters could be added to provide greater effluent disposal flexibility. The effluent pump station would be expanded to enable offsite recharge and reuse. The tertiary equipment would be constructed in a sequential and common walled arrangement, as much as practical, to provide a more compact footprint.

Solids Handling: Aerobic digesters would be constructed (common walled with the aeration basins) along with a new RAS/WAS Building and a new Solids Handling Building. The existing sludge storage basin would be drained and decommissioned at the completion of Phase 2. These improvements may be completed as part of Phase 1; however, this approach may result in separate digesters not common walled with the aeration basins.

10.3 Buildout

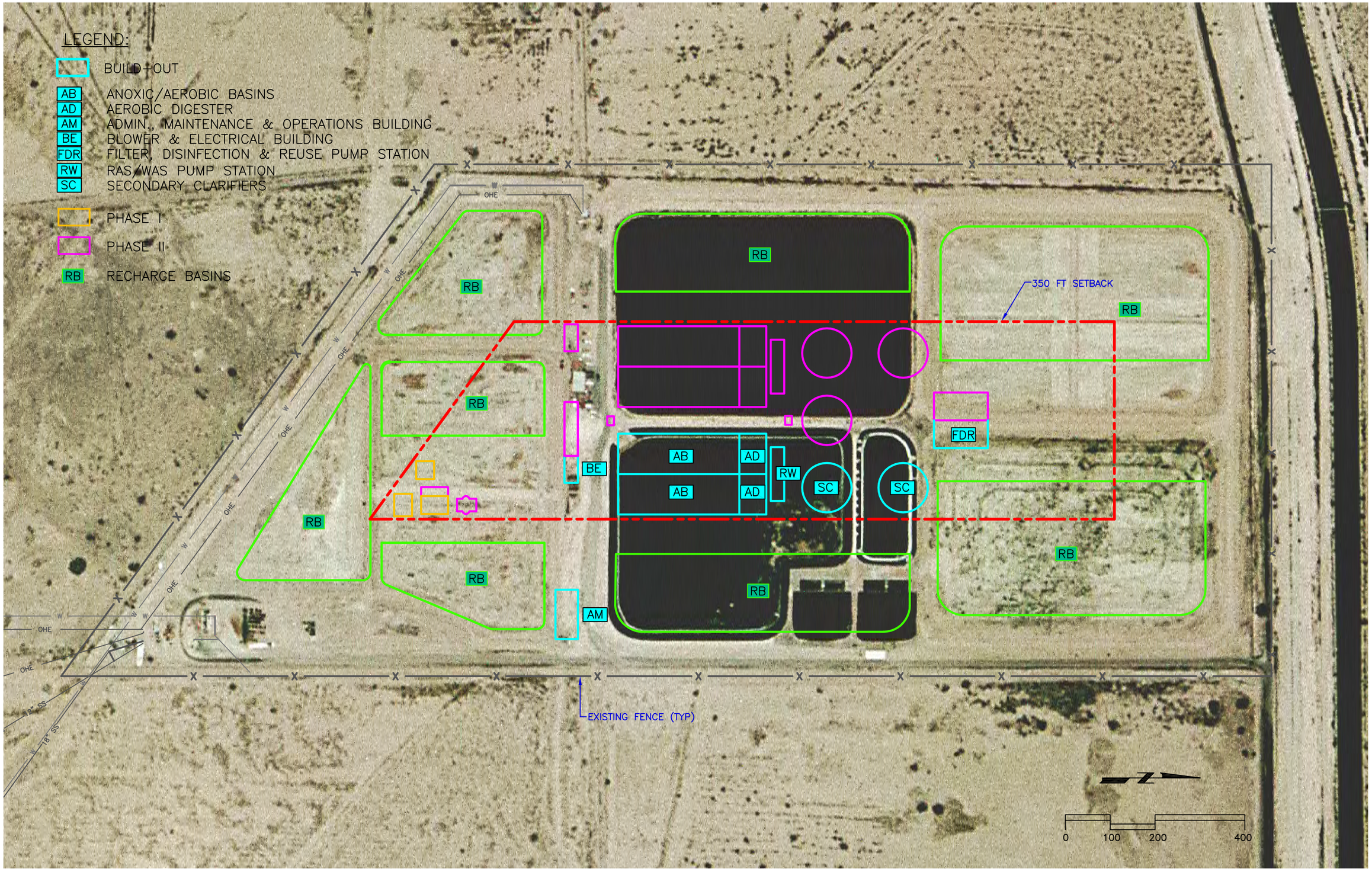
The third and possibly fourth phase(s) would bring the capacity of the WWTP to buildout at 14 mgd AADF. This phase is illustrated in Figure 1.10, followed by a process flow schematic presented in Figure 1.11. In addition, each phased expansion is summarized in Table 1.13.

Preliminary Treatment: Two additional screen channels and two mechanically cleaned screens would be added. A second grit chamber would also be added. Additional pumps would be added to the influent lift station. The Headworks Building would be expanded to accommodate the additional screening equipment.

Secondary Treatment: An additional 7 mgd AADF MLE process, comprised of two equally sized trains, would be constructed along with two additional external clarifiers and blowers. The additional biological basins would be common walled with the basins constructed under Phase 2, to provide a more compact footprint.

Tertiary Treatment: Additional filtration and disinfection equipment would be added. The effluent disposal pump station would be expanded, likely by adding additional pumps.

Solids Handling: Additional aerobic digesters would be common wall constructed with the aeration basins. The solids handling equipment would be expanded to match the increase in the plant capacity.



BUILD-OUT WATER RECLAMATION FACILITY LAYOUT (14 MGD, AADF)

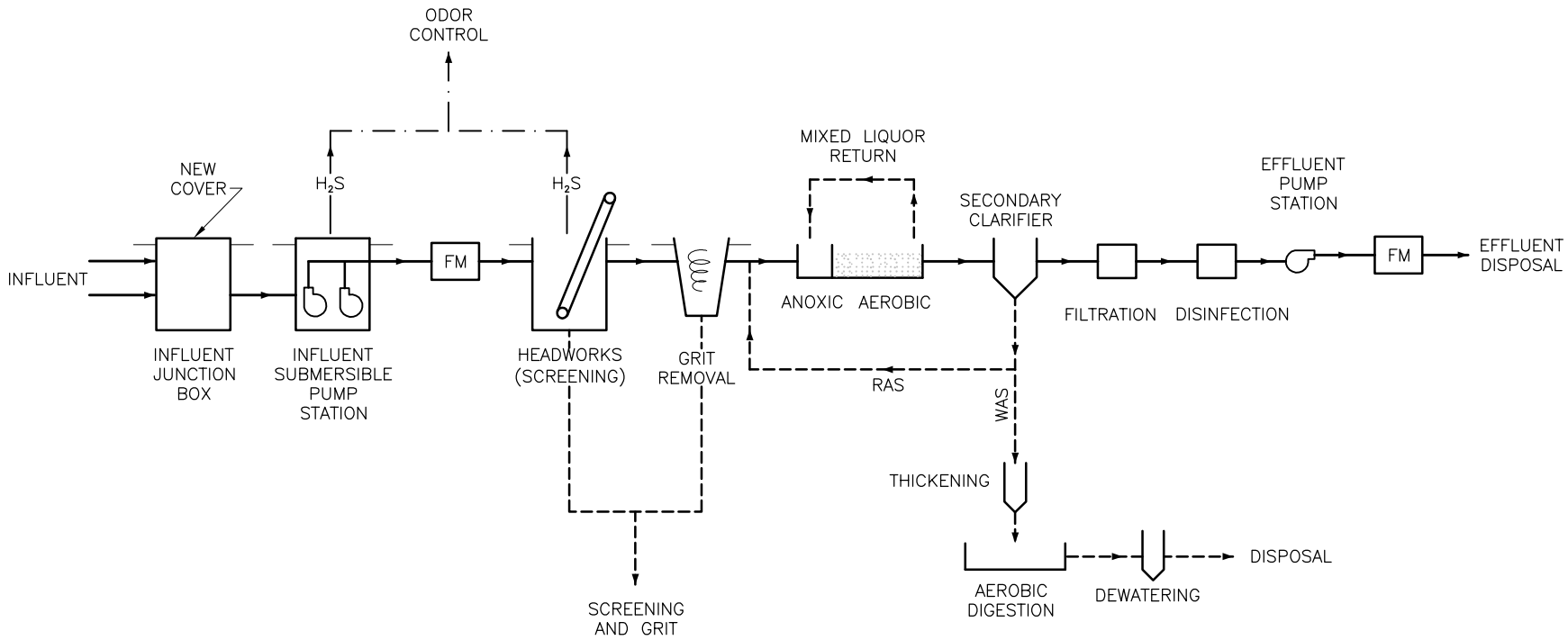
Figure 1.10

CITY OF ELOY, ARIZONA SEWER SERVICE AREA STUDY
Technical Memorandum No. 1
DRAFT
May 2006

carollo ENGINEERS

J:\Client\ELOY_PHXC\7266B00\TASK004\FIG-1-10 5-23-06 04:21pm AGilmore ; 1117-bdr ;20060302085357.bmp;H:\CanonScans\CAD\1st Floor\20060302085357.tif;eloy_image.tif

BUILDOUT WATER RECLAMATION FACILITY PROCESS SCHEMATIC



LEGEND

PROCESS FLOW
RECYCLE OR SOLIDS FLOW
FOUL AIR STREAM

ODOR CONTROL FOR SECONDARY TREATMENT PROCESS AND SOLIDS HANDLING NOT SHOWN, FOR CLARITY PURPOSES.

Figure 1.11

carollo engineers

City of ELOY, Arizona – Sewer Servive Area Study
Technical Memorandum No. 1 DRAFT

May 2006

J:\Client\ELOY PHX\766800\TASK004\FIG_1_11 5_24_06 10:16am AGilmore . 811_hdr

Table 1.13 Expansion Plan Matrix
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

	Existing WWTP	Phase 1 Expansion	Phase 2 Expansion	Buildout [1]
Annual Average Daily Flow (mgd AADF)	2	4	7	14
Average Day Max Month Flow (mgd ADMMF)	3[2]	6[2]	9.5[3]	19[3]
Preliminary Treatment				
Screening	Static screens	One mechanically cleaned screen One manually cleaned screen	Add one mechanically cleaned screen to replace manually cleaned screen	Four mechanically cleaned screens
Grit Removal	None	None	One mechanical vortex grit chamber	Two mechanical vortex grit chambers
Lift Station	Wet Pit (10' diameter)	New wet well lift station	Add pumps	Wet well lift station
Odor Control	None	Wet chemical scrubber or biofilter to treat channel headspace and lift station	Expand to include headworks building	Wet chemical scrubber or Biofilter
Secondary Treatment				
Biological	Two 1 mgd Biolac®	Add 2 mgd Biolac®	Add 7 mgd AADF MLE process (two 3.5 mgd AADF trains)	14 mgd AADF MLE process (four 3.5 mgd AADF trains)
Clarification	Four integral	Six integral	Three external 110' diameter circular clarifiers	Five external 110' diameter circular clarifiers
RAS/WAS Pumping	Air lift	Air lift	Wet pit submersible pump station	Wet pit submersible pump station

Table 1.13 Expansion Plan Matrix
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

	Existing WWTP	Phase 1 Expansion	Phase 2 Expansion	Buildout [1]
Tertiary Treatment				
Disinfection	Bulk hypochlorite (not used)	Bulk hypochlorite or UV	Expand disinfection	Bulk hypochlorite or UV
Filtration	None	None	Option - disk filters	Option - disk filters
Effluent Disposal				
Effluent Disposal Pump Station	One pump (not used)	Same	New vertical turbine pump station	Vertical turbine pump station
Required Recharge[4] Area (acres)	11.2	22.4	39.4	78.8
Max. Onsite Recharge Available (acres)	25.4	23.4	18.2	19.5
Offsite Recharge Required (acres)[5]	None	None	21.2	59.3
Solids Handling				
Thickening	None	None	Centrifuge,gravity belt thickener, or rotary drum thickener	Centrifuge, gravity belt thickener, or rotary drum thickener
Digestion	Sludge drying bed	Sludge drying bed or aerobic digestion	Two aerobic digesters	Four aerobic digesters
Dewatering	None	None	Centrifuge or belt filter press	Centrifuge or belt filter press

Table 1.13 Expansion Plan Matrix
Existing WWTP Evaluation and Expansion Plan
City of Eloy, Arizona

	Existing WWTP	Phase 1 Expansion	Phase 2 Expansion	Buildout (1)
Miscellaneous				
Admin, Maintenance, & Lab Building	Trailer	Same	Option - add building	Option - add building
Headworks Building	None	None	Add building	Headworks building
Solids Handling Building	None	None	Add building	Solids handling building
Blower/Electrical Building	Three sided shed	Expand existing, enclose, add noise controls	New building	Blower and electrical building with climate control

Notes:

(1) Buildout features shown represent the final quantity and type of each feature, while Phases 1 and 2 represent the additions to the facility.

(2) Assumed Peaking Factor of 1.5.

(3) Assumes peaking factor reduced to 1.35 as collection area expands.

(4) Required recharge area includes a 10% increase to account for containment berms and access roads. However, these features could require additional land. These quantities are to serve as an approximation with accurate land areas determined through site-specific hydrogeologic testing.

(5) Assumes recharge is the only method of effluent disposal. Offsite Recharge Required is the difference between the Max. Onsite Recharge Available and the Required Recharge Area. Required Recharge Area is based upon 0.6 acre-ft/acre/day design percolation rate used at the existing WWTP, rate taken from Westland (2004).

Offsite recharge may be performed at the 81.5 acres of City owned land to the north of the existing WWTP. This would enable all recharge to be handled offsite and provide more space at the existing WTTP for treatment process and support facilities.

Appendix A

AQUIFER PROTECTION PERMIT NO. 101689

Janet Napolitano
Governor

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

1110 West Washington Street • Phoenix, Arizona 85007
(602) 771-2300 • www.adeq.state.az.us

Stephen A. Owens
Director

March 21, 2005

Doug Olson, Wastewater System Manager
1750 N 11 Mile Corner
Eloy, Arizona 85231

Re: Eloy Wastewater Treatment Plant (WWTP)
Amendment to Aquifer Protection Permit (APP) No. 101689.

Dear Mr. Olson:

Enclosed is a copy of the signed Aquifer Protection Permit Other Amendment, and the Executive Summary for the above referenced facility. The APP conditions shall apply from January 11, 2005, which is the date of the Water Quality Division Director's signature, and shall be valid for the life of the facility (operational, closure, and post-closure periods).

Thank you for your cooperation in protecting the water quality of the State of Arizona. If you have any questions about the permit or need further assistance, please contact me at (800) 234-5677 ext.771- 4613 or (602) 771-4613.

Sincerely,

Donald Bell, Project Mgr.
Wastewater, Recharge, & Reuse Unit
Water Permits Section, Water Quality Division

Enclosures (2): Permit & Fact Sheet
cc: Water Resources & Conservation Div., Attn: Mason Bolitho
Pinal County Planning & Zoning
Pinal County Health Department
Roman Diaz, NRO Compliance Unit, ADEQ
Don Shroyer, Mgr., Water Quality Data Unit, ADEQ
Lynne Dekarske, Administrative Assistant, Water Programs Section, ADEQ
ADEQ Regional Liaison Officer, ADEQ
Bill Hare, WQ Compliance Unit, ADEQ
Michael Caparoso, Project Mgr., Westland Resources, Inc.

WRR05:0118

FACT SHEET

Aquifer Protection Permit # 101689
City of Eloy Wastewater Treatment Plant

The Arizona Department of Environmental Quality (ADEQ) proposes to issue an aquifer protection permit for the subject facility that covers the life of the facility, including operational, closure, and post-closure periods unless suspended or revoked pursuant to A.A.C. R18-9-A213. This document gives pertinent information concerning the issuance of the permit. The requirements contained in this permit will allow the permittee to comply with the two key requirements of the Aquifer Protection Program: 1) meet Aquifer Water Quality Standards at the Point of Compliance; and 2) demonstrate Best Available Demonstrated Control Technology (BADCT). BADCT's purpose is to employ engineering controls, processes, operating methods or other alternatives, including site-specific characteristics (i.e., the local subsurface geology), to reduce discharge of pollutants to the greatest degree achievable before they reach the aquifer.

I. FACILITY INFORMATION

Name and Location

Permittee's Name:	City of Eloy Wastewater Treatment Plant (WWTP)
Mailing Address:	Doug Olson 1750 N. 11 mile Corner Road Eloy, AZ 85231
Facility name and location:	1750 N. 11 Mile Corner Rd. Eloy, AZ 85231

Regulatory Status:

Prior to the construction of the existing Biolac treatment plant, wastewater was treated through four aeration lagoons (shown as basins 1-4 on map) which discharged effluent to four unlined effluent storage ponds (shown as basins 5-7 and plant expansion area on map). Under consent Order No P-82-97, issued May 15, 1997, the facility constructed the Biolac WWTP in the southeast storage pond. That consent order was satisfied and terminated on March 22, 2001. The old aeration lagoons were subsequently closed, the soil and sludge tested and sludge was removed, pipelines were capped, and the remaining equipment was removed and taken to an approved landfill. The lagoons did not go through a formal closure and the area remains a part of the WWTP footprint. The facility will convert these old lagoons into additional recharge basins at some future date as additional recharge basins are needed. At that future time, these lagoons will be redesigned as recharge basins and submitted for ADEQ approval in the future. Before these basins are re-constructed, the facility shall test the soils for soil remediation levels to ensure pollutants will not be flushed to the aquifer. The existing Biolac WWTP was approved under an Approval to Construct (ATC) on March 27, 1998 and an Approval of Construction on December 3, 1999.

The facility obtained an ADWR approval (Application No. 71-591932) for their underground storage facility permit on July 30, 2003. The facility will construct "sub-basins" within each of the three recharge basin areas and will operate the recharge basins using wet/dry cycles.
Date of Permit issuance and other applicable information:

Reclaimed Water Permit R-101689:	Issued December 30, 1999 (expired Dec. 31, 2004) Issued November 9, 2000 (Modification)
Previous APP:	Issued October 28, 1997 Issued November 30, 1999 (Amendment)
Current Amendment Application:	Issued November 26, 2002 (Significant Amendment)

Facility Description

This Facility is located in the Pichacho Structural Basin and rests on typical alluvial deposits consisting mostly of interbedded sand, gravel, silt and clay. The permittee is authorized to operate the WWTP with a maximum of 2.0 million gallons per day flow. The existing Biolac treatment plant using extended aeration technology, was approved by ADEQ under an Approval to Construct in 1998. The treatment process consists of headworks, including lift station, bar screen, flow splitters, nitrification and denitrification, and clarification prior to discharge of effluent to percolation ponds. The effluent is chlorinated as necessary for disinfection to meet the Class C requirements.

The permittee is authorized to discharge a maximum of 0.525 million gallons (MGD) average flow of Class C Reclaimed Water as per A.A.C. R18-11-307 to farm fields for present pasture irrigation requirements under Reclaimed Water Permit No. R101689, issued prior to the new reclaimed water rules, and which expires on December 30, 2004. Discharges beyond December 31, 2004 can occur only if the facility has obtained a valid reclaimed water permit from ADEQ.

Before the recharge basins were reconstructed, the facility tested the soils for remediation levels to insure pollutants are not flushed to the aquifer. Upon completion of re-construction of the recharge basins, the permittee is authorized to discharge of 2.0 MGD average daily flow to the three recharge basins. Disinfection of effluent discharged to recharge basins is not required because the facility has demonstrated soil aquifer treatment in the vadose zone as per the A.A.C. R18-9-B202(A)(3).

Sludge produced at this facility will be conveyed to an aerobic digester and onto a vacuum sludge drying bed. After drying, the sludge shall be removed from the sludge drying beds and disposed of off site at an approved facility. Removal of sludge to the landfill will occur periodically, as necessary.

In addition to the APP conditions pertaining to treatment and disposal of sewage sludge, the permittee must also comply with the requirements for sewage sludge disposal in 40 Code of Federal Regulations (CFR) Part 503 and 18 A.A.C. Chapter 9, Article 10. The WWTP solid waste disposal system has been designed and constructed according to plans approved by the ADEQ Wastewater, Recharge, & Reuse Unit.

Amendment Description

The amendment of this permit was requested for the following actions:

1. Part 2.2.1: Add language concerning: (A) Class C Reclaimed Water Classification as per a valid Reclaimed Water Permit; and (B) Describe the new treatment process and disposal to recharge basins.

2. Part 2.2. 2: Add; recharge as another method of discharge in addition to reuse.

3. Part 2.4: Add upgradient monitoring well.

4. Part 3.0: Add compliance schedule requirements.

5. Part 4.0. Table II: Discharge Monitoring. Add fecal coliform monitoring for Class C reclaimed water.

6. Part 4.0 Table III: Add TDS, cations and anions to characterize the groundwater.

7. Part 4.0 Table IV: Add upgradient monitoring well for nitrogen monitoring.

8. The boilerplate of this permit has been revised using a new format.

II. Best Available and Demonstratable Control Technology (BADCT)

The WWTP design was reviewed and issued an Approval to Construct [ADEQ Engineering File No. 970502] by ADEQ on May 5, 1998 and issued an Approval of Construction on December 3, 1999.

III. COMPLIANCE WITH AQUIFER WATER QUALITY STANDARDS

Monitoring and Reporting Requirements

The discharge monitoring is split into two levels for monitoring: (1) discharge for reuse with Class C reclaimed water; or (2) discharge to the recharge basins. The facility is expecting to phase out the irrigation in favor of recharging for developing groundwater credits. In addition to

daily flow, the discharge is monitored for fecal coliform for Class C discharges and total nitrogen for discharge to percolation ponds. Metals and VOCs are only monitored annually because the monitoring history of the facility indicates no previous violations of these parameters.

Background Groundwater Information

The facility is located over groundwater of the Pinal Active Management Area. The depth to groundwater is approximately 220 feet bls and the regional direction of groundwater flow is generally to the northwest. The nearest points of use in the aquifer are three irrigation wells: one located approximately 1/3 mile north of the facility and the other two located approximately ½ mile northeast of the facility. The point of compliance was selected to be protective of all downgradient uses of the aquifer. Groundwater quality monitoring will be conducted from an existing hazardous point of compliance monitor well (MW-1) located near the western property boundary of the facility. Also, there are no known sources of soil or groundwater contamination that might be impacted by the recharge facility, except for an old, closed construction debris landfill that exists just south of the facility (adjacent to the southern property boundary). However, groundwater quality data from a downgradient well suggests that the underlying aquifer has not been degraded by discharges from the landfill. Nevertheless, groundwater level monitoring will be conducted from well MW-2 to observe rises of the groundwater table below the landfill.

The WWTP and recharge basins are located on old agriculture farm fields. Nitrogen from those old agriculture operations has been detected leaching into the aquifer since the beginning of the operation of the WWTP. The nitrogen monitoring levels peaked at 36mg/l, and the levels have since steadily declined to 16 mg/l. The nitrogen concentration in groundwater is expected to return to ambient upstream conditions (9-12 mg/l) within the next two years due to the recharge of the denitrified effluent produced by the Biolac Plant. The nitrogen content of the effluent is consistently below 5 mg/l, and this effluent is expected to continue to dilute the nitrogen in the vadose zone and groundwater in the future and thus improve the groundwater quality. POC #1 is downgradient of the WWTP and measures the effects of the WWTP and nitrogen leaching from the vadose zone. This expectation will be documented as shown in the Section 3.0 Compliance Schedule of this permit and as shown in Section 5, Compliance Schedule, of this Fact Sheet.

The upgradient monitoring well is situated to measure the up gradient existing conditions to assess potential off-site upgradient contributing sources. The permit requires monitoring at this location to assess baseline groundwater quality. This upgradient well is also situated to measure impacts from an old Eloy landfill, or other upgradient source of pollution. Based upon groundwater samples collected in the upgradient monitor well prior to permit issuance, it does not appear that the landfill has degraded groundwater quality beneath the WWTP. The upstream well will also provide a baseline by which to assess the background groundwater quality and data from this well will be compared to downgradient water quality data for identifying possible contributing effects from the WWTP discharge. In addition, the upgradient monitor well (Table IV-A, MW-2) will be used to monitor for nitrogen, cations, anions, and groundwater level. Increases in groundwater levels due to recharge, could reverse the existing groundwater flow

direction due to mounding beneath the facility. A reversal in groundwater flow direction, as well as shallower groundwater depths, could negatively impact the closed landfill by causing migration of any existing groundwater plumes or vadose zone contaminants.

To further evaluate ambient or baseline groundwater quality, the Compliance Schedule in the permit requires the permittee to monitor both wells as shown in Table II to establish the groundwater ambient conditions and give the vadose zone a reasonable opportunity to flush out the contaminants. During this period of time, the facility shall sample other wells in the immediate area to further assess and more completely establish the ambient conditions in this immediate area. Should any sampling data indicate any unexpected or undisclosed exceedance problems, the facility shall bring this to the attention of ADEQ within 48 hours of receiving the data. Within 5 days of receiving that data the facility shall submit a compliance plan to ADEQ's Water Quality Compliance Unit (WQCU) explaining the plans to mitigate the problems or plans to further sample the situation to better understand the data. Thereafter the facility shall submit a plan to ADEQ's WQCU every 30 days until the problem is resolved.

The downgradient POC groundwater monitoring well will be monitored for total nitrogen, total and fecal coliform, metals and VOCs. Additionally, the groundwater will be monitored for indicator parameters bicarbonate, calcium, carbonate, chloride, magnesium, potassium, sodium, and sulfate.

Point(s) of Compliance (P.O.C)

The POC for this facility is Monitoring Well No.1 and is located between Pond # 5 and Pond # 6 on the west side of the facility, at the property boundary and down gradient of the WWTP. Monitoring Well #2 will monitor the up gradient groundwater and establish the ambient groundwater conditions for this facility. These wells are located at:

Well Locations	Latitude	Longitude
POC Monitoring well #1(down gradient)	32^0 46' 07" N	111^0 34' 26"W

The Director may designate additional points of compliance if information on groundwater gradients or groundwater usage indicates the need.

IV. STORM WATER and SURFACE WATER CONSIDERATIONS

The Berms around the Basins and the WWTP provide flood protection from 100 year 24 hour storm events.

V. COMPLIANCE SCHEDULE [Section 3.0 of this permit, A.R.S. § 49-243(K)(5) and A.A.C. R18-9-A208]

For each compliance schedule item listed below, the permittee shall submit the required information, including a cover letter that lists the compliance schedule items, to the Water Permits Section. A copy of the cover letter must also be submitted to the Water Quality Compliance Section, Data Unit.

3-11-06 1. The facility shall complete the construction of the infiltration basins within one year of the signature date of the permit.

done 2. Within 60 days of the signature date of the permit, the permittee shall begin collecting 12 monthly samples from upgradient monitor well MW-2. This data shall be used to establish numeric aquifer quality limits for Nitrate-Nitrite.

ADEQ graft cover letter 7-11-05 3. Within 120 days of the signature date of the permit, the permittee shall submit an assessment (with calculations) of the impact on groundwater quality (in the aquifer beneath the facility) from the flushing of nitrate through the vadose zone. The assessment shall include an estimate of when the flushing of Nitrate will subside to the point that the aquifer quality limit (once established as a numeric limit) will no longer be exceeded.

ADEQ letter 6-11-05 4. Within 90 days of the signature date of the permit, the permittee shall submit a contingency plan which specifies the actions to be taken by the permittee in notifying downgradient users of the aquifer in the event that the assessment (compliance item #2) indicates that the user's wells could be impacted by discharges from the facility and the flushing of nitrate through the vadose zone.

ADEQ letter 8-11-05 5. Within 30 days of the completion of the assessment (item #3), the permittee shall submit a plan for the mitigation of the Nitrate plume if the assessment indicates that the groundwater quality of downgradient users will be degraded by the Nitrate plume resulting from the flushing of the vadose zone.

5-11-06 graft 6. Within 60 days of the 12th sampling event (from item #1), the permittee shall submit a request to an amendment of the permit for the purpose of establishing numeric alert levels and aquifer quality limits in point of compliance well MW-1. The request shall include a report with an assessment on the groundwater quality collected from POC well MW-1.

6-11-05 samples 7. Within 90 days of the signature date of the permit, the permittee shall locate and sample the immediate downgradient drinking water well(s) to determine the affect the flushing of the vadose zone is having on the downgradient drinking water wells. If there are no exceedances, the permittee shall monitor the drinking water well(s) semi-annually until the total nitrogen in POC well MW-1 meets the permit Aquifer Quality Limits. If there are exceedances of total nitrogen in the drinking water well(s), then the well(s) shall be monitored monthly and the results transmitted to the owners as well as to ADEQ. If other

sources are believed to be a cause of downgradient exceedances, the facility shall investigate and report on those sources to provide proof thereof.

VI. OTHER REQUIREMENTS FOR ISSUING THIS PERMIT

Technical Capability
The City of Eloy has demonstrated the technical competence necessary to carry out the terms and conditions of the permit in accordance with A.R.S. § 49-243(N) and A.A.C. R18-9-A202(B). The permit requires that appropriate documents be sealed by an Arizona registered geologist or professional engineer. This requirement is a part of an on-going demonstration of technical capability. The permittee is expected to maintain technical capability throughout the life of the facility.

Financial Capability
The City of Eloy has demonstrated the financial responsibility necessary to carry out the terms and conditions of the permit in accordance with A.R.S. § 49-243(N) and A.A.C. R18-9-A203. The permittee is expected to maintain financial; capability throughout the life of the facility.

Zoning Requirements
The City of Eloy has been properly zoned for the permitted use and the permittee has complied with all Pinal County zoning ordinances in accordance with A.R.S. § 49-243(O) and A.A.C. R18-9-A201(A)(2)(c).

VII. ADMINISTRATIVE INFORMATION

Public Notice (A.A.C. R18-9-108(A))

The public notice is the vehicle for informing all interested parties and members of the general public of the contents of a draft permit or other significant action with respect to a permit or application. The basic intent of this requirement is to ensure that all interested parties have an opportunity to comment on significant actions of the permitting agency with respect to a permit application or permit. This permit was public noticed in a local newspaper Casa Grande Dispatch, on May 24, 2004, after a pre-notice review by the applicant and other affected agencies.

Public Comment Period (A.A.C. R18-9-109(A))

The aquifer protection program rules require that permits be public noticed in a newspaper of general circulation within the area affected by the facility or activity and provide a minimum of 30 calendar days for interested parties to respond in writing to ADEQ. After the closing of the public comment period, ADEQ is required to respond to all significant comments at the time a final permit decision is reached or at the same time a final permit is actually issued. There were no comments to respond to.

Public Hearing (A.A.C R18-9-109(B))

A public hearing may be requested in writing by any interested party. The request should state the nature of the issues proposed to be raised during the hearing. A public hearing will be held if the Director determines there is a significant amount of interest expressed during the 30-day public comment period, or if significant new issues arise that were not considered during the permitting process.

VIII. ADDITIONAL INFORMATION

Additional information relating to this proposed permit may be obtained from:

Arizona Department of Environmental Quality
Water Quality Division
Water Permits Section, Wastewater, Recharge and Reuse Unit
Attn: Donald Bell, Project Officer
1110 W. Washington St., Mail Code 5415B-3
Phoenix, Arizona 85007
Phone: (602) 771-4613

STATE OF ARIZONA
AQUIFER PROTECTION PERMIT NO. P-101689
PLACE ID # 1576, LTF 28481
SIGNIFICANT AMENDMENT

1.0 AUTHORIZATION

In compliance with the provisions of Arizona Revised Statutes (A.R.S.) Title 49, Chapter 2, Articles 1, 2 and 3, Arizona Administrative Code (A.A.C.) Title 18, Chapter 9, Articles 1 and 2, A.A.C. Title 18, Chapter 11, Article 4 and amendments thereto, and the conditions set forth in this permit, City of Eloy is hereby authorized to operate the City of **Eloy Wastewater Treatment Plant** (WWTP), located at 1750 North 11 mile Corner, in Eloy, Arizona, in Pinal County, over groundwater of the Pinal Active Management Area (AMA), groundwater basin in Township 07 S, Range 07 E, Section 36, W ½ and portions of the NW ¼ and SE1/4 - Gila and Salt River Base Line and Meridian Basin.

This permit becomes effective on the date of the Water Quality Division Director's signature and shall be valid for the life of the facility (operational, closure, and post-closure periods), unless suspended or revoked pursuant to A.A.C. R18-9-A213. The permittee shall construct, operate and maintain the permitted facilities:

1. all the conditions of this permit including the design and operational information documented or referenced below, and
2. such that Aquifer Water Quality Standards (AWQS) are not violated at the applicable point(s) of compliance (POC) set forth below or if an AWQS for a pollutant has been exceeded in an aquifer at the time of permit issuance, that no additional degradation of the aquifer relative to that pollutant and as determined at the applicable POC occurs as a result of the discharge from the facility.

1.1 PERMITTEE INFORMATION

Facility Name: Eloy Wastewater Treatment Plant

Permittee:	**Mailing Address:**	**Facility's Street Address:**
City of Eloy	Doug Olson 1750 N. 11 mile Corner Eloy, AZ 85231	1750 N. 11 mile Corner Eloy, AZ 85231

Facility Contact: Doug Olson, Water/Wastewater System Manager (520) 464-1392

Emergency Telephone Number: (520) 251-0784

Latitude: 32° 46' 25" N **Longitude:** 111° 34 ' 30" W

Legal Description: Township 07 S, Range 07 E, Section 36 - Gila and Salt River Base Line and Meridian .

1.2 AUTHORIZING SIGNATURE

Karen L. Smith, Director
Water Quality Division
Arizona Department of Environmental Quality
Signed this 11th day of March, 2005

THE TEXT IN THIS AMENDMENT SUPERCEDCES THE TEXT IN ALL PREVIOUS AQUIFER PROTECTION PERMITS ISSUED FOR THIS FACILITY

2.0 SPECIFIC CONDITIONS [A.R.S. §§ 49-203(4), 49-241(A)]

2.1 Facility / Site Description [A.R.S. § 49-243(K)(8)]

The permittee is authorized to operate the WWTP with a maximum of 2.0 million gallons per day flow. The existing Biolac treatment process consists of headworks, including lift station, bar screen, flow splitters, nitrification and denitrification, and clarification prior to discharge of effluent to percolation ponds. The effluent is chlorinated as necessary for disinfection to meet the Class C requirements. The permittee is authorized to discharge a maximum of 0.525 million gallons (MGD) average daily flow of Class C Reclaimed Water as per A.A.C. R18-11-307 to farm fields for pasture irrigation requirements. A valid Reclaimed Water Permit shall be maintained as long as the facility wishes to discharge effluent for reclaimed water purposes.

The permit requires reconstruction of existing recharge basins under a compliance schedule. Upon notification to ADEQ of completion of re-construction of the recharge basins, the permittee is authorized to discharge 2.0 MGD average daily flow to three recharge basins. Disinfection of effluent discharged to recharge basins is not required because of the existing soil aquifer treatment already exhibited in the vadose zone as per the A.A.C. R18-9-B204(A)(4).

Sludge produced at this facility will be conveyed to an aerobic digester and onto a vacuum sludge drying bed. After drying, the sludge shall be removed from the sludge drying beds and disposed of at the City of Eloy landfill located at the 305 North Toltec Highway in Eloy. Removal of sludge to the landfill will occur periodically, as necessary. The WWTP is designed and constructed according to plans approved by the ADEQ Wastewater, Recharge, & Reuse Unit. The WWTP and solid waste disposal system has been designed and constructed according to plans previously approved by ADEQ Wastewater, Recharge and Reuse Unit.

The depth to groundwater in this area varies between 200 to 400 feet below ground surface (bgs) and the direction of groundwater flow is to the northwest.

The site includes the following permitted discharge facility:

Facility	Latitude	Longitude
Wastewater Treatment Plant and Percolation Basins	32° 46' 25" N	111° 34' 30" W

2.2 Best Available Demonstrated Control Technology [A.R.S. § 49-243(B) and A.A.C. R18-9-A202(A)(5)]

The Wastewater Treatment Plant is designed to meet the treatment performance criteria for new facilities as specified in Arizona Administrative Code R18-9-B204 and includes the best available Demonstratable Control Technology.

The facility meets the requirements for the pretreatment by conducting monitoring as per R18-9-B204(A)(6)(b)(ii).

All industrial hookups and other non-residential hookups to the treatment system shall be authorized according to the applicable federal, state or local regulations.

2.2.1 Engineering Design

The WWTP was designed as per the design report was prepared by Stanley Consultants, and was issued an Approval to Construct [ADEQ Engineering File 970502] dated May 27, 1998. The Approval of Construction was dated December 3, 1999. Reconstruction

dividing the existing basins into smaller units was approved under the review of plans submitted November 26, 2002, by Westland Resources, Inc.

2.2.2 Site-specific Characteristics

The Eloy Recharge Basins are located within the Eloy WWTP site. Indicator monitoring well#2 is upstream and measures the up gradient existing conditions. This up gradient well #2 is situated to measure the up gradient existing conditions for nitrogen and to measure any impacts from an old landfill, or any other upgradient source of pollution. The upgradient well will provide a baseline by which to judge the contributing effects of the WWTP discharge. No impacts from the landfill, or other facilities except agriculture farming, have been detected at the time of issuance of this permit.

The property upon which the WWTP and the recharge basins have been constructed, was previously an old agriculture farm field. Nitrogen from those agriculture operations, which are now the recharge basins, has been detected leaching into the aquifer since the beginning of the recharge operations in 2001 and the nitrogen monitoring values are now decreasing and are expected to return to ambient conditions within the next year.

The nitrogen content of the effluent is consistently below 5 mg/l, and this effluent is expected to dilute the effects of the vadose zone nitrogen and the existing aquifer. POC MW #1 is downstream of the WWTP and measures the effects of the WWTP and this nitrogen leaching. The leaching is expected to consistently decrease within the two years and to be within the permit limits of 10 mg/l. The effects on the aquifer are considered to be minimal at the time of the issuance of this permit and the reduced content of the effluent is expected to improve the nitrogen quality of the aquifer in the future.

Disinfection of effluent discharged to percolation ponds is not required because of the existing soil aquifer treatment in the vadose zone and depth to groundwater (200 plus feet) have been demonstrated in past reporting as per the performance requirements in A.A.C. R18-9-B204(A)(4).

2.2.3 Pre-Operational Requirements

The WWTP is currently in operation. The permittee will re-construct the recharge basins to make smaller more manageable basins with this permit.

2.2.4 Operational Requirements

1. The permittee shall maintain a copy of the new O & M manual at the WWTP site at all times and shall be available upon request during inspections by ADEQ personnel.

2. The pollution control structures shall be inspected for the items listed in Section 4.0, TABLE V - FACILITY INSPECTION (OPERATIONAL MONITORING).

3. If any damage of the pollution control structures is identified during inspection, proper repair procedures shall be performed. All repair procedures and material(s) used shall be documented on the Self-Monitoring Report Form submitted quarterly to the ADEQ Water Quality Compliance.

2.2.5 Wastewater Treatment Plant Classification
A.C. R18-9-703(C)(2)(a), A.A.C. R18-11-303 THROUGH 307]

The facility shall produce Class C reclaimed water meeting the standards in A.A.C R18-11-307 to be delivered pasture and grain reuse areas under Reclaimed Water Permit No. 101689.

2.3 Discharge Limitations [A.R.S. §§ 49-201(14), 49-243 and A.A.C. R18-9-A205(B)]

The permittee is authorized to operate the WWTP with a maximum average monthly flow of 2.0 MGD. Discharge is further limited to 0.525 maximum flow to reuse areas until completion of construction of the recharge basins.

2.4 Points of Compliance (P.O.C.) [A.R.S. § 49-244]

The Point of Compliance is established by the following monitoring location:

P.O.C #	P.O.C. Locations	Latitude	Longitude
1	MW #1 down gradient	32° 46' 23" N	111° 34' 33" W

Monitoring Well # 2 will monitor and establish the ambient groundwater conditions for this facility. The Director may amend this permit to designate additional points of compliance if information on groundwater gradients or groundwater usage indicates the need.

2.5 Monitoring Requirements [A.R.S. § 49-243(K)(1), A.A.C. R18-9-A206(A)]

All monitoring required in this permit shall continue for the duration of the permit, regardless of the status of the facility. All sampling, preservation and holding times shall be in accordance with currently accepted standards of professional practice. Trip blanks, equipment blanks and duplicate samples shall also be obtained, and chain of custody procedures shall be followed, in accordance with currently accepted standards of professional practice. The permittee shall consult the most recent version of the ADEQ Quality Assurance Project Plan (QAPP) and EPA 40 CFR PART 136 for guidance in this regard. Copies of laboratory analyses and chain of custody forms shall be maintained at the permitted facility. Upon request these documents shall be made immediately available for review by ADEQ personnel.

2.5.1 Discharge Monitoring

The permittee shall monitor the wastewater according to Section 4.0, TABLE I and II. A representative sample of the wastewater shall be collected at the point of discharge from the outfall pipe to the recharge basins.

2.5.2 Facility / Operational Monitoring

Operational monitoring inspections shall be conducted according to Section 4.0, TABLE V.

a. If any damage of the pollution control structures is identified during inspection, proper repair procedures shall be performed. All repair procedures and materials used shall be documented on the Self-Monitoring Report Form (SMRF) submitted quarterly to the ADEQ Water Quality Compliance. If none of the conditions occur, the report shall say "no event" for a particular reporting period. If the facility is not in operation, the permittee shall indicate that fact in the SMRF.

b. The permittee shall submit data required in Section 4.0, TABLE V regardless of the operating status of the facility unless otherwise approved by the Department or allowed in this permit.

2.5.3 Groundwater Monitoring and Sampling Protocols

The permittee shall monitor the groundwater according to Section 4.0, TABLE III and IV. Static water levels shall be measured and recorded prior to sampling. Wells shall be purged of at least three borehole volumes (as calculated using the static water level) or until indicator parameters (pH, temperature, conductivity) are stable, whichever represents the greater volume. If evacuation results in the well going dry, the well shall be allowed to recover to 80% of the original borehole volume, or for 24 hours, whichever is shorter, prior to sampling. If after 24 hours there is not sufficient water for sampling, the well shall be recorded as "dry" for the monitoring event. An explanation for reduced pumping volumes, a record of the volume pumped, and modified sampling procedures shall be reported and submitted with the Self- Monitoring Report Form (SMRF).

2.5.4 Surface Water Monitoring and Sampling Protocols

Routine surface water monitoring is not required under the terms of this permit.

2.5.5 Analytical Methodology

All samples collected for compliance monitoring shall be analyzed using Arizona state approved methods. If no state approved method exists, then any appropriate EPA approved method shall be used. Regardless of the method used, the detection limits must be sufficient to determine compliance with the regulatory limits of the parameters specified in this permit. Analyses shall be performed by a laboratory licensed by the Arizona Department of Health Services, Office of Laboratory Licensure and Certification. For results to be considered valid, all analytical work shall meet quality control standards specified in the approved methods. A list of Arizona state certified laboratories can be obtained at the address below:

Arizona Department of Health Services
Office of Laboratory Licensure and Certification
1740 W. Adams Street, Room 203 North
Phoenix, AZ 85007
Phone: (602) 364-0720

2.5.6 Installation and Maintenance of Monitoring Equipment

Monitoring equipment required by this permit shall be installed and maintained so that representative samples required by the permit can be collected. If new groundwater wells are determined to be necessary, the construction details shall be submitted to the ADEQ Water Permits Section for approval prior to installation and the permit shall be amended to include any new points.

2.6 Contingency Plan Requirements
[A.R.S. § 49-243(K)(3), (K)(7) and A.A.C. R18-9-A204 and R18-9-A205]

2.6.1 General Contingency Plan Considerations

At least one copy of the approved contingency and emergency response plan(s) submitted in the application shall be maintained at the location where day-to-day decisions regarding the operation of the facility are made. The permittee shall be aware of and follow the contingency and emergency plans.

Any alert level (AL) that is exceeded or any violation of an aquifer quality limit (AQL), discharge limit (DL), or other permit condition shall be reported to ADEQ following the reporting requirements in Section 2.7.3.

Some contingency actions involve verification sampling. Verification sampling shall consist of the first follow-up sample collected from a location that previously indicated a violation or the exceedance of an AL. Collection and analysis of the verification sample shall use the same protocols and test methods to analyze for the pollutant or pollutants that exceeded an AL or violated an AQL. The permittee is subject to enforcement action for the failure to comply with any contingency actions in this permit. Where verification sampling is specified in this permit, it is the option of the permittee to perform such sampling. If verification sampling is not conducted within the timeframe allotted, ADEQ and the permittee shall presume the initial sampling result to be confirmed as if verification sampling has been conducted. The permittee is responsible for compliance with contingency plans relating to the exceedance of an AL or violation of a DL, AQL or any other permit condition.

2.6.2 Exceeding of Alert Levels/Performance Levels

2.6.2.1 Exceeding of Performance Levels (PL) Set for Operational Conditions

1. If the operational PL set in Section 4.0, TABLE V has been exceeded (permit condition violated) the permittee shall

    a. Notify the ADEQ Water Quality Compliance Section within five (5) days of becoming aware of a violation of any permit condition.

    b. Submit a written report within thirty (30) days after becoming aware of a violation of a permit condition. The report shall document all of the following:

        1. A description of the violation and its cause;

        2. the period of violation, including exact date(s) and time(s), if known, and the anticipated time period during which the violation is expected to continue;

        3. any action taken or planned to mitigate the effects or the violation, or the spill, or to eliminate or prevent recurrence of the violation;

        4. any monitoring activity or other information which indicates that any pollutants would be reasonably expected to cause a violation of an Aquifer Water Quality Standard; and

        5. any malfunction or failure of pollution control devices or other equipment or process.

2. The facility is no longer on alert status once the operational indicator no longer indicates that a PL is being exceeded. The permittee shall, however, complete all tasks necessary to return the facility to its pre-alert operating condition.

2.6.2.2 Exceeding of Alert Levels Set for Discharge Monitoring

1. If an AL set in Section 4.3, TABLE I or II has been exceeded, the permittee shall immediately investigate to determine the cause of the AL being exceeded. The investigation shall include the following:

   a. Inspection, testing, and assessment of the current condition of all treatment or pollutant discharge control systems that may have contributed to the AL being exceeded.

   b. Review of recent process logs, reports, and other operational control information to identify any unusual occurrences;

2. The permittee shall initiate actions identified in the approved contingency plan referenced in Section 5.0 and specific contingency measures identified in Section 2.6 to resolve any problems identified by the investigation which may have led to an AL being exceeded. To implement any other corrective action the permittee shall obtain prior approval from ADEQ according to Section 2.6.6.

3. Within thirty (30) days after confirmation of an AL being exceeded, the permittee shall submit the laboratory results to the ADEQ Water Quality Compliance Section, Data Unit, along with a summary of the findings of the investigation, the cause of the AL being exceeded, and actions taken to resolve the problem.

4. Upon review of the submitted report, the Department may require additional monitoring, increased frequency of monitoring, amendments to permit conditions or other actions.

2.6.2.3 Exceeding of Alert Levels in Groundwater Monitoring

2.6.2.3.1 Alert Levels for Indicator Parameters

Not required at time of permit issuance.

2.6.2.3.2 Alert Levels for Pollutants with Numeric Aquifer Water Quality Standards

1. If an AL for a pollutant set in Section 4.0, TABLE III or IV has been exceeded, the permittee may conduct verification sampling within 5 days of becoming aware of an AL being exceeded.

2. If verification sampling confirms the AL being exceeded, the permittee shall increase the frequency of monitoring to Daily', 'Weekly', and 'Monthly' for constituents that have a permit monitoring frequency of 'Weekly', 'Monthly', and 'Quarterly', 'Semi-Annual' or 'Annual' respectively. In addition, the permittee shall immediately initiate an investigation of the cause of the AL being exceeded, including

inspection of all discharging units and all related pollution control devices, review of any operational and maintenance practices that might have resulted in an unexpected discharge, and hydrologic review of groundwater conditions including upgradient water quality.

3. The permittee shall initiate actions identified in the approved contingency plan referenced in Part 5.0 and specific contingency measures identified in Part 2.6 to resolve any problems identified by the investigation which may have led to an AL being exceeded. To implement any other corrective action the permittee shall obtain prior approval from ADEQ according to Section 2.6.6. Alternatively, the permittee may submit a technical demonstration, subject to written approval by the Water Permits Section, that although an AL is exceeded, pollutants are not reasonably expected to cause a violation of an AQL. The demonstration may propose a revised AL or monitoring frequency for approval in writing by the Water Permits Section.

4. Within thirty (30) days after confirmation of an AL being exceeded, the permittee shall submit the laboratory results to the Water Quality Compliance Section, Data Unit along with a summary of the findings of the investigation, the cause of the AL being exceeded, and actions taken to resolve the problem.

5. Upon review of the submitted report, the Department may require additional monitoring, increased frequency of monitoring, amendments to permit conditions or other actions.

6. The increased monitoring required as a result of ALs being exceeded may be reduced to Section 4.0, TABLE III or IV frequencies, if the results of four sequential sampling events demonstrate that no parameters exceed the AL.

2.6.2.3.3 Alert Levels to Protect Downgradient Users from Pollutants Without Numeric Aquifer Water Quality Standards

Not required at time of issuance.

2.6.3 Discharge Limitations (DL) Violations

1. If a DL set in Section 4.0, Table I or II, has been violated, the permittee shall immediately investigate to determine the cause of the violation. The investigation shall include the following:

   a. Inspection, testing, and assessment of the current condition of all treatment or pollutant discharge control systems that may have contributed to the violation;

   b. Review of recent process logs, reports, and other operational control information to identify any unusual occurrences;

   c. Sampling of individual waste streams composing the wastewater for the parameters in violation.

The permittee also shall submit a report according to Section 2.7.3, which includes a summary of the findings of the investigation, the cause of the violation, and actions taken to resolve the problem. The permittee shall consider and ADEQ may require corrective action that may include control of the source of discharge, cleanup of affected soil, surface water or groundwater, and mitigation of the impact of pollutants on existing uses of the aquifer. Corrective actions shall either be specifically identified in this permit, included in an ADEQ approved contingency plan, or separately approved according to Section 2.6.6.

2. Upon review of the submitted report, the Department may require additional monitoring, increased frequency of monitoring, amendments to permit conditions or other actions.

2.6.4 Aquifer Quality Limit (AQL) Violation

1. If an AQL set in Section 4.0, TABLE III or IV, has been exceeded, the permittee may conduct verification sampling within 5 days of becoming aware of an AQL being exceeded.

2. If verification sampling confirms that the AQL is violated for any parameter, the permittee shall increase the frequency of monitoring to 'Daily', 'Weekly', and 'Monthly' for constituents that have a permit monitoring frequency of 'Weekly', 'Monthly', and 'Quarterly', 'Semi-Annual' or 'Annual' respectively. In addition, the permittee shall immediately initiate an evaluation for the cause of the violation, including inspection of all discharging units and all related pollution control devices, and review of any operational and maintenance practices that might have resulted in unexpected discharge.

   The permittee also shall submit a report according to Section 2.7.3, which includes a summary of the findings of the investigation, the cause of the violation, and actions taken to resolve the problem. The permittee shall consider and ADEQ may require corrective action that may include control of the source of discharge, cleanup of affected soil, surface water or groundwater, and mitigation of the impact of pollutants on existing uses of the aquifer. Corrective actions shall either be specifically identified in this permit, included in an ADEQ approved contingency plan, or separately approved according to Section 2.6.6.

3. Upon review of the submitted report, the Department may require additional monitoring, increased frequency of monitoring, amendments to permit conditions or other actions.

2.6.5 Emergency Response and Contingency Requirements for Spills and Unauthorized Discharges

2.6.5.1 Duty to Respond

The permittee shall act immediately to correct any condition resulting from a discharge if that condition could pose an imminent and substantial endangerment to public health or the environment.

2.6.5.2 Discharge of Hazardous Substances or Spills of Toxic Pollutants

In the event of any unauthorized discharge (A.R.S. § 49-201(12)) of suspected hazardous substances (A.R.S. § 49-201(18)) or any spills of toxic pollutants (A.R.S. § 49-243(I)) on the facility site, the permittee shall promptly isolate the area and attempt to identify the spilled material. The permittee shall record

information, including name, nature of exposure and follow-up medical treatment, if necessary, on persons who may have been exposed during the incident. Spilled materials, absorbents, and contaminated media generated during emergency response shall be removed and disposed of according to applicable federal, state and local regulations. The permittee shall notify the ADEQ Water Quality Field Service Unit at (602) 771-4841 within 24-hours upon discovering the discharge of hazardous material which: a) has the potential to cause an AWQS or AQL to be exceeded; or b) could pose an endangerment to public health or the environment.

2.6.5.3 Discharge of Non-hazardous Materials

In the event of any unauthorized discharge of non-hazardous materials from the facility, the permittee shall promptly attempt to cease the discharge and isolate the discharged material. Discharged material shall be removed and the site cleaned up as soon as possible. The permittee shall notify the ADEQ Water Quality Field Services Unit at (602) 771-4841, within 24-hours upon discovering the discharge of non-hazardous material which: a) has the potential to cause an AQL to be exceeded; or b) could pose an endangerment to public health or the environment.

2.6.5.4 Reporting Requirements

The permittee shall submit a written report for any unauthorized discharges described in Sections 2.6.5.2 and 2.6.5.3 to ADEQ Water Quality Field Services Unit, Mail Code: 5415B-1, 1110 West Washington Street, Phoenix, AZ, within thirty days of the discharge or as required by subsequent ADEQ action. The report shall summarize the event, including any human exposure, and facility response activities and include all information specified in Section 2.7.3. If a notice is issued by ADEQ subsequent to the discharge notification, any additional information requested in the notice shall also be submitted within the time frame specified in that notice. Upon review of the submitted report, ADEQ may require additional monitoring or corrective actions.

2.6.6 Corrective Actions

Specific contingency measures identified in Part 2.6 have already been approved by ADEQ and do not require written approval to implement.

With the exception of emergency response actions taken under Section 2.6.5, the permittee shall obtain written approval from the Water Permits Section prior to implementing a corrective action to accomplish any of the following goals in response to exceeding an AL or violation of an AQL, DL, or other permit condition:

1. Control of the source of an unauthorized discharge;
2. Soil cleanup;
3. Cleanup of affected surface waters;
4. Cleanup of affected parts of the aquifer;
5. Mitigation to limit the impact of pollutants on existing uses of the aquifer.

Within 30 days of completion of any corrective action, the operator shall submit to the ADEQ Water Quality Compliance Section, a written report describing the causes, impacts, and actions taken to resolve the problem.

2.7 Reporting and Recordkeeping Requirements [A.R.S. § 49-243(K)(2) and A.A.C. R18-9-A206(B) and R18-9-A207]

2.7.1 Self Monitoring Report Forms (SMRF)

1. The permittee shall complete the SMRFs provided by ADEQ, and submit them to the Water Quality Compliance Section, Data Unit.

2. The permittee shall complete the SMRF to the extent that the information reported may be entered on the form. If no information is required during a quarter, the permittee shall enter "not required" on the SMRF and submit the report to ADEQ. The permittee shall use the format devised by ADEQ.

3. The tables contained in Sections 4.0 list the parameters to be monitored and the frequency for reporting results for groundwater compliance monitoring. Monitoring methods shall be recorded on the SMRFs.

4. In addition to the SMRF, the information contained in Section 6.9.3 shall be included for exceeding an AL or violation of an AQL, DL, or any other permit condition being reported in the current reporting period.

2.7.2 Operation Inspection / Log Book Recordkeeping

A signed copy of this permit shall be maintained at all times at the location where day-to-day decisions regarding the operation of the facility are made. A log book (paper copies, forms or electronic data) of the inspections and measurements required by this permit shall be maintained at the location where day-to-day decisions are made regarding the operation of the facility. The log book shall be retained for ten years from the date of each inspection, and upon request, the permit and the log book shall be made immediately available for review by ADEQ personnel. The information in the log book shall include, but not be limited to, the following information as applicable:

1. Name of inspector;
2. Date and shift inspection was conducted;
3. Condition of applicable facility components;
4. Any damage or malfunction, and the date and time any repairs were performed;
5. Documentation of sampling date and time;
6. Any other information required by this permit to be entered in the log book, and
7. Monitoring records for each measurement shall comply with R18-9 A206(B)(2).

2.7.3 Permit Violation and Alert Level Status Reporting

1. The permittee shall notify the Water Quality Compliance Section, Enforcement Unit in writing within five days (except as provided in Section 2.6.5) of becoming aware of a violation of any permit condition, discharge limitation or of an Alert Level being exceeded.

2. The permittee shall submit a written report to the Water Quality Compliance Section, Enforcement Unit within 30 days of becoming aware of the violation of any permit condition or discharge limitation. The report shall document all of the following:

a. Identification and description of the permit condition for which there has been a violation and a description of its cause.

b. The period of violation including exact date(s) and time(s), if known, and the anticipated time period during which the violation is expected to continue.

c. Any corrective action taken or planned to mitigate the effects of the violation, or to eliminate or prevent a recurrence of the violation.

d. Any monitoring activity or other information which indicates that any pollutants would be reasonably expected to cause a violation of an Aquifer Water Quality Standard.

e. Proposed changes to the monitoring which include changes in constituents or increased frequency of monitoring.

f. Description of any malfunction or failure of pollution control devices or other equipment or processes.

2.7.4 Operational, Other or Miscellaneous Reporting

The permittee shall complete the Self-Monitoring Report Form provided by the Department to reflect facility inspection requirements designated in Section 4.0, TABLE V and submit to the ADEQ, Water Quality Compliance quarterly along with other reports required by this permit. Facility inspection reports shall be submitted no less frequently than quarterly, regardless of operational status.

In addition to the above, the facility is required to monitor the upgradient monitoring conditions over the next 2 years, as per Section 3.5, and submit a report to ADEQ with ambient groundwater conditions proposed.

2.7.5 Reporting Location

All SMRFs shall be submitted to:

Arizona Department of Environmental Quality
Water Quality Compliance Section, Data Unit
Mail Code: 5415B-1
1110 W. Washington Street
Phoenix, AZ 85007
Phone (602) 771-4681

All documents required by this permit to be submitted to the Water Quality Compliance Section shall be directed to:

Water Quality Compliance Section, Enforcement Unit
Mail Code: 5415B-1
1110 W. Washington Street
Phoenix, AZ 85007
Phone (602) 771-4614

All documents required by this permit to be submitted to the Water Permits Section shall be directed to:

Arizona Department of Environmental Quality
Water Permits Section
Mail Code: 5415B-3
1110 W. Washington Street
Phoenix, AZ 85007
Phone (602) 771-4428

2.7.6 **Reporting Deadline**

The following table lists the quarterly report due dates:

Monitoring conducted during quarter:	Quarterly Report due by:
January-March	April 30
April-June	July 30
July-September	October 30
October-December	January 30

2.7.7 **Changes to Facility Information in Section 1.0**

The Water Permits Section and Water Quality Compliance Section shall be notified within 10 days of any change of facility information including Facility Name, Permittee Name, Mailing or Street Address, Facility Contact Person or Emergency Telephone Number.

2.8 Temporary Cessation [A.R.S. § 49-243(K)(8) and A.A.C. R18-9-A209(A)]

The permittee shall give written notice to the Water Quality Compliance Section upon ceasing operation of the facility for a period of 60 days or greater. The permittee shall take the following measures upon temporary cessation:

1. If applicable, direct the wastewater flows from the facility to another State approved wastewater treatment facility.

2. Correct the problem that caused the temporary cessation of the facility.

3. Notify ADEQ with a monthly facility Status Report describing the activities conducted on the WWTP to correct the problem

At the time of notification the permittee shall submit for ADEQ approval a plan for maintenance of discharge control systems and for monitoring during the period of temporary cessation. Immediately following ADEQ's approval, the permittee shall implement the approved plan. If necessary, ADEQ shall amend permit conditions to incorporate conditions to address temporary cessation. If the facility ceases operation, the permittee shall submit closure notification, as set forth in Section 2.9 below.

2.9 Closure [A.R.S. §§ 49-243(K)(6), 49-252 and A.A.C. R18-9-A209(B)]

The permittee shall give written notice of closure to the Water Quality Compliance Section before closing, or before ceasing use of a facility addressed under this permit if the cessation is projected to last more than three years.

2.9.1 Closure Plan

A specific closure plan is required within 180 days of closure of the facility. Within 90 days following notification of closure, the permittee shall submit for approval to the Water Permits Section, a detailed Closure Plan which meets the requirements of A.R.S. § 49-252 and A.A.C. 18-9-A209(B)(1)(a).

If the closure plan achieves clean closure immediately, ADEQ shall issue a letter of approval to the permittee. If the closure plan contains a schedule for bringing the facility to a clean closure Configuration at a future date, ADEQ may incorporate any part of the schedule as an amendment to this permit.

2.9.2 Closure Completion

Upon completion of closure activities, the permittee shall give written notice to the Water Permits Section indicating that the approved Closure Plan has been implemented fully. If clean closure has been achieved, ADEQ shall issue a letter of approval to the permittee at that time. If any of the following conditions apply, the permittee shall follow the terms of Post Closure stated in this permit:

1. Clean closure cannot be achieved at the time of closure notification or within one year thereafter under a diligent schedule of closure actions;
2. Further action is necessary to keep the facility in compliance with aquifer water quality standards at the applicable point of compliance;
3. Continued action is required to verify that the closure design has eliminated discharge to the extent intended;
4. Remedial or mitigative measures are necessary to achieve compliance with Title 49, Ch. 2;
5. Further action is necessary to meet property use restrictions.

2.10 Post-Closure [A.R.S. §§ 49-243(K)(6), 49-252 and A.A.C. R18-9 A209(C)]

Post-closure requirements shall be established based on a review of facility closure actions and will be subject to review and approval by the Water Permits Section.

In the event clean closure cannot be achieved pursuant to A.R.S. § 49-252, the permittee shall submit for approval to the Water Permits Section a Post-Closure Plan that addresses post-closure maintenance and monitoring actions at the facility. The Post-Closure Plan shall meet all requirements of A.R.S. §§ 49- 201(29) and 49-252 and A.A.C. R18-9-A209(C). Upon approval of the Post-Closure Plan, this permit shall be amended or a new permit shall be issued to incorporate all post-closure controls and monitoring activities of the Post-Closure Plan.

2.10.1 Post-Closure Plan

A specific post closure plan may be required upon the review of the closure plan.

2.10.2 Post-Closure Completion

Not required at the time of permit issuance.

3.0 COMPLIANCE SCHEDULE [A.R.S. § 49-243(K)(5) and A.A.C. R18-9-A208]

For each compliance schedule item listed below, the permittee shall submit the required information, including a cover letter that lists the compliance schedule items, to the Water Permits Section. A copy of the cover letter must also be submitted to the Water Quality Compliance Section, Data Unit.

1. The facility shall complete the construction of the infiltration basins within one year of the signature date of the permit. Before recharge basins are reconstructed, the remaining soils shall be tested for soil remediation levels (SRL) to insure pollutants are not flushed into the aquifer.

2. Within 60 days of the signature date of the permit, the permittee shall begin collecting 12 monthly samples from upgradient monitor well MW-2. This data shall be used to establish numeric aquifer quality limits for Nitrate-Nitrite.

3. Within 120 days of the signature date of the permit, the permittee shall submit an assessment (with calculations) of the impact on groundwater quality (in the aquifer beneath the facility) from the flushing of nitrate through the vadose zone. The assessment shall include an estimate of when the flushing of Nitrate will subside to the point that the aquifer quality limit (once established as a numeric limit) will no longer be exceeded.

4. Within 90 days of the signature date of the permit, the permittee shall submit a contingency plan which specifies the actions to be taken by the permittee in notifying downgradient users of the aquifer in the event that the assessment (compliance item #2) indicates that the user's wells could be impacted by discharges from the facility and the flushing of nitrate through the vadose zone.

5. Within 30 days of the completion of the assessment (item #3), the permittee shall submit a plan for the mitigation of the Nitrate plume if the assessment indicates that the groundwater quality of downgradient users will be degraded by the Nitrate plume resulting from the flushing of the vadose zone. .

6. Within 60 days of the 12th sampling event (from item #1), the permittee shall submit a request to an amendment of the permit for the purpose of establishing numeric alert levels and aquifer quality limits in point of compliance well MW-1. The request shall include a report with an assessment on the groundwater quality collected from POC well MW-1.

7. Within 90 days of the signature date of the permit, the permittee shall locate and sample the immediate downgradient drinking water well(s) to determine the affect the flushing of the vadose zone is having on the downgradient drinking water wells. If there are no exceedances, the permittee shall monitor the drinking water well(s) semi-annually until the total nitrogen in POC well MW-1 meets the permit Aquifer Quality Limits. If there are exceedances of total nitrogen in the drinking water well(s), then the well(s) shall be monitored monthly and the results transmitted to the owners as well as to ADEQ. If other sources are believed to be a cause of downgradient exceedances, the facility shall investigate and report on those sources to provide proof thereof.

4.0 TABLES OF MONITORING REQUIREMENTS

TABLE I A
DISCHARGE MONITORING FOR DISCHARGE TO PERCOLATION PONDS

Sampling Point Number	Identification	Latitude	Longitude
2	Metering location, adjacent to holding pond	32° 46' 22" N	111° 34' 25" W

Parameter	A L[1]	DL[2]	Units	Sampling Frequency	Reporting Frequency
Maximum Daily Flow	Not Established	Not Established	MGD	Daily	Quarterly
Monthly Average Flow	1.9	2.0	MGD	Calculated Monthly[3]	Quarterly
Nutrients:					
Total Nitrogen[4]	8.0	10.0	mg/l	Quarterly	Quarterly
Nitrate as N Nitrite as N	Not Established	Not established	mg/l	Quarterly	Quarterly
Total Kjeldahl Nitrogen (TKN)	No Limit	No Limit	mg/l	Quarterly	Quarterly

1 AL=Alert Level
2 DL=Discharge Level. All discharges and alert limits are in mg/l, except flow which is presented in million gallons per day (MGD), fecal coliform which is in Colony Forming Units (CFU), or most probable number (MPN) per 100 ml sample. The ALs and DLs are maximum numbers.
3 Monthly = calculated value. Average of maximum daily flows for the month.
4 Total Nitrogen is equal to nitrate and nitrite as N plus TKN.

4.0 TABLES OF MONITORING REQUIREMENTS (Continued)

TABLE I B
DISCHARGE MONITORING

Parameter	AL	DL	Units	Sampling Frequency	Reporting Frequency
Metals (Total):					
Antimony	0.0048	0.006	mg/l	Annual	Annual
Arsenic	0.04	0.05	mg/l	Annual	Annual
Barium	1.60	2.00	mg/l	Annual	Annual
Beryllium	0.0032	0.004	mg/l	Annual	Annual
Cadmium	0.004	0.005	mg/l	Annual	Annual
Chromium	0.08	0.1	mg/l	Annual	Annual
Cyanide (As free cyanide)	0.16	0.2	mg/l	Annual	Annual
Fluoride	3.2	4.0	mg/l	Annual	Annual
Lead	0.04	0.05	mg/l	Annual	Annual
Mercury	0.0016	0.002	mg/l	Annual	Annual
Nickel	0.08	0.1	mg/l	Annual	Annual
Selenium	0.04	0.05	mg/l	Annual	Annual
Thallium	0.0016	0.002	mg/l	Annual	Annual

4.0 TABLES OF MONITORING REQUIREMENTS (Continued)

TABLE 1 C
DISCHARGE MONITORING

Parameter	AL	DL	Units	Sampling Frequency	Reporting Frequency
Volatile Organic Compounds (VOCs):					
Benzene	0.004	0.005	mg/l	Annual	Annual
Carbon tetrachloride	0.004	0.005	mg/l	Annual	Annual
o-Dichlorobenzene	0.48	0.6	mg/l	Annual	Annual
para-Dichlorobenzene	0.06	0.075	mg/l	Annual	Annual
1,2-Dichloroethane	0.004	0.005	mg/l	Annual	Annual
1,1-Dichloroethylene	0.0056	0.007	mg/l	Annual	Annual
cis-1,2-Dichloroethylene	0.05	0.07	mg/l	Annual	Annual
trans-1,2-Dichloroethylene	0.08	0.1	mg/l	Annual	Annual
Dichloromethane	0.004	0.005	mg/l	Annual	Annual
1,2-Dichloropropane	0.004	0.005	mg/l	Annual	Annual
Ethylbenzene	0.56	0.7	mg/l	Annual	Annual
Monochlorobenzene	0.08	0.1	mg/l	Annual	Annual
Styrene	0.08	0.1	mg/l	Annual	Annual
Tetrachloroethylene	0.004	0.005	mg/l	Annual	Annual
Toluene	0.8	1.0	mg/l	Annual	Annual
Trihalomethanes (total)[5]	0.08	0.1	mg/l	Annual	Annual
1,1,1-Trichloroethane	0.16	0.2	mg/l	Annual	Annual
1,2,4 – Trichlorobenzene	0.056	0.07	mg/l	Annual	Annual
1,1,2 – Trichloroethane	0.004	0.005	mg/l	Annual	Annual
Trichloroethylene	0.004	0.005	mg/l	Annual	Annual
Vinyl Chloride	0.0016	0.002	mg/l	Annual	Annual
Xylenes (Total)	8.0	10.0	mg/l	Annual	Annual

[5] Total Trihalomethanes comprises of Bromoform, Bromodichloromethane, Chloroform, and Dibromochloromethane.

4.0 TABLES OF MONITORING REQUIREMENTS (Continued)

TABLE II
DISCHARGE MONITORING FOR CLASS C RECLAIMED WATER

Sampling Point Number		Sampling Point Identification		Latitude	Longitude
1		Downstream of the chlorination unit		32° 12' 00" N	111° 40' 00" W
Parameter	**AL[1]**	**DL[2]**	**Units**	**Sampling Frequency**	**Reporting Frequency**
Flow: Daily	Reserved	Reserved [3]	MGD[4]	Daily [5]	Quarterly
Flow: Average Monthly	0.49875	0.525	MGD	Monthly [6]	Quarterly
Fecal Coliform Single sample maximum	No Limit	4000	CFU or MPN [7]	Monthly	Quarterly
Fecal Coliform Seven sample median	No Limit	1000	CFU or MPN	Monthly	Quarterly

1 AL = Alert Level.
2 DL = Discharge Limit.
3 Reserved = Monitoring required but no limits have been specified at time of permit issuance.
4 MGD = Million Gallons per Day.
5 Flow shall be measured, using a continuous recording flow meter.
6 Monthly = Calculated value = Average of daily flows in a month.
7 CFU = Colony Forming Units / 100 ml sample. MPN = Most Probable Number / 100 ml sample

4.0 TABLES OF MONITORING REQUIREMENTS (Continued)

TABLE III A
GROUNDWATER MONITORING

Sampling Point Number	Sampling Point Identification		Latitude		Longitude
3	POC MW #1 (downgradient)		32° 46' 07" N		111° 34' 26" W
Parameter	**AL[1]**	**AQL[2]**	**Units**	**Sampling Frequency**	**Reporting Frequency**
Total Nitrogen[3]:	Reserved[4]	Reserved	mg/l	Monthly	Quarterly
Nitrate-Nitrite as N	Reserved	Reserved	mg/l	Monthly	Quarterly
Total Kjeldahl Nitrogen (TKN)	Reserved	Reserved	mg/l	Monthly	Quarterly
Fecal Coliform	Absence	Absence[5]	CFU or MPN[6]	Monthly	Quarterly
Total Coliform	Absence	Absence	CFU or MPN	Monthly	Quarterly
Total Dissolved Solids	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Bicarbonate	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Calcium	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Carbonate	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Chloride	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Magnesium	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Potassium	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Sodium	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Sulfate	Reserved	Reserved	mg/l	Semi-annual	Semi-annual

1 AL = Alert Level
2 AQL = Aquifer Quality Limit
3 Total Nitrogen is equal to nitrate as N plus nitrite as N plus TKN.
4 Reserved = Monitoring is required, limits will be established following completion of Compliance Schedule item number 6.
5 Each groundwater sample shall be analyzed for total coliform and then followed with a sampling for both total and fecal coliforms if the original sample for total coliform is positive. A positive total coliform result followed by a negative fecal coliform result shall not be considered an exceedance of the AQL. Any positive result for both total coliforms and fecal coliforms in the same sample shall be considered an exceedance of the AQL.
6 CFU = Colony Forming Units per 100 ml, MPN = Most Probable Number per 100 ml.

4.0 TABLE OF MONITORING REQUIREMENTS (Continued)

TABLE III B
GROUNDWATER MONITORING

Parameter	AL	AQL	Units	Sampling Frequency	Reporting Frequency
Metals (Total):					
Antimony	0.0048	0.006	mg/l	Annual	Annual
Arsenic	0.04	0.05	mg/l	Annual	Annual
Barium	1.60	2.00	mg/l	Annual	Annual
Beryllium	0.0032	0.004	mg/l	Annual	Annual
Cadmium	0.004	0.005	mg/l	Annual	Annual
Chromium	0.08	0.1	mg/l	Annual	Annual
Cyanide (As free cyanide)	0.16	0.2	mg/l	Annual	Annual
Fluoride	3.2	4.0	mg/l	Annual	Annual
Lead	0.04	0.05	mg/l	Annual	Annual
Mercury	0.0016	0.002	mg/l	Annual	Annual
Nickel	0.08	0.1	mg/l	Annual	Annual
Selenium	0.04	0.05	mg/l	Annual	Annual
Thallium	0.0016	0.002	mg/l	Annual	Annual

4.0 TABLES OF MONITORING REQUIREMENTS (continued)

TABLE III C
GROUNDWATER MONITORING

Parameter	AL	AQL	Units	Sampling Frequency	Reporting Frequency
Volatile Organic Compounds (VOCs):					
Benzene	0.004	0.005	mg/l	Annual	Annual
Carbon tetrachloride	0.004	0.005	mg/l	Annual	Annual
o-Dichlorobenzene	0.48	0.6	mg/l	Annual	Annual
para-Dichlorobenzene	0.06	0.075	mg/l	Annual	Annual
1,2-Dichloroethane	0.004	0.005	mg/l	Annual	Annual
1,1-Dichloroethylene	0.0056	0.007	mg/l	Annual	Annual
Cis-1,2-Dichloroethylene	0.05	0.07	mg/l	Annual	Annual
trans-1,2-Dichloroethylene	0.08	0.1	mg/l	Annual	Annual
Dichloromethane	0.004	0.005	mg/l	Annual	Annual
1,2-Dichloropropane	0.004	0.005	mg/l	Annual	Annual
Ethylbenzene	0.56	0.7	mg/l	Annual	Annual
Monochlorobenzene	0.08	0.1	mg/l	Annual	Annual
Styrene	0.08	0.1	mg/l	Annual	Annual
Tetrachloroethylene	0.004	0.005	mg/l	Annual	Annual
Toluene	0.8	1.0	mg/l	Annual	Annual
Trihalomethanes (total)[7]	0.08	0.1	mg/l	Annual	Annual
1,1,1-Trichloroethane	0.16	0.2	mg/l	Annual	Annual
1,2,4 – Trichlorobenzene	0.056	0.07	mg/l	Annual	Annual
1,1,2 – Trichloroethane	0.004	0.005	mg/l	Annual	Annual
Trichloroethylene	0.004	0.005	mg/l	Annual	Annual
Vinyl Chloride	0.0016	0.002	mg/l	Annual	Annual
Xylenes (Total)	8.0	10.0	mg/l	Annual	Annual

[7] Total Trihalomethanes comprises of Bromoform, Bromodichloromethane, Chloroform, and Dibromochloromethane.

4.0 TABLES OF MONITORING REQUIREMENTS (Continued)

TABLE IV A
GROUNDWATER MONITORING

Sampling Point Number	Sampling Point Identification		Latitude	Longitude	
4	Indicator MW#2 (up gradient)[1]		32° 46' 23" N	111° 34' 33" W	
Parameter	**AL[2]**	**AQL[3]**	**Units**	**Sampling Frequency**	**Reporting Frequency**
Groundwater Level	Reserved[4]	Reserved	Feet below surface	Monthly	Quarterly
Total Nitrogen[5]:	Reserved	Reserved	mg/l	Monthly	Quarterly
Nitrate-Nitrite as N	Reserved	Reserved	mg/l	Monthly	Quarterly
Total Kjeldahl Nitrogen (TKN)	Reserved	Reserved	mg/l	Monthly	Quarterly
Fecal Coliform	Absence	Absence[6]	CFU or MPN[7]	Monthly	Quarterly
Total Coliform	Absence	Absence	CFU or MPN	Monthly	Quarterly
Total Dissolved Solids	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Bicarbonate	Reserved	Reserved	m/l	Semi-annual	Semi-annual
Calcium	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Carbonate	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Chloride	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Magnesium	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Potassium	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Sodium	Reserved	Reserved	mg/l	Semi-annual	Semi-annual
Sulfate	Reserved	Reserved	mg/l	Semi-annual	Semi-annual

1 Monitor Nitrate as Nitrogen only.
2 AL = Alert Level
3 AQL = Aquifer Quality Limit
4 Reserved = Monitoring required, but no limits have been established at this time.
5 Total Nitrogen is equal to nitrate as N plus nitrite as N plus TKN.
6 Each groundwater sample shall be analyzed for total coliform and then followed with a sampling for both total and fecal coliforms if the original sample for total coliform is positive. A positive total coliform result followed by a negative fecal coliform result shall not be considered an exceedance of the AQL. Any positive result for both total coliforms and fecal coliforms in the same sample shall be considered an exceedance of the AQL.
7 CFU = Colony Forming Units per 100 ml, MPN = Most Probable Number per 100 ml.

4.0 TABLE OF MONITORING REQUIREMENTS (Continued)

TABLE IV B
GROUNDWATER MONITORING

Parameter	AL	AQL	Units	Sampling Frequency	Reporting Frequency
Metals (Total):					
Antimony	0.0048	0.006	mg/l	Annual	Annual
Arsenic	0.04	0.05	mg/l	Annual	Annual
Barium	1.60	2.00	mg/l	Annual	Annual
Beryllium	0.0032	0.004	mg/l	Annual	Annual
Cadmium	0.004	0.005	mg/l	Annual	Annual
Chromium	0.08	0.1	mg/l	Annual	Annual
Cyanide (As free cyanide)	0.16	0.2	mg/l	Annual	Annual
Fluoride	3.2	4.0	mg/l	Annual	Annual
Lead	0.04	0.05	mg/l	Annual	Annual
Mercury	0.0016	0.002	mg/l	Annual	Annual
Nickel	0.08	0.1	mg/l	Annual	Annual
Selenium	0.04	0.05	mg/l	Annual	Annual
Thallium	0.0016	0.002	mg/l	Annual	Annual

4.0 TABLES OF MONITORING REQUIREMENTS (continued)

TABLE IV C
GROUNDWATER MONITORING

Parameter	AL	AQL	Units	Sampling Frequency	Reporting Frequency
Volatile Organic Compounds (VOCs):					
Benzene	0.004	0.005	mg/l	Annual	Annual
Carbon tetrachloride	0.004	0.005	mg/l	Annual	Annual
o-Dichlorobenzene	0.48	0.6	mg/l	Annual	Annual
para-Dichlorobenzene	0.06	0.075	mg/l	Annual	Annual
1,2-Dichloroethane	0.004	0.005	mg/l	Annual	Annual
1,1-Dichloroethylene	0.0056	0.007	mg/l	Annual	Annual
Cis-1,2-Dichloroethylene	0.05	0.07	mg/l	Annual	Annual
trans-1,2-Dichloroethylene	0.08	0.1	mg/l	Annual	Annual
Dichloromethane	0.004	0.005	mg/l	Annual	Annual
1,2-Dichloropropane	0.004	0.005	mg/l	Annual	Annual
Ethylbenzene	0.56	0.7	mg/l	Annual	Annual
Monochlorobenzene	0.08	0.1	mg/l	Annual	Annual
Styrene	0.08	0.1	mg/l	Annual	Annual
Tetrachloroethylene	0.004	0.005	mg/l	Annual	Annual
Toluene	0.8	1.0	mg/l	Annual	Annual
Trihalomethanes (total)[8]	0.08	0.1	mg/l	Annual	Annual
1,1,1-Trichloroethane	0.16	0.2	mg/l	Annual	Annual
1,2,4 - Trichlorobenzene	0.056	0.07	mg/l	Annual	Annual
1,1,2 - Trichloroethane	0.004	0.005	mg/l	Annual	Annual
Trichloroethylene	0.004	0.005	mg/l	Annual	Annual
Vinyl Chloride	0.0016	0.002	mg/l	Annual	Annual
Xylenes (Total)	8.0	10.0	mg/l	Annual	Annual

[8] Total Trihalomethanes comprises of Bromoform, Bromodichloromethane, Chloroform, and Dibromochloromethane.

4.0 TABLES OF MONITORING REQUIREMENTS (Continued)

TABLE V
FACILITY INSPECTION (operational monitoring)

Pollution Control Structures/Parameter	Performance Levels	Inspection Frequency	Reporting frequency
Pump Integrity	Good Working Condition[1]	Monthly	Quarterly
Berm Integrity	No visible erosion	Monthly	Quarterly
Wastewater Containment Structures:	No cracks or spalling in concrete that results in leaks or impairs structural integrity.	Monthly	Quarterly
Treatment Plant Components	Good Working Condition [2]	Monthly	Quarterly

1 The pump or pumping equipment is operating appropriately and the wastewater is being discharged to its intended location.

2 The WWTP components are operating in a manner to produce the quality effluent that is required by this permit and there is no discharge to any unauthorized sites.

5.0 REFERENCES AND PERTINENT INFORMATION

The terms and conditions set forth in this permit have been developed based upon the information contained in the following, which are on file with the Department:

1.	APP Application dated:	October 28, 1997 (original APP) November 30, 1999 (Amendment) November 26, 2002 (Sig. Amendment)
2.	Contingency Plan, dated:	October 28, 1997 November 26, 2002(Sig. Amendment)
3.	Final Hydrologist Report dated:	April 7, 2004 (Sig. Amendment)
4.	Final Engineering Report dated:	March 23, 1998 (ATC) (Sig. Amendment)
5.	Public Notice dated:	August 26, 1999 (Original APP) May 24, 2004 (Sig. Amendment)
6.	Public Hearing, dated:	N/A
7.	Responsiveness Summary, dated:	N/A

6.0 GENERAL CONDITIONS AND RESPONSIBILITIES

6.1 Annual Registration Fees

The permittee is notified of the obligation to pay an Annual Registration Fee to ADEQ. The Annual Registration Fee is based upon the amount of daily influent or discharge of pollutants in gallons per day as established by A.R.S. § 49-242(D). This fee is payable to ADEQ each year.

6.2 Duty to Comply [A.R.S. §§ 49-221 through 263]

The permittee is notified of the obligation to comply with all conditions of this permit and all applicable provisions of Title 49, Chapter 2, Articles 1, 2 and 3 of the Arizona Revised Statutes, Title 18, Chapter 9, Articles 1 through 4, and Title 18, Chapter 11, Article 4 of the Arizona Administrative Code. Any permit non-compliance constitutes a violation and is grounds for an enforcement action pursuant to Title 49, Chapter 2, Article 4 or permit amendment, suspension, or revocation.

6.3 Duty to Provide Information [A.R.S. §§ 49-243(K)(2) and 49-243(K)(8)]

The permittee shall furnish to the Director, or an authorized representative, within a time specified, any information which the Director may request to determine whether cause exists for amending or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

6.4 Severability [A.R.S. § 49-243(K)(8)]

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

6.5 Proper Operation and Maintenance [A.R.S. § 49-243(K)(8)]

The permittee shall properly operate and maintain all facilities, treatment processes, and discharge control systems which are installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

6.6 Compliance with Aquifer Water Quality Standards [A.R.S. §§ 49-243(B)(2) and 49-243(B)(3)]

The permittee shall not cause or contribute to a violation of an aquifer water quality standard at the applicable point of compliance for the facility. Where, at the time of issuance of the permit, an aquifer already exceeds an aquifer water quality standard for a pollutant, the permittee shall not discharge that pollutant so as to further degrade, at the applicable point of compliance for the facility, the water quality of any aquifer for that pollutant.

6.7 Technical and Financial Capability [A.R.S. §§ 49-243(K)(8) and 49-243(N) and A.A.C. R18-9-A202(B) and R18-9-A203(E) and (F)]

The permittee shall have and maintain the technical and financial capability necessary to fully carry out the terms and conditions of this permit. Any bond, insurance policy, trust fund, or other financial assurance mechanism provided as a demonstration of financial capability in

the permit application, pursuant to A.A.C. R18-9-A203(D), shall be in effect prior to any discharge authorized by this permit and shall remain in effect for the duration of the permit.

6.8 Reporting of Bankruptcy or Environmental Enforcement [A.A.C. R18-9-A207(C)]

The permittee shall notify the Director within five days after the occurrence of any one of the following:

1. The filing of bankruptcy by the permittee.

2. The entry of any order or judgment not issued by the Director against the permittee for the enforcement of any environmental protection statute or rule.

6.9 Monitoring and Records [A.R.S. § 49-243(K)(8) and A.A.C. R18-9-A206]

The permittee shall conduct any monitoring activity necessary to assure compliance with this permit, with the applicable water quality standards established pursuant to A.R.S. §§ 49-221 and 49-223 and §§ 49-241 through 49-252.

1. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

2. The permittee shall retain records of all monitoring information, including copies of all reports required by this permit and records of all data used to complete the application for this permit, for a period of 10 years from the date of the sample, measurement report, or application. This period may be extended by request of the Director at any time.

3. At a minimum, records of monitoring information shall include:

   a. Date, time, and exact place of sampling or measurements;
   b. Individual(s) who performed the sampling or measurements;
   c. Date(s) analyses were performed;
   d. Individual(s) or laboratory who performed the analyses;
   e. Analytical techniques or methods used;
   f. Results of such analyses;
   g. Chain of custody records;
   h. Names of samples;
   i. Static water level in monitor well prior to sampling;
   j. Sampling method;
   k. Purging volume;
   l. Indicator parameters including field conductance (μmhos/cm), field temperature (°C), and field pH (standard units);
   m. Preservation and transportation procedures;
   n. Name of the analytical facility, and;
   o. Any field notes relating to the information described in (a) – (n) above.

6.10 Other Information [A.R.S. § 49-243(K)(8)]

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, the permittee shall promptly submit the correct facts or information.

6.11 Inspection and Entry [A.R.S. §§ 49-203(B) and 49-243(K)(8)]

The permittee shall allow the Director, or an authorized representative, upon the presentation of credentials and other documents as may be required by law, to enter and inspect the facility

as reasonably necessary to ensure compliance with Title 49, Chapter 2, Article 3 of the Arizona Revised Statutes, and Title 18, Chapter 9, Articles 1 through 4 of the Arizona Administrative Code and the terms and conditions of this permit. In so doing, the Department representative may:

1. Enter upon the operator's premises where a regulated facility or activity is located or conducted, or locations where records must be kept under the conditions of this permit.

2. Have access to and copy, at reasonable times, any records required to be kept under the conditions of this permit.

3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit.

4. Sample or monitor at reasonable times, for the purposes of assuring permit compliance, any substances or parameters at any location.

5. Take photographs or video tape.

6. Take other actions reasonably necessary to determine compliance with Aquifer Protection Permit statutes or rules or the terms and conditions of this permit.

6.12 Duty to Modify [A.R.S. § 49-243(K)(8)]

The permittee shall apply for and receive a written amendment before deviating from any of the designs or operational practices authorized by this permit.

6.13 Permit Action: Amendment, Transfer, Suspension & Revocation [A.R.S. §§ 49-201, 49-241 through 251, A.A.C. R18-9-A211, R18-9-A212 and R18-9-A213]

This permit may be amended, transferred, renewed, or revoked for cause, under the rules of the Department. The filing of a request by the permittee for a permit action does not stay or suspend the effectiveness of any existing permit condition. The Director shall issue a public notice of all proposed permit actions pursuant to A.A.C. R18-9-A211, R18-9-A212 and R18-9-A213.

6.13.1 Permit Reopen

The Director may reopen this permit and amend it pursuant to A.A.C. R18-9-A211.

6.13.2 Permit Transfer

This permit may not be transferred to any other person except after notice to and approval of the transfer by the Department. No transfer will be approved until the applicant complies with all transfer requirements as specified in A.A.C. R18-9-A212(B) and (C).

The permittee shall notify the Water Permits Section in writing within 15 days after any change in the owner or operator of the facility. The notification shall state the permit number, the name of the facility, the date of property transfer, and the name, address, and phone number where the new owner or operator can be reached. The operator shall advise the new owner or operators of the terms of this permit and the need for permit transfer in accordance with the rules.

Appendix B

UNDERGROUND STORAGE PERMIT NO. 71-591932

PERMIT NO. 73-591932 LTSA No. 70-431130

ARIZONA DEPARTMENT OF WATER RESOURCES

WATER STORAGE PERMIT

PERMIT NO. 73-591932

STATE OF ARIZONA)ss.
)
COUNTY OF MARICOPA)

This is to certify that I have determined that Application No. 73-591932 for a Water Storage Permit meets the requirements of Arizona Revised Statutes Title 45, Chapter 3.1, Article 3 for a Water Storage Permit. The Director hereby grants authority to the City of Eloy to store water, subject to the following limitations and conditions:

Permit Limitations

Permittee: City of Eloy
1750 North 11-Mile Corner Road
Eloy, AZ 85231

PERMIT NO. 73-591932 LTSA No. 70-431130

Storage Facility Name:	City of Eloy Reclaimed Water Recovery Facility
Storage Facility Permit Number:	No. 71-591932
Management Area:	Pinal AMA
Sub-basin:	Eloy
Water To Be Stored:	Effluent
Legal Basis for Acquiring Water To Be Stored:	Ownership of the *City of Eloy Wastewater Treatment Plant* and effluent.
Maximum Permitted Storage:	2,240 acre feet per annum
Effective Date:	February 3, 2004
Expiration Date:	Date of Expiration of Underground Storage Facility Permit No. 71-591932

Permit Conditions

1. The quantity of water stored shall be reported to the Records Management Unit, Arizona Department of Water Resources, 500 North 3rd Street, Phoenix, Arizona 85004 in the form of annual data reports. The annual report shall be submitted no later than March 31 following the end of each completed annual reporting period. The first annual reporting period shall be from the date of this permit through December 31, 2003. Subsequent annual reporting periods shall be January 1 through December 31.

2. The Permittee shall continue to meet the requirements of A.R.S. § 45-831.01 during water storage.

3. Recovery of stored water is prohibited unless the Permittee obtains a recovery well permit pursuant to A.R.S. § 45-834.01.

4. The Permittee shall not recover water in excess of the amount allowed by Title 45, Chapter 3.1, Article 4, Arizona Revised Statutes.

5. The Permittee shall report all assignments of long-term storage credits accrued pursuant to this permit to the Arizona Department of Water Resources in accordance with A.R.S. § 45-854.01.

6. Water may be stored pursuant to this permit only at Constructed Underground Storage Facility, Permit No. 71-591932.

7. The Permittee shall comply with the plan of operation associated with Constructed Underground Storage Facility, Permit No. 71-591932.

8. The Director may withhold long-term storage credits under this permit for water stored during any period of time for which the director of environmental quality has issued a final determination of a violation of the water quality limits contained in Aquifer Protection Permit P-101689 if the Director determines, after consultation with the director of environmental quality, that the violation has had or will have a significant adverse effect on aquifer water quality.

Witness my hand and seal of office this 3rd day of February, 2004.

Jim Holway, Assistant Director

PERMIT 71-591932

COPY
5/12/04 M. Ridgell has original.

ARIZONA DEPARTMENT OF WATER RESOURCES

UNDERGROUND STORAGE FACILITY PERMIT

CONSTRUCTED

PERMIT NO. 71-591932

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

This is to certify that Application No. 71-591932 meets the requirements of Arizona Revised Statutes Title 45, Chapter 3.1, Article 2, for a Constructed Underground Storage Facility Permit. The Director hereby grants authority to the City of Eloy to operate a constructed underground storage facility, subject to the following limitations and conditions:

Permit Limitations

Permittee: City of Eloy
1750 N. 11-Mile Road
Eloy, Arizona 85231

PERMIT 71-591932

Active Management Area:	Pinal AMA
Subbasin:	Eloy
Name of Facility:	Eloy Reclaimed Water Recharge Project (ERWRP)
Location of Facility:	SW¼ of NE¼ of Sec. 36, T7S, R7E, GRB&M
Maximum Storage at Facility:	2,240 acre-feet per annum
Source Water to be Stored:	Effluent
Effective Date:	February 3, 2004
Expiration Date:	February 3, 2024

Permit Conditions

1. The facility shall be constructed and operated as specified in the following supporting documents, correspondence and reports (hereinafter referred to as "hydrologic report"), which are incorporated in and made a part of this permit:

   a. Underground Storage Facility (USF) & Water Storage (WS) Permits Applications for the Eloy Reclaimed Water Recharge Project (ERWRP) dated November, 2002.

   b. Response to the Incomplete and Incorrect Determination for City of Eloy Underground Storage Facility Permit Application No. 71-591932 dated June 24, 2003.

   c. Correspondence from Westland Resources, Inc. dated July 25, 2003.

2. The permittee shall provide all monitoring data in the form of quarterly and annual reports as required below:

   a. The permittee shall provide all monitoring data for the first two years after the commencement of recharge activities in the form of **quarterly** reports, which shall be submitted to the Arizona Department of Water Resources (ADWR) within forty-five (45) days of the completed quarterly reporting period. **The permittee shall send two (2) copies of all quarterly data reports to the Groundwater Management Support Section, Arizona Department of Water Resources, 500 North Third Street, Phoenix, Arizona 85004.**

b. Pursuant to A.R.S. § 45-875.01 the permittee shall submit an **annual** data report to the ADWR no later than March 31 following the end of each completed annual reporting period. The first reporting period shall be from the issuance date of this permit through December 31, 2003. Subsequent reporting periods shall be January 1 through December 31. The fourth quarter data report may be combined with the annual data report. **The permittee shall send two (2) copies of all annual data reports to the Records Management Unit, Arizona Department of Water Resources, 500 North Third Street, Phoenix, Arizona 85004.**

3. The **quarterly and annual** reports shall include all monitoring data pursuant to this permit and as described in the permittee's hydrologic report. The reports shall include, at a minimum of, the following:

a. Groundwater Level(s):

The report shall contain the groundwater level data gathered and reported in accordance with **permit condition 4.a.** and **Tables 1 & 2.** The groundwater level data shall be presented using tables and hydrographs and shall indicate at a minimum, the following: unique well identification, ADWR well registration number, cadastral location, measurement date, measuring point description, height of measuring point above (or below) land surface, and the water level measurement in 1) feet above mean sea level and 2) feet below land surface. The report shall note, at the time of measurement, if the pumping of any nearby large production wells could have affected the water level measurement.

b. Water Quantity:

The report shall contain the water quantity data for the recharge facility in accordance with **permit condition 4.b.** and **Tables 3 & 4.** The data shall be presented in monthly summaries indicating, at a minimum, basin identifier, month, beginning and ending daily flowmeter readings totaled for the month in gallons and acre-feet and the daily wet or dry status of each recharge basin.

c. Infiltration Rates:

The report shall contain infiltration rates as described in **permit condition 4.c.** for each recharge basin listed in **Table 3.**

The reports shall describe the method used to calculate the infiltration rates and present the data using tables. The tables shall indicate, at a minimum, recharge basin identifier, the method used, time interval of the wet/dry cycle, the volume discharged in acre-feet, duration of recharge, the maximum wetted area as listed in **Table 3**, and

the infiltration rate in feet per day. If more than one measurement is made during the reporting period, all data, including the average rate, shall be presented.

d. Water Quality (Source Water and Groundwater):

The report shall contain the water quality data required in accordance with **permit condition 5.c.**

e. Alert Level Exceedance(s):

i. The report shall contain a summary of the activities and information described in **permit condition 5.a.** for any groundwater level exceedance of any monitor well or piezometer alert or action level.

ii. The report shall contain a summary of the exceedance of any flowmeter accuracy requirements and/or failures causing the monitoring equipment to be out of compliance with **permit condition 5.b.**

f. Monitoring Change(s):

In the event that any monitoring provisions under this permit are modified, in accordance with **permit condition 7.f.**, the permittee shall submit documentation of the approved change in the monitoring plan in the **quarterly and/or annual report.**

4. Monitoring Requirements:

a. Groundwater Levels:

i. The permittee shall measure water levels, at a minimum, to within an accuracy of one-tenth (0.1) of a foot for the monitor wells and piezometer listed in **Tables 1 & 2.**

ii. Initial static water levels of the monitor wells listed in **Table 1** shall be measured and recorded prior to the commencement of recharge activities.

iii. If the monitor wells listed in **Table 1** are equipped with a pump, initial water levels shall be measured and recorded a minimum of seventy-two (72) hours after the pump has been turned off.

iv. If the water level measured in either of the monitoring wells listed in **Table 1** rises to 50 feet or less below the land surface, the permittee shall install and

monitor the piezometer as listed in **Table 2**. Within 30 days of this groundwater level exceedance, the permittee shall submit to ADWR a timeline and plan detailing the piezometer installation.

b. Water Quantity

i. The permittee shall measure daily inflows to the recharge facility with the measuring device listed in **Table 4**.

ii. The permittee shall determine and record a wet or dry status for each recharge basin listed in **Table 3** on a daily basis.

c. Infiltration Rate:

The permittee shall measure the infiltration rate, in feet per day, for each basin listed in **Table 3**, at a minimum, quarterly.

d. Water Quality

The water quality shall be monitored. This requirement is met by APP number **P-101689**, issued by ADEQ.

5. Alert Levels and Response Requirements:

a. Water Levels

The water level in the monitor wells listed in **Table 1** and/or the piezometer listed in **Table 2** shall not rise within **20** feet of the land surface. If the water level rises to within **20** feet below land surface, the permittee shall notify ADWR within 48 hours of the exceedance and the following actions shall be implemented:

i. Facility operation shall be modified and/or project inflow reduced and daily monitoring implemented or continued to determine if water levels stabilize.

ii. If water levels remain above the alert level for two weeks, recharge activities shall be stopped, pursuant to this permit, until water levels drop below the alert level.

iii. A report shall be submitted to ADWR, within thirty (30) days of the sample date, detailing the exceedance including, at a minimum, the amount, date, duration of the exceedance, an explanation of the method(s) used to correct the exceedance, and a determination of any unreasonable harm caused by the exceedance to the land owners or other water users.

b. Water Quantity

The monitoring equipment listed in **Table 4** shall continue to function and accurately quantify flow and water level conditions pursuant to A.R.S. § 45-872.01.

If the **flow sensor** listed in **Table 4** fails to perform its designated function (A.A.C. R12-15-905 and 906) for more than 72 hours, ADWR shall be notified in writing within seven (7) calendar days. Within thirty (30) days a report shall be submitted that contains, at a minimum, the monitoring point, the date of the malfunction, the amount of time the device failed to properly operate, an estimate of the amount of flow, an explanation of the method(s) used to calculate the estimated amount of flow, and a plan to correct the malfunction.

c. Water Quality

The facility operator shall notify ADWR of any suspension, revocation or termination of Aquifer Protection Permit number **P-101689** within ten (10) days of the suspension, revocation or termination. The notification shall include a written description of the reason for the suspension, revocation or termination and a copy of any written action by the Arizona Department of Environmental Quality (ADEQ) suspending, revoking or terminating the APP. Permittees shall not store water pursuant to this permit during any period in which the APP is suspended, and this permit shall terminate if the APP is revoked or terminated.

6. Operational Provisions:

a. **Evaporation Calculation Method:**

Evaporation from the basins listed in **Table 3** shall be estimated on a monthly basis and reported in the quarterly and annual data reports using the methods specified in Evaporation from Open Water Surfaces in Arizona, by Keith R. Cooley (1970) using the maximum evaporation rating curve. When calculating evaporative losses, the permittee shall use the basin acreages listed in **Table 3** for basins assigned a wet status per **permit condition 4.b.ii**.

b. Wellhead Elevations:

A surveyed wellhead elevation for the wells listed in **Table 1** shall be submitted and entered into this permit before commencing recharge activities. When the piezometer listed in **Table 2** is installed pursuant to **permit condition 4.a.iv.**, a surveyed wellhead elevation for that piezometer shall be submitted and entered into this permit upon construction completion.

PERMIT 71-591932

7. General Provisions:

a. Water entering the facility shall be measured in a manner consistent with the requirements and specifications for water measuring devices adopted pursuant to A.R.S. § 45-872.01.

b. In accordance with A.R.S. § 45-814.01(G), the Director may modify the conditions of this permit.

c. The facility shall continue to meet the requirements of A.R.S. § 45-811.01 during operation of the facility.

d. No waters other than those waters specified under the permit limitations are authorized for recharge at this facility.

e. The issuance of this permit does not waive compliance with any federal, state, county or local government statutes, rules or permits.

f. Any changes or modifications to the design, operation, and/or monitoring of the facility shall be submitted to the ADWR for approval prior to implementation.

g. The facility shall be operated only in conjunction with the applicable Water Storage Permit(s) and subject to the conditions set forth within that permit(s).

h. The permittee shall contact ADWR thirty (30) days prior to the commencement of recharge to arrange a pre-recharge inspection of the site.

i. The Director may terminate this permit if the permittee does not substantially complete construction of the facility within five years after the effective date of the permit.

j. For all reporting and general recharge and permit questions, please contact the Recharge Coordinator at the Arizona Department of Water Resources.

Witness my hand and seal of office this 3rd day of February, 2004.

Jim Holway, Assistant Director

PERMIT 71-591932

Table 1
Water Level Monitoring*
(Monitor Wells)

Monitor Point	ADWR Registration Number	Location	Well Elevation (ft msl)	Well Depth (feet bls)	Screened Interval (feet bls)	Measuring Device	Monitoring Frequency[1] 1st 2 years	Monitoring Frequency[1] next 18 years	Reporting Frequency 1st 2 years	Reporting Frequency next 18 years	Alert Water Level (feet bls)
MW1	55-573280	D(7-7) 36acb	*	263	203-243	sounder	weekly	monthly	quarterly	annually	20
MW2	55-589858	D(7-7)36dbb	*	243	200-243	sounder	weekly	monthly	quarterly	annually	20

* The permittee shall submit to ADWR the wellhead elevation data before the commencement of recharge activities. The information will be inserted into this table at that time.

[1] The data shall be compiled by month and reported to ADWR as specified in this table.

Table 2
Water Level Monitoring*
(Piezometers)

Monitor Point	ADWR Registration Number	Location[2]	Well Elevation (ft msl)	Well[2] Depth (feet bls)	Screened[2] Interval (feet bls)	Measurement Device	Monitoring Frequency	Reporting Frequency[1]	Alert Water Level (feet bls)
*	55- *	*	*	30	20-30	sounder	weekly/monthly	quarterly/annual	20

* The permittee shall submit to ADWR the ADWR Well Registration Number and other pertinent data, when this piezometer is installed per permit condition 4.a.iv. The information will be inserted into this table at that time.

1 The data shall be compiled by month and reported to ADWR as specified in this table.

2 The piezometer will be located and constructed in accordance with the information provided in the **Correspondence from Westland Resources, Inc.** dated **July 25, 2003.**

Table 3
Basin Description

Basin Identifier	Location T7S, R7E, Sec 36[1]	Maximum Wetted Area (Acres)
5A	ACB	1.29
5B	ACB	1.29
5C	ACC	1.29
5D	ACC	1.29
6A	ABC	1.29
6B	ABC	1.29
6C	ABC/ACD	1.29
6D	ABC/ACD	1.29
7A	ABD	1.31
7B	ABD/ABC	1.27
7C	ABD/ABC/ACB/ACA	1.27
7D	ABD/ACA	1.30
TOTAL		15.47 Acres

1 See Exhibit 4 in the Response to the Incomplete and Incorrect Determination for City of Eloy Underground Storage Facility Permit Application for No. 71-591932 dated June 24, 2003.

PERMIT 71-591932

Table 4
Facility Monitoring

Monitor Point	Measuring Device	Parameter	Location	Monitoring Frequency[1]	Reporting Frequency 1st 2 years	Reporting Frequency next 18 years
FS 2	Paddlewheel flow sensor	Plant effluent flow	See Exhibit 4[2]	daily	quarterly	annual

1 The data shall be compiled by month and reported to ADWR as specified in this table.

2 Exhibit 4 is in **Response to the Incomplete and Incorrect Determination for City of Eloy Underground Storage Facility Permit Application for No. 71-591932** dated **June 24, 2003**.

Appendix B

TECHNICAL MEMORANDUM NO. 2 PHASED REGIONAL WASTEWATER RECLAMATION FACILITIES REVIEW AND APPROVAL PROCESS, SEPTEMBER 2006

City of Eloy

TECHNICAL MEMORANDUM NO. 2
PHASED REGIONAL WASTEWATER RECLAMATION FACILITIES REVIEW AND APPROVAL PROCESS

September 2006

3033 NORTH 44TH STREET, SUITE 101 • PHOENIX, ARIZONA 85018 • (602) 263-9500 • FAX (602) 265-1422

City of Eloy

TECHNICAL MEMORANDUM
NO. 2

PHASED REGIONAL WASTEWATER RECLAMATION FACILITY
REVIEW AND APPROVAL PROCESS

TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION 2-1
  1.1 Wastewater Master Plan and 208 Plan Amendment 2-2
  1.2 Phased Regional WRF Review Process Concept 2-2
2.0 PHASED REGIONAL WRF ASSUMPTIONS 2-3
3.0 CITY OF ELOY BOUNDARIES 2-4
4.0 COUNTY APPROVAL PROCESS 2-4
5.0 PROPOSED PHASED REGIONAL WRF REVIEW AND APPROVAL PROCESS 2-6

Appendix A Phased Regional WRF – Data Sheet
Appendix B Phased Regional WRF – City Internal Review Form
Appendix C Phased Regional WRF – Engineering Report Requirements

LIST OF FIGURES

Figure 2.1 Wastewater Service Areas and Proposed Regional WRF Locations 2-5

PHASED REGIONAL WRF REVIEW AND APPROVAL PROCESS

1.0 INTRODUCTION

The City of Eloy is expecting rapid growth within the next twenty years. To identify the wastewater system required to handle this growth, the City is updating its wastewater master plan. This plan will identify the future areas to be served, the location and size of major collection system trunk lines, and the location and size of future wastewater reclamation facilities (WRF).

Although this wastewater master plan update is intended to be completed by the end of the summer of 2006, it will take many years for the actual facilities to be constructed. However, development does not generally follow a logical path and wait for facilities to be in place. Instead, developers tend to build where land is the most economical, and this means that many new developments could be constructed in areas without existing wastewater infrastructure. These developments must have wastewater service including collection, treatment, and effluent disposal/reuse. One way for the development to obtain wastewater service is for the development to construct the collection system and the initial phase(s) of the Regional WRFs.

The City supports this concept, but historically, small wastewater systems have caused problems because of poor design, poor construction, or lack of effective long-term operation and maintenance. In addition, all wastewater treatment plants greater than 24,000 gallons per day (gpd) capacity are currently required to go through a Central Arizona Association of Governments (CAAG) 208 Area Wide Water Quality Management Plan amendment (208 Plan), which can take up to 12 months to finalize. Pinal County also has a policy of not approving a land use permit for any wastewater plant under 1.0 million gallons per day (mgd) capacity. In addition, as a private utility system, the developer must also obtain a Certificate of Convenience and Necessity (CC&N) from the Arizona Corporation Commission.

The proposed Phased Regional WRF sites, as identified in the Wastewater Master Plan, all lie within the City's existing Designated Management Area (DMA). Therefore, the City has authority to approve or disapprove any new WRF within its DMA, per the 208 Plan Amendment process. To minimize the problems associated with the development of small WRFs and to assist developers through the process, the City has developed a Regional WRF and Approval Process.

1.1 Wastewater Master Plan and 208 Plan Amendment

The master plan includes two goals relative to the planning and 208 permitting of the Regional WRFs:

1. Define potential locations and ultimate capacities of the future Regional WRFs for incorporation into the 208 Plan.
2. Develop a Phased Regional WRF Review Process.

This master plan will be used to update the 208 Plan. The 208 Plan Amendment process, through CAAG and ADEQ, commenced in July 2006 with completion likely in the first or second quarter of 2007. It is a goal to incorporate all of the proposed Regional WRFs into this 208 Plan Amendment process. It is possible that a development schedule identifies the need to pursue an individual Regional WRF 208 Plan Amendment. In this event, the developer(s) and the City could consider an individual developer-driven 208 Plan Amendment for the specific Regional WRF. However, it is very likely that individual 208 Plan Amendments will not be pursued due to the timing and benefits of combining all the Regional WRFs into one 208 Plan Amendment.

The City is currently pursuing annexation of land outside its existing DMA, which would be served by the nearest Regional WRF once the areas are developed. It is anticipated that a 208 Plan Amendment(s) will be pursued to include these future annexation areas, however these areas will not be included in the 2006 208 Plan Amendment process, but rather the amendment(s) will be pursued after the annexation within these areas is finalized.

1.2 Phased Regional WRF Review Process Concept

The Phased Regional WRF Review Process will allow the City the maximum level of control in the planning and construction of the WRFs including:

- Location
- Size
- Process selection
- Design criteria
- Operation and maintenance (O&M) requirements
- Solids handling
- Effluent disposal/reuse
- Planning for the future integration into the City system and community
- Planning for future Regional WRF expansions

Within this Review Process, the City is developing two major elements:

1. **Phased Regional WRF Review and Approval Process:** This details the steps the City and Developer must use to obtain the appropriate City, County (if necessary), and CAAG (if necessary) approval.
2. **Phased Regional WRF Design and Construction Guidelines:** This identifies the guidelines and criteria for the selection of the WRF process, manufacturers, construction quality, and criteria to allow for future expansions at these sites.

This document describes the Phased Regional WRF Review and Approval Process. A separate document has been prepared for the Phased Regional WRF Design and Construction Guidelines.

2.0 PHASED REGIONAL WRF ASSUMPTIONS

The Phased Regional WRF shall be defined as a wastewater reclamation facility that will be expanded over several phases as the developments within its wastewater service area are constructed. The initial phase will be constructed by the developer(s) within the wastewater service area, in order to expedite the construction of these facilities, to provide timely wastewater service to these developments, and to promote growth outside the existing City wastewater collection system. The Regional WRFs will be planned with the goal of beneficial reuse of reclaimed water. As such, the WRFs will likely be located near reclamation opportunities and will (in contrast to typical wastewater treatment plants) <u>not</u> necessarily be located at the geographic low point of the wastewater service area. The initial phase of each Regional WRF might not include features of the Ultimate Regional WRF. The initial phase is assumed to be constructed as a relatively small wastewater facility, likely with a rated capacity under 1 or 2 mgd. However, larger initial facilities can be pursued on a case-by-case basis if warranted by the development.

The development of the proposed Phased Regional WRF Review and Approval Process requires some initial assumptions regarding the WRFs, including the following:

1. Regional WRFs will only be considered within the service areas established by the City.
2. Each Regional WRF will be constructed by the developer as the initial phase of the permanent Regional WRF.
3. Each Regional WRF will be constructed at a location advantageous to water reclamation.
4. Adequate space will be provided to accommodate future expansion of each Regional WRF to serve its designated region. The initial phase shall be planned to accommodate future expansions to build-out at the designated site.
5. The initial phase of each Regional WRF must have the capability to meet all required effluent water quality standards as stated in the Arizona Administrative Code (A.A.C.).

In addition, each WRF will not discharge to any waters of the U.S. (thereby requiring an NPDES permit).

6. Once built, each Regional WRF will be owned and operated by the City.

3.0 CITY OF ELOY BOUNDARIES

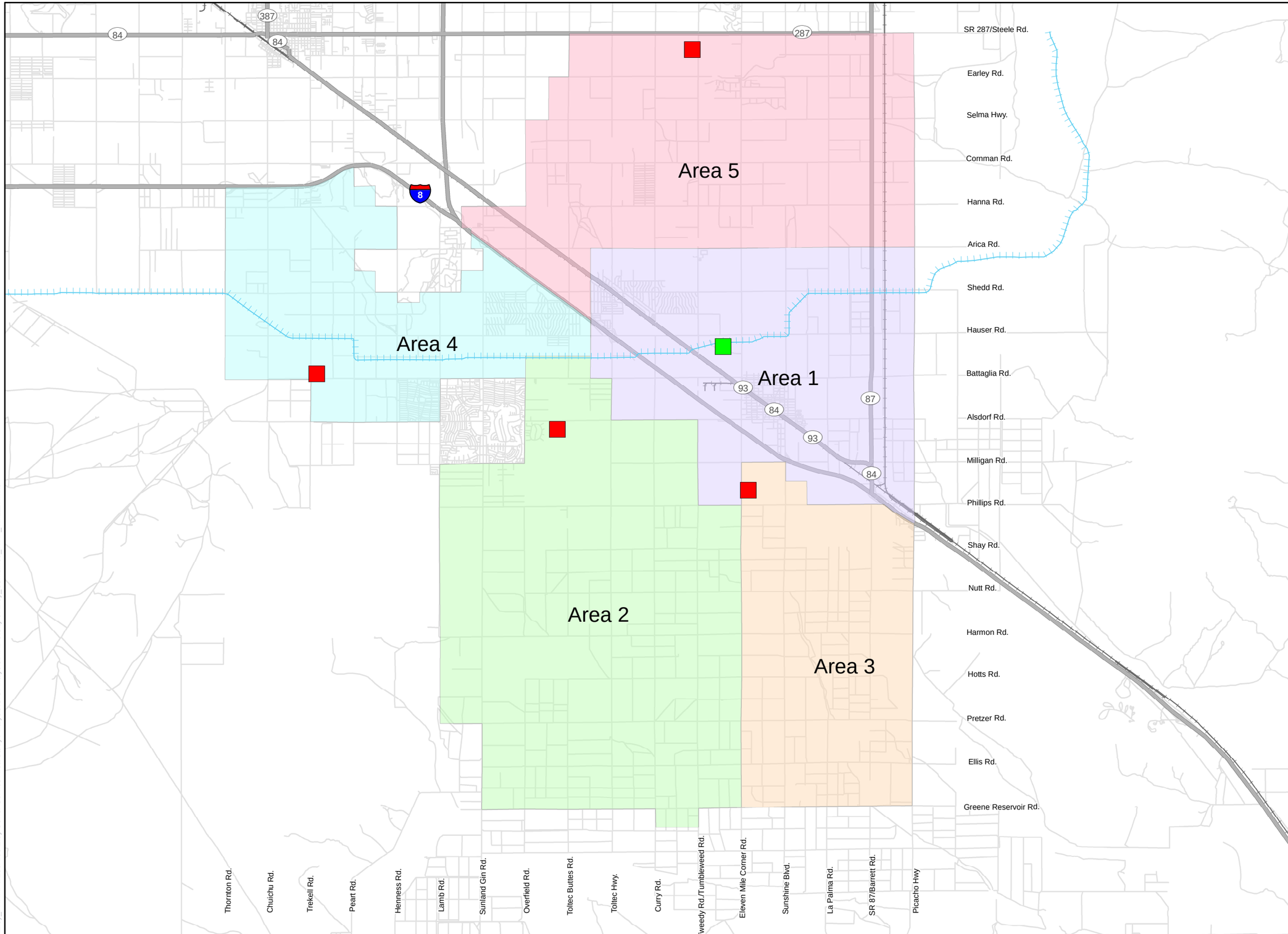
Figure 2.1 shows the existing wastewater planning and service area for the City. Also shown is the DMA boundary, proposed planning, and future service areas of the City, along with the proposed locations for the future Regional WRFs. The Phased Regional WRF Review and Approval Process would be initiated for each of the Regional WRF shown in Figure 2.1.

4.0 COUNTY APPROVAL PROCESS

Currently, the City has no formal wastewater facility review and approval process for any area inside or outside of its current DMA boundaries. A Developer wishing to construct a wastewater treatment system outside the City DMA must go through the County review and approval system. For comparison purposes, the general steps a Developer would have to go through (if the proposed plant was greater than 24,000 gpd) includes the following just to meet 208 Plan Amendment requirements:

1. Developer meets with County to identify project.
2. Obtain land use permit from County Board of Supervisors (Note: the County has a policy of not approving treatment facilities less than 1.0 mgd, and to obtain a land use permit for a treatment facility less than 1.0 mgd could require an extensive effort).
3. Developer submits Draft 208 Amendment Report to County.
4. County reviews Draft 208 Amendment Report.
5. If the proposed plan concept fits into the County's overall plan, the County will send a letter and a proposal summary to CAAG (with copy to the developer), stating that the treatment facility is compatible with the 208 Plan.
6. CAAG reviews submittal to verify compliance with the 208 Plan and that the Regional impacts have been addressed. If the treatment facility is compatible, CAAG will submit the proposal to the CAAG committees and the Regional Council.
7. 208 Amendment approved by CAAG Sub Committees, Regional Council and State Water Quality Working Group.
8. Based on the Regional Council actions, CAAG informs the Arizona Department of Environmental Quality (ADEQ) that the treatment facility is compatible with the 208 Plan.

EPA reviews Amendment and if acceptable, the Governor signs the Amendment.



N

Legend

- Existing WRF
- Proposed WRF
- Area 1
- Area 2
- Area 3
- Area 4
- Area 5
- Streets
- Streets
- Railroad
- Canal

Notes:

1. The Transportation layers are GIS data from ESRI Data & Maps (2004).

2. The planning boundary and developments are based on information obtained from the City of Eloy.

3. This GIS map is a limited representation of facilities, intended for planning purposes only. It is not intended for construction or other purposes requiring greater positional accuracy.

4. The Sewer Service Areas and WRF locations provided are preliminary and are based upon the Planning Area as defined for this Study.

0 0.5 1 2 Miles

City of Eloy, Arizona - Sewer Service Area Study, Technical Memorandum No. 2

carollo engineers

M:\Client\Eloy_PHX\MP\7266A.00 Eloy Sewer Service Area Study\Analysis\GIS Analysis\MXDs\City of Eloy_Combined_WRF_TM1117.mxd

Sewer Service Areas and Proposed Regional WRF Locations

Figure 2.1

Items 1 through 9 can take up to 24 months or more to complete depending on the problems in obtaining the land use permit. In addition, any new treatment facility near the City's existing DMA and planning area is subject to City comments or objections through the 208 Plan Amendment process.

The City's Regional WRF approach will shorten this timeline since the City initiated 208 Plan Amendment includes all of the future Regional WRF, thereby eliminating the steps outlined above. Developments seeking to construct wastewater facilities within the City's existing DMA are discussed in the following section, which details steps in the City's proposed Review and Approval Process.

5.0 PROPOSED PHASED REGIONAL WRF REVIEW AND APPROVAL PROCESS

This section describes the proposed process for the City to review and approve the initial phase of the Regional WRF being proposed by developers within the City's DMA.

The process for review and approval of the initial phase of the Regional WRF is as follows:

1. Developer meets with City to discuss the project and City requirements.
2. Developer submits phased Regional WRF Data Sheet to City (see Appendix A).
3. City reviews phased Regional WRF Data sheet, and approves or disapproves initial phase request based on the review criteria contained in Appendix B.
4. City sends a concept approval letter to developer.
5. If City approves the initial phased Regional WRF concept, the Developer will submit a phased Regional WRF Engineering Report to City.
6. City reviews Engineering Report.
7. Upon acceptance of the Engineering Report, the developer can proceed in obtaining the necessary Approval to Construct and APP permits from ADEQ. The developer shall provide copies of the ADEQ permitting submittals to the City.
8. Developer submits intermediate (approximately 60-percent completion stage) design drawings and specifications for City review and comment.
9. Upon City approval of the intermediate design submittal, the developer submits Final (100-percent completion stage) design drawings and specifications for final City comment and approval.
10. Upon acceptance of the Final design drawings and specifications the City will issue a Regional WRF Construction Permit.

The Engineering Report and design submittals must all conform to Appendix C and the Phase Regional Design and Construction Guidelines.

Since the City will own and operate each Regional WRF once construction is complete, the Developer will not be required to go through the effort to obtain the CC&N for the system, since it will never operate as a privately owned system.

Should the Developer not be able to work out the details of its proposed initial phase of the Regional WRF with the City, it would not be able to proceed. The City would not approve the Final plans and specifications without a letter of compliance from ADEQ. ADEQ will not give a letter of compliance without letters of concept approval and support from the City.

This approach is in line with the overall approach of the Certified Areawide Water Quality Management Plan (A.A.C. R18-9-5-301), which is commonly termed the 208 Plan, since it promotes wastewater treatment on a Regional basis and it is intended that all developments within the City Planning Area will be served by a future Regional WRF.

.

Appendix A

PHASED REGIONAL WRF DATA SHEET

CITY OF ELOY
PHASED REGIONAL
WASTEWATER RECLAMATION FACILITY
DATA SHEET
City of Eloy 628 N. Main St., Eloy, AZ 85231
Tel. No. (520) 466-9201, Fax (520) 466-3161

1. PROJECT/DEVELOPMENT DESCRIPTION

Project Name _____

Street Address _____

Legal Description (Section, Township & Range) _____

Land Area (Acres) _____

Brief Description of Project (Type of development, number of homes, density of homes, etc.)

_____

_____

_____

_____

Project Schedule (Start construction, homes in first year, homes in next 4 years)

_____

_____

Please attach figures of the proposed developments

2. APPLICANT INFORMATION

Name _____

Mailing Address _____

Phone _____ Fax _____

Status (Owner, Agent, Engineer, etc.) _____

3. OWNER INFORMATION (If different from above)

Name _____

Mailing Address _____

Phone _____ Fax _____

4. PROJECTED WASTEWATER FLOW

Estimated Flow per Dwelling Unit (gallons per day) _____

Future Flows (gallons per day) _____

_____

Proposed Maximum Capacity of Plant _____

5. PARTNERSHIPS (if any other Owner/developments to be included in initial phase of Regional WRF)

Name _____

Mailing Address _____

Phone _____ Fax _____

If needed attach a second page with information on the partners for this project.

6. PROPOSED WRF SITE DESCRIPTION

Street Address (or boundary roads) _____

Legal Description (Section, Township & Range) _____

Land Area (Acres) Min/Max available_____

Brief Description of Site and any Potential Issues with Site

_____

_____

_____

7. EFFLUENT REUSE/SOLIDS DISPOSAL

Planned Reuses _____

Emergency Discharge _____

Solids Disposal _____

Other opportunities for Water Reuse _____

8. CAPITAL FUNDING

Estimated Capital Cost _____

Estimated Operation & Maintenance Cost per Year _____

Appendix B

PHASED REGIONAL WRF APPLICATION CITY INTERNAL REVIEW FORM

CITY OF ELOY
PHASED REGIONAL
WASTEWATER RECLAMATION FACILITY
CITY INTERNAL REVIEW FORM
City of Eloy 628 N. Main St., Eloy, AZ 85231
Tel. No. (520) 466-9201, Fax (520) 466-3161

1. WASTEWATER SERVICE AREA

Wastewater Service Area to be Served _____

Location of Nearest Sewer Line _____

Distance to Nearest Sewer Line _____

Location of Proposed Sewer Line _____

Schedule for Proposed Sewer Line _____

Distance to Nearest Planned or Existing Treatment Facility _____

2. POTENTIAL WRF BENEFITS

Potential Benefits Could Include: Delays or promotes interceptor construction, allows additional development in area, designated by City as a site for future Regional plant, provides water source, etc.)

_____

_____

_____

_____

3. POTENTIAL WRF PROBLEMS

Potential Problems Could Include: Location and size not as defined in Master Plan, other non-conformance issues with Master Plan, excess effluent for proposed reuses, no solids disposal plan, site proposed is too small, permitting, other issues with location, etc.

_____

_____

_____

4. POTENTIAL FOR COMBINING WITH OTHER DEVELOPMENTS

Nearest Proposed Development _____

_____

Nearest Proposed Common Sewer Line _____

_____

Other Developments that this Initial Phase WRF Could Serve _____

_____

Potential for Additional Funding Partners (see other developments above) _____

_____

5. FINANCIAL

Estimated Capital Cost _____

Estimated O&M Cost _____

6. Other Comments

_____

_____

_____

_____

_____

_____

Appendix C

PHASED REGIONAL WRF ENGINEERING REPORT REQUIREMENTS

CITY OF ELOY
PHASED REGIONAL
WASTEWATER RECLAMATION FACILITY
ENGINEERING REPORT REQUIREMENTS
City of Eloy 628 N. Main St., Eloy, AZ 85231
Tel. No. (520) 466-9201, Fax (520) 466-3161

INSTRUCTIONS

After the initial Data Sheet has been approved by the City for the Regional WRF, the applicant will submit an engineering report describing the following details about the proposed development and the initial phase of the Regional WRF. The Engineering Report shall be sealed and signed by an Arizona licensed professional engineer. **The Engineering Report must also correspond to the requirements set forth under the Phase Regional WRF Design and Construction Guidelines.**

1. DEVELOPMENT DESCRIPTION

   This description will cover the following items:

   - General location map showing development location within the City, development boundaries, water courses, nearest City sewer lines, scale and north arrow
   - Development description including type of development, residential, mixed use, commercial, etc.
   - Proposed size of development
   - Proposed schedule for construction

2. PROJECTED FLOW

   - Land use densities
   - Unit flows per dwelling unit
   - Peaking factors
   - Phasing of projected flows by year
   - Projected influent quality and loadings - BOD, SS, NH3

3. WRF LOCATION

   Regional WRF location map showing:

   - Plant location
   - Floodplain
   - Washes
   - Surrounding land use
   - Water wells within 1/2 mile
   - Initial and maximum area available for the Regional WRF
   - Setbacks

4. EFFLUENT QUALITY

Identify effluent disposal methods, locations for disposal, and associated quality requirements.

Proposed effluent quality: A+, A, B+, B, etc.

5. PROCESS SELECTION

This section identifies which treatment processes were evaluated and which process was selected for the initial phase of the Regional WRF.

- Describe treatment options identified and evaluated
- Describe evaluation process
- Describe the selected system
- Describe conformance to BADCT standards

6. PRELIMINARY PLANT DESIGN

Describe the WRF unit operations, configuration, flow diagram, storage areas, discharge locations, etc. The following shall be addressed:

- Treatment units
- Unit sizes
- Plant layout
- Disinfection (dechlorination if chlorine disinfection)
- Odor control
- Process control
- Emergency power
- Expansion options
- Solids handling
- Solids disposal
- Effluent disposal/reclamation
- Geotechnical Report including soils investigation
- Figures showing the schematic diagram, preliminary hydraulics, and facility layout, are required

7. Operation

- Describe normal operation of facility
- Provide operation and maintenance plan for WRF
- Contingency and emergency operation plan
- System start-up plan

8. COST ESTIMATE

- Capital costs
- O&M costs

9. Permitting and Approval

This identifies the additional permitting and approvals required for the WRF:

- APP
- County
- Other

10. PROJECT SCHEDULE

Identify the total plant schedule including:

- Start construction
- Start-up
- On-line

11. EXPANSION PLANNING

Suitability of the proposed site for the Buildout Regional WRF shall be addressed including:

- Layout Figure of Buildout Regional WRF on the proposed site, include setbacks
- Basis for layout of Buildout Regional WRF
- Processes requiring odor control due to setbacks and buildout layout
- Features of initial WRF that can be used for Buildout Regional WRF
- Buildout effluent disposal methods (if effluent disposal cannot be met by onsite recharge only, discuss feasible alternatives and quantify offsite effluent disposal)

Appendix C

TECHNICAL MEMORANDUM NO. 3
PHASED REGIONAL WATER RECLAMATION FACILITY DESIGN AND CONSTRUCTION GUIDELINES, SEPTEMBER 2006

City of Eloy

TECHNICAL MEMORANDUM NO. 3
PHASED REGIONAL
WATER RECLAMATION FACILITY
DESIGN AND
CONSTRUCTION GUIDELINES

September 2006

3033 NORTH 44TH STREET, SUITE 101 • PHOENIX, ARIZONA 85018 • (602) 263-9500 • FAX (602) 265-1422

City of Eloy

TECHNICAL MEMORANDUM
NO. 3

PHASED REGIONAL WATER RECLAMATION FACILITY
DESIGN AND CONSTRUCTION GUIDELINES

TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION 3-1
1.1 Wastewater Master Plan and 208 Plan Amendment 3-2
1.2 Phased Regional WRF Review Process Concept 3-2
2.0 PHASED REGIONAL WRF ASSUMPTIONS 3-3
3.0 GENERAL REGIONAL WRF DESIGN AND CONSTRUCTION GUIDELINES 3-4
3.1 Initial Project Phasing 3-4
3.2 Effluent Disposal 3-4
3.3 Effluent Quality 3-7
3.4 Design Peaking Factors 3-9
3.5 WRF Site Requirements 3-9
3.5.1 Site Access and Security 3-11
3.5.2 Aesthetics 3-12
3.5.3 Location of Facilities Relative to Future Connections 3-12
3.5.4 WRF Redundancy and Contingency Options 3-12
3.5.5 Flood Control 3-13
3.5.6 Storm Water Management 3-13
3.6 Acceptable Treatment Processes and Equipment 3-13
3.6.1 Influent Pumping 3-15
3.6.2 Screening Facilities 3-15
3.6.3 Biological Secondary Treatment 3-15
3.6.4 Secondary Clarification 3-17
3.6.5 Tertiary Filtration 3-19
3.6.6 Disinfection 3-19
3.6.7 Effluent Pumping 3-20
3.6.8 Reclaimed Water Storage 3-20
3.6.9 Reclaimed Water Disposal 3-20
3.6.10 Solids Processing and Disposal 3-21
3.7 Odor Control 3-21
3.8 Noise Control 3-22
3.9 Utility and Standby Power 3-22
3.10 Instrumentation, Controls and Alarm Telemetry 3-23
3.11 Utilities, Process Piping and Yard Piping 3-25
3.12 Valves 3-26
3.13 Applicable Codes and Standards 3-26
3.14 Construction Requirements 3-26
3.14.1 Project Contractor 3-27
3.14.2 Acceptable Manufacturer Requirements 3-27
3.14.3 Local Facilities and Support 3-27
3.14.4 Equipment Installation Oversight 3-27

3.14.5 Training 3-27
3.15 Submittal Requirements 3-27
3.16 Operations and Maintenance Manual 3-28
3.17 Spare Parts 3-28
3.18 Applicable Permits 3-28
3.19 Insurance Requirements 3-29
3.20 Warranties and Guarantees 3-29
3.21 WRF Acceptance by City 3-30
3.21.1 Completion of Construction 3-30
3.21.2 Equipment Performance Test 3-30
3.21.3 Facility Performance Test 3-30
3.21.4 Resolution of All Disputes, Claims and Legal Actions 3-30
3.21.5 Transfer of Documents 3-30

4.0 RECLAIMED WATER SYSTEM 3-31
4.1 Supply, Storage and Pumping 3-31
4.2 Transmission and Distribution 3-31
4.3 Criteria Summary 3-32
4.4 Construction Requirements 3-32

5.0 WASTEWATER COLLECTION SYSTEM 3-32
5.1 Pipe Capacities 3-33
5.2 Flow Depth (d/D) 3-33
5.3 Changes in Pipe Size 3-34
5.4 Lift Stations 3-34
5.4.1 Lift Station Approval Process 3-35
5.4.2 Temporary and/or "Packaged" Lift Stations 3-35
5.4.3 Normal Operation 3-36
5.4.4 Emergency Operation 3-36
5.4.5 Lift Station Design References 3-37
5.5 Force Mains 3-37
5.6 Gravity Sewer Planning Guidelines 3-37
5.7 Criteria Summary 3-38

Appendix A Sewage Collection System Requirements (A.A.C. R18-9-E301)

LIST OF TABLES

Table 3.1 Minimum Reclaimed Water Requirements for Direct Reuse 3-6
Table 3.2 BADCT Effluent Requirements 3-7
Table 3.3 Reclaimed Water Quality Standards..... 3-8
Table 3.4 Recommended Effluent Design Criteria 3-8
Table 3.5 Acceptable Design Peaking Factors..... 3-9
Table 3.6 Regional WRFs - Projected Land Requirements..... 3-10
Table 3.7 Facility Setback Requirements 3-11
Table 3.8 Typical Design Parameters for Biological Treatment Processes..... 3-17
Table 3.9 Typical Design Parameters for Secondary Clarifiers 3-18
Table 3.10 Parameters Measured and Suggested Instruments 3-24
Table 3.11 Permits Required for Regional WRF 3-29
Table 3.12 Reclaimed Water System Criteria Summary 3-32
Table 3.13 Recommended Minimum Slopes for Circular Pipes 3-34
Table 3.14 Wastewater System Criteria Summary..... 3-38

LIST OF FIGURES

Figure 3.1 Sewer Service Areas and Proposed Regional WRF Locations 3-5
Figure 3.2 Initial Phase - Regional WRF Process Schematic..... 3-14

PHASED REGIONAL WRF DESIGN AND CONSTRUCTION GUIDELINES

1.0 INTRODUCTION

The City of Eloy is expecting rapid growth within the next twenty years. To identify the wastewater system required to handle this growth, the City is updating its wastewater/ sewer master plan. This plan will identify the future areas to be served, the location and size of major collection system trunk lines, and the location and size of future water reclamation facilities (WRFs).

Although this wastewater master plan update is intended to be completed during the summer of 2006, it will take many years for the actual facilities to be constructed. However, development generally does not follow a logical timeline and wait for facilities to be in place. Instead, developers tend to build where land is the most economical, and this means that many new developments could be constructed in areas without existing wastewater infrastructure. These developments must eventually have wastewater service including collection, treatment, and effluent disposal/reuse. One way for the development to obtain wastewater service is for the development to construct the collection system and the initial phase(s) of the Regional WRFs, through developer agreements with the City.

The City supports this concept, but historically, small wastewater systems have caused problems because of poor design, poor construction, or lack of effective long-term operation and maintenance. In addition, all wastewater treatment plants greater than 24,000 gallons per day (gpd) capacity are currently required to go through a Central Arizona Association of Governments (CAAG) 208 Area Wide Water Quality Management Plan (208 Plan) amendment, which can take more than 12 months to finalize. Pinal County also has a policy of not approving a land use permit for any wastewater treatment plant under 1.0 million gallons per day (mgd) capacity. In addition, the developer must also obtain a Certificate of Convenience and Necessity (CC&N) from the Arizona Corporation Commission, if they intend to operate the facility as an independent utility system (e.g. non-City operated facility).

The proposed Phased Regional WRF sites, as identified in the Wastewater Master Plan, all lie within the City's existing Designated Management Area (DMA). Therefore, the City has authority to approve or disapprove any new WRF within its DMA, per the 208 Plan Amendment process. To minimize the problems associated with the development of small WRFs and to assist developers through the process, the City has developed a Regional WRF and Approval Process.

1.1 Wastewater Master Plan and 208 Plan Amendment

The master plan includes two goals relative to the planning and 208 permitting of the Regional WRFs:

1. Define potential locations and ultimate capacities of the future Regional WRFs for incorporation into the 208 Plan
2. Develop a Phased Regional WRF Review and Approval Process

The 208 Plan Amendment process, as defined by the current wastewater master planning efforts and permitted through CAAG and ADEQ, commenced in July 2006 with completion likely in the first or second quarter of 2007. The goal was to incorporate all of the proposed Regional WRFs into this 208 Plan Amendment process. It is possible that a specific development schedule may dictate the need to pursue an individual Regional WRF 208 Plan Amendment, prior to the completion of the City's overall 208 Plan Amendment. In this event, the developer(s) and the City could consider an individual developer-driven 208 Plan Amendment for the specific Regional WRF. However, it is very likely that individual 208 Plan Amendments will not be pursued due to the timing and benefits of combining all the Regional WRFs into one 208 Plan Amendment.

The City is currently pursuing annexation of land outside its existing DMA, which would be served by the nearest Regional WRF once the areas are developed. It is anticipated that 208 Plan Amendment(s) will be pursued to include these future annexation areas; however, these areas will not be included in the current (2006) 208 Plan Amendment process, but rather this process will be pursued after the annexation within these areas is finalized.

1.2 Phased Regional WRF Review Process Concept

The Phased Regional WRF Review Process will allow the City the maximum level of control in the planning and construction of the WRFs including:

- Location
- Size
- Process selection
- Design criteria
- Operation and maintenance (O&M) requirements
- Solids handling
- Effluent disposal/reuse
- Planning for the future integration into the City system and community
- Planning for future Regional WRF expansions

Within this Review Process, the City is developing two major elements:

1. **Phased Regional WRF Review and Approval Process:** This details the steps the City and Developer must follow to obtain the appropriate City, County (if necessary), and CAAG (if necessary) approval.
2. **Phased Regional WRF Design and Construction Guidelines:** This identifies the guidelines and criteria for the selection of the WRF process, manufacturers, construction quality, and criteria to allow for future expansions at these sites.

This document describes the Phased Regional WRF Design and Construction Guidelines. A separate document has been prepared for the Phased Regional WRF Review and Approval Process. Both of these documents are to be used in the proposed review and approval process.

2.0 PHASED REGIONAL WRF ASSUMPTIONS

The Phased Regional WRF shall be defined as a water reclamation facility that will be expanded over several phases as the developments within its wastewater service area are constructed. The initial phase will be constructed by the developer(s) within the wastewater service area, in order to expedite the construction of these facilities, to provide timely wastewater service to these developments, and to promote growth outside the existing City sewer collection system. The Regional WRFs will be planned with the goal of beneficial reuse of reclaimed water. As such, the WRFs will likely be located near reclamation opportunities and will (in contrast to typical wastewater treatment plants) <u>not</u> necessarily be located at the geographic low point of the wastewater service area. The initial phase of each Regional WRF might not include features of the ultimate Regional WRF. The initial phase is assumed to be constructed as a relatively small wastewater facility, likely with a rated capacity under 1 or 2 mgd. However, larger initial facilities can be pursued on a case-by-case basis if warranted by the development.

The development of the proposed Phased Regional WRF Review and Approval Process requires some initial assumptions regarding the WRFs, including the following:

1. Regional WRFs will only be considered within the service areas established by the City.
2. Each Regional WRF will be constructed by the developer as the initial phase of the permanent Regional WRF.
3. Each Regional WRF will be constructed at a location advantageous to water reclamation.
4. Adequate space will be provided to accommodate future expansion of each Regional WRF to serve its designated region. The initial phase shall be planned to accommodate future expansions to buildout at the designated site.
5. The initial phase of each Regional WRF must have the capability to meet all required effluent water quality standards as stated in the Arizona Administrative Code (A.A.C.).

In addition, each WRF will not discharge to any waters of the U.S. (thereby requiring an NPDES permit).

6. Once built, each Regional WRF will be owned and operated by the City.

The potential locations of the Regional WRFs and their respective service areas are presented in Figure 3.1. Note that the Wastewater Service Area 1 is served by the existing wastewater treatment plant (WWTP). The existing WWTP is not included in the Phased Regional WRF Process since it is an existing facility. Expansions to the existing WWTP are covered under Technical Memorandum No. 1.

3.0 GENERAL REGIONAL WRF DESIGN AND CONSTRUCTION GUIDELINES

3.1 Initial Project Phasing

It is recognized that wastewater quantity will increase as developments grow. To accommodate this condition, water reclamation facilities are often constructed in phases. Typically, a relatively small facility will be constructed to accommodate flows from the initial development and as the development progresses, the wastewater facilities are expanded to treat the higher flows generated by the growth.

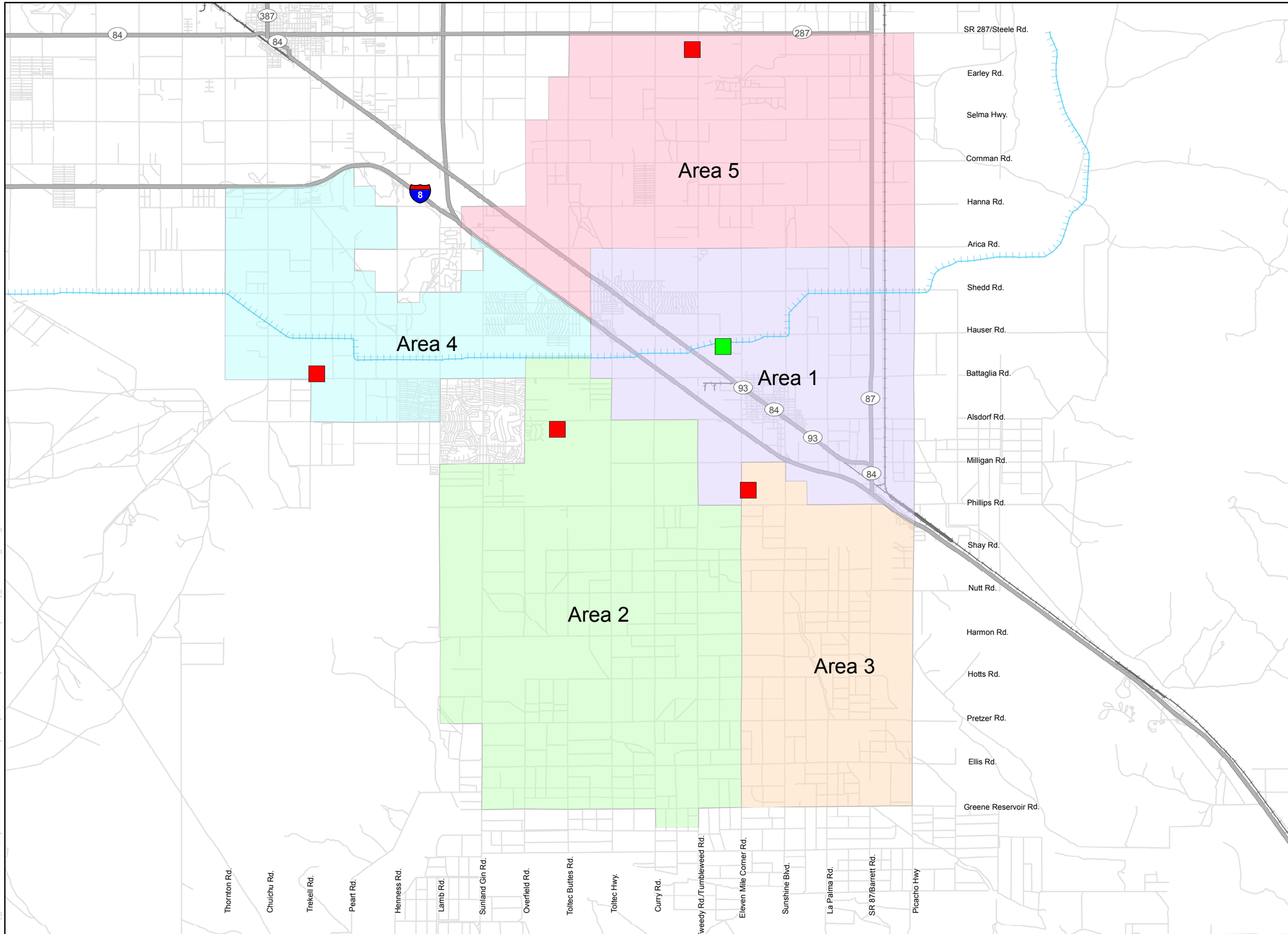
The initial capacity required for each Regional WRF covered under these guidelines, as defined by the annual average daily design flow (AADF) will be determined on a site-by-site basis. The primary decision factor regarding the acceptable initial capacity will be the anticipated timing of construction of the developments within the wastewater service area served by the Regional WRF.

The unit cost of treating wastewater will generally decrease as the size of the WRF increases. Therefore, as part of the project-specific Engineering Report required for each Regional WRF (see Section 3.14 herein), an estimate of annual O&M costs for treatment shall be required.

3.2 Effluent Disposal

The level of treatment (effluent quality) required at each Regional WRF will be dependent upon the effluent disposal method(s) and the best available demonstrated control technology (BADCT) treatment performance requirements as defined by ADEQ. The effluent disposal methods promoted by the City are:

- Urban Lakes, Wetlands, and Riparian Preserves
- Recharge Basins
- Athletic fields and other open access landscape irrigation
- Agricultural uses



Legend

- Existing WRF
- Proposed WRF
- Area 1
- Area 2
- Area 3
- Area 4
- Area 5
- Streets
- Streets
- Railroad
- Canal

Notes:

1. The Transportation layers are GIS data from ESRI Data & Maps (2004).

2. The planning boundary and developments are based on information obtained from the City of Eloy.

3. This GIS map is a limited representation of facilities, intended for planning purposes only. It is not intended for construction or other purposes requiring greater positional accuracy.

4. The Sewer Service Areas and WRF locations provided are preliminary and are based upon the Planning Area as defined for this Study.

0 0.5 1 2 Miles

City of Eloy, Arizona - Sewer Service Area Study, Technical Memorandum No. 3

carollo engineers

M:\Client\Eloy_PHX\MP7266A.00 Eloy Sewer Service Area Study\Analysis\GIS Analysis\MXDs\City of Eloy_Combined_WRF_TM1117.mxd

Sewer Service Areas and Proposed Regional WRF Locations

Figure 3.1

Other effluent disposal methods may be proposed and will be handled on a case-by-case basis. The minimum reclaimed water quality requirements for different reuse options are provided in the following table.

Table 3.1 Minimum Reclaimed Water Requirements for Direct Reuse[(1)]
Phased Regional WRF - Design and Construction Guidelines
City of Eloy, Arizona

Type of Direct Reuse	Minimum Class of Reclaimed Water Required
Irrigation of food crops	A
Recreational Impoundments	A
Residential Landscape Irrigation	A
School ground landscape irrigation	A
Open access landscape irrigation	A
Toilet and urinal flushing	A
Fire protection systems	A
Spray irrigation of an orchard or vineyard	A
Commercial closed loop air conditioning systems	A
Vehicle and equipment washing (does not include self-service vehicle washes)	A
Snowmaking	A
Surface irrigation of an orchard or vineyard	B
Golf course irrigation	B
Restricted access landscape irrigation	B
Landscape impoundment	B
Dust control	B
Soil compaction and similar construction activities	B
Pasture for milking animals	B
Livestock watering (dairy animals)	B
Concrete and cement mixing	B
Materials washing and sieving	B
Street cleaning	B
Pasture for non-dairy animals	C
Livestock watering (non-dairy animals)	C
Irrigation of sod farms	C
Irrigation of fiber, seed, forage, and similar crops	C
Silviculture	C

Notes:
(1) Reference: A.A.C. R18-11-309 Table A
(2) Denitrification is designated by adding a "+" to the Class, for example A+.

3.3 Effluent Quality

As stated previously, the treated effluent must (at a minimum) meet or exceed the current standards set forth in the Arizona Administrative Code (A.A.C.), specifically as defined in R18-9 and R18-11. The specific WRF effluent limits, sampling parameters, and sampling frequency shall be determined by the various permits required for the Regional WRF.

Typically, ADEQ requires Class B+ for effluent disposal via recharge basins, while open access methods, also promoted by the City, require Class A+. Since the land requirement for disposal via recharge basins is substantial, it is anticipated that each Regional WRF will use multiple effluent disposal methods. Therefore, each Regional WRF may include the flexibility to produce Class A+ or Class B+ depending upon the disposal method. While effluent disposal methods requiring a Class C level of treatment may be available, it should be noted that the effluent would still be required to meet the BADCT standards, which requires denitrification and more stringent disinfection requirements.

The BADCT treatment performance requirements, reclaimed water quality standards, and recommended effluent design criteria are provided in Tables 3.2, 3.3, and 3.4, respectively.

Table 3.2 BADCT Effluent Requirements
Phased Regional WRF - Design and Construction Guidelines
City of Eloy, Arizona

Parameter	Average Daily Flow < 250,000 gpd Effluent Limits(1)	Average Daily Flow > 250,000 gpd Effluent Limits(1)
pH	6.0 - 9.0	6.0 - 9.0
BOD (30 day average)	< 30 mg/L	< 30 mg/L
BOD (7 day average)	< 45 mg/L	< 45 mg/L
TSS (30 day average)	< 30 mg/L	< 30 mg/L
TSS (7 day average)	< 45 mg/L	< 45 mg/L
Removal Efficiency for BOD, CBOD, TSS	85%	85%
Total Nitrogen (as N) (2)	< 10 mg/L	< 10 mg/L
Fecal Coliform		
Single sample maximum	800 cfu/100 mL	23 cfu/100 mL
Seven sample median	200 cfu/100 mL	2.2 cfu/100 mL

Notes:
(1) Reference: A.A.C. R18-9-B204
(2) Five month rolling geometric mean

Table 3.3 Reclaimed Water Quality Standards
Phased Regional WRF - Design and Construction Guidelines
City of Eloy, Arizona

Parameter	Class A+ (1) Effluent Limits	Class B+ (2) Effluent Limits	Class C (3) Effluent Limits
Total Nitrogen (as N) (4)	< 10 mg/L	< 10 mg/L	N/A
Turbidity			
Daily (24-hour) average	2 NTU	N/A	N/A
Single sample maximum	5 NTU	N/A	N/A
Fecal Coliform			
Single sample maximum	23 cfu/100 mL	800 cfu/100 mL	4,000 cfu/100 mL
Four out of last seven daily samples	Non Detect	200 cfu/100 mL	1,000 cfu/100 mL

Notes:
(1) Reference: A.A.C. R18-11-303
(2) Reference: A.A.C. R18-11-305
(3) Reference: A.A.C. R18-11-307
(4) Five sample geometric mean
(5) Class A, B, C, etc uses are listed in R18-11 Table A.

Table 3.4 Recommended Effluent Design Criteria
Phased Regional WRF - Design and Construction Guidelines
City of Eloy, Arizona

Parameter	Effluent Limits
pH	6.0 - 9.0
BOD	< 10 mg/L
TSS	< 10 mg/L
Total Nitrogen (as N)	< 8 mg/L
Turbidity (1)	
Daily (24-hour) average	2 NTU
Single sample maximum	5 NTU
Fecal Coliform (2)	
Single sample maximum	23 cfu/100 mL
Seven sample median	2.2 cfu/100 mL

Notes:
(1) Turbidity monitoring only required if Class A+ reclaimed water is being produced.
(2) Fecal Coliform for four out of last seven daily samples must be non detect if Class A+ reclaimed water is being produced.

In order to meet these effluent water quality requirements, the initial phase of the Regional WRF will be required to provide (at a minimum) preliminary and secondary treatment, followed by tertiary filtration and disinfection. Specific treatment processes and design criteria for the initial phase of the Regional WRF in the City will be described in further detail in Section 3.5.

3.4 Design Peaking Factors

The most common method of determining applicable peaking factors is from the analysis of existing flow rate data. However, if existing flow measurement records are unavailable or inadequate (as is expected for the initial phases of the WRFs), the peaking factors in Table 3.5 (at a minimum) shall be applied.

Table 3.5 Acceptable Design Peaking Factors
Phased Regional WRF - Design and Construction Guidelines
City of Eloy, Arizona

Parameter	Peak Factor
Peak Hour	4.0
Peak Day	3.0
Average Day Peak Month	2.0

3.5 WRF Site Requirements

Site selection criteria for the Regional WRFs, including site access and security, aesthetics, location of facilities relative to future connection (per Eloy Wastewater Master Plan), facility redundancy and contingency options, flood control, and storm water management, are discussed herein.

Potential sites shall be of sufficient area to accommodate the ultimate Regional WRF footprint. If the ultimate Regional WRF will include adjacent effluent disposal features (such as riparian preserve, recharge basins, etc.), the land requirement will be contingent upon the site-specific soil infiltration capabilities. Regional WRF proposed without adjacent effluent disposal features must identify, in the Engineering Report, the location(s) for the effluent disposal features. Minimum land requirements for the WRF are provided in Table 3.6. The land requirements shown may be reduced based upon site-specific soil information, and increases of effluent disposal by methods other than recharge basins (such as irrigation and Aquifer Storage and Recovery Wells).

Table 3.6 Regional WRFs - Projected Land Requirements Phased Regional WRF - Design and Construction Guidelines City of Eloy, Arizona				
Waste-water Service Area	**Ultimate Average Daily Flow (mgd)**	**Estimated Process Footprint (Acres)(1)**	**Estimated Recharge Area (Acres)**	**Total Estimated WRF Footprint (Acres)(2)**
1	Refer to Tech Memo No. 1 for information on the existing WWTP			
2	21	45	97	142
3	14	37	65	102
4	6	30	28	58
5	15	38	707	108
6	9	28	42	70
7	14	37	65	102
8	8	25	37	62
9	16	40	74	114
10	1.5	10	7	17

Notes:

(1) WRF process footprints determined from the potential ultimate buildout layout of the WRF and a 350 setback to property lines for full odor and noise controls. Footprint will be dependent upon the facilities selected for the ultimate Regional WRF the numbers provided are for planning purposes only.

(2) Total estimated footprint area requirement includes land required for effluent disposal features (recharge basins, riparian preserve, etc.) with an estimated percolation rate of 1.2-feet per day, a 50% increase in recharge land area for wet/dry cycling, and an additional 20% increase to account for containment berms and access roadways. Also assumes 25% of reclaimed water is disposed via other methods, irrigation, ASR, etc. [Note: Percolation rate from existing Eloy WWTP recharge basin design.]

(3) Areas provided are approximate and will require site-specific planning measures to determine the actual area required for the ultimate Regional WRF sites.

Potential sites for the Regional WRFs must be of sufficient size to meet the setback requirements set forth in A.A.C. R18-9-B201, as summarized in Table 3.6. Setback is defined as the distance from the WRF to the nearest contiguous property line. Selected sites must take into account the future expansion of the Regional WRF and its ultimate size. Additional space is to be set aside on the site for treating of flows from future developments within the wastewater service area, for future sludge processing on-site, or other operation and maintenance-related activities. Therefore the ultimate site footprint shall provide the setback requirements for facilities over 1 mgd, as defined in Table 3.7. The setbacks may be required between the WRF and any contiguous effluent disposal features since these features will likely be frequented by the community. This will be addressed on a case-by-case basis.

Table 3.7 Facility Setback Requirements Phased Regional WRF - Design and Construction Guidelines City of Eloy, Arizona		
Sewage Treatment Facility Design Flow (gpd)	**No Noise, Odor, or Aesthetic Controls (feet)**	**Full Noise, Odor, and Aesthetic Controls (feet)**
24,000 to less than 100,000	350	50
100,000 to less than 500,000	500	100
500,000 to less than 1,000,000	750	250
1,000,000 or greater	1,000	350
Source: Arizona Administrative Code (A.A.C.) R18-9-B201		

All wastewater facilities within Eloy are intended to be "good neighbors," meaning that all WRFs shall be provided with odor and noise control, as defined further in Sections 3.6 and 3.7, respectively. All property owners whose property is adjacent to the proposed WRF site shall be fully informed about the proposed WRF. The WRF site plan shall be submitted to the City of Eloy for review and approval as part of the Engineering Report submittal.

3.5.1 Site Access and Security

The requirement for access for the WRF site includes adequate access for operations and maintenance vehicles to the site from public roads and within the site to the process tanks and buildings.

Access roads to a site from public roads and access roads within the site shall be a minimum 24-foot wide road, designed in accordance with the latest edition of the Maricopa Association of Governments Standards for Public Works Construction. Where possible, access shall be from a main road and not a side street in a subdivision. Two entrances from separate roads to the site shall be provided, where practical.

The WRF roadway system shall be laid out to provide access for large trucks to all treatment facilities for WRF operation and maintenance. The minimum turning radius for WRF roads shall be 40 feet. Where equipment maintenance requires the use of truck-mounted or portable hoists, space must be sufficiently allocated for this equipment.

Secured access to the WRF site shall be provided, in the form of either full perimeter fencing or block walls, with lockable gates. Signs shall be posted identifying the site as a water reclamation facility and forbidding trespassing. The potential for vandalism at a given site shall be discussed with the City, and appropriate security measures designed and constructed. All exterior doors shall be of metal construction, and all glass shall be tempered. Exterior locks shall be of the mortise type. A single key shall operate all locks.

The WRF access shall be reviewed with the City of Eloy Fire Department to verify that the requirements for fire protection have been met.

Access within the WRF shall be provided for general operation and maintenance of all equipment as follows:

- A minimum of 3 feet clearance space around all process equipment.
- A minimum of 3 feet clearance in front of electrical panels.
- A minimum of 3 feet clearance in back of control panels.
- Walkways 4 feet wide shall be provided around all process tanks.

3.5.2 Aesthetics

In addition to the odor and noise control requirements per Sections 3.6 and 3.7, respectively, the site and the facility shall be designed to be compatible with the environment of the surrounding area, while presenting an image of being unobtrusive and aesthetically pleasing. The following shall be considered:

- Use low water plantings for landscaping. Landscape plants that will act to visually shield the WRF process tanks are encouraged.
- Use materials that are the same as, or compatible with, neighboring structures.
- Roofs and/or tops of structures shall be as free of visible mechanical equipment as possible.
- Use site lighting per the City's standards.
- In general, materials of construction shall be corrosion resistant and require a minimum amount of maintenance.

3.5.3 Location of Facilities Relative to Future Connections

The future use of the site will be contingent upon a number of factors, including growth of the development and surrounding area, and coordination with the City's Wastewater and Water Master Plans. It is assumed that the Regional WRF site will ultimately serve its entire wastewater service area. The ability to connect the entire wastewater service area to the Regional WRF shall be considered when locating the new site. As such, the required location and orientation of some facilities on the site will be dependent on the overall site location within the City's planning area, and will require coordination and final approval by the City.

3.5.4 WRF Redundancy and Contingency Options

Since the Regional WRF will be a stand-alone facility, WRF bypass capability will not be available. Therefore, sufficient WRF redundancy will be required.

Redundancy shall be achieved by providing multiple treatment trains and standby equipment as identified in Section 3.5 herein. Sufficient spare parts shall be provided in the initial WRF construction to repair or replace any piece of critical process equipment within 24 hours.

If there is a major interruption in the treatment process and wastewater is not treated or only partially treated, the contingent procedures may involve emergency basin storage and pump-back facilities, and possibly the use of tanker trucks to collect and transport flows to the nearest wastewater treatment facility until the major interruption is mitigated. All contingency options must be addressed in the Engineering Report submittal for the City's review and approval.

3.5.5 Flood Control

The flood potential of the site shall be addressed in the Engineering Report submittal. If the site is subject to potential flooding, flood protection for structures and equipment shall be provided in the form of berms, dikes, or floodwalls. The flood protection shall be designed to allow WRF operation to continue during a 25-year flood, and to protect the facilities from damage during a 100-year flood. Access to the site and the protected facilities shall be maintained under these flood conditions.

3.5.6 Storm Water Management

All storm water from the WRF site shall be retained on-site. The site shall be graded such that surface water does not drain into the WRF collection system or the process tanks.

3.6 Acceptable Treatment Processes and Equipment

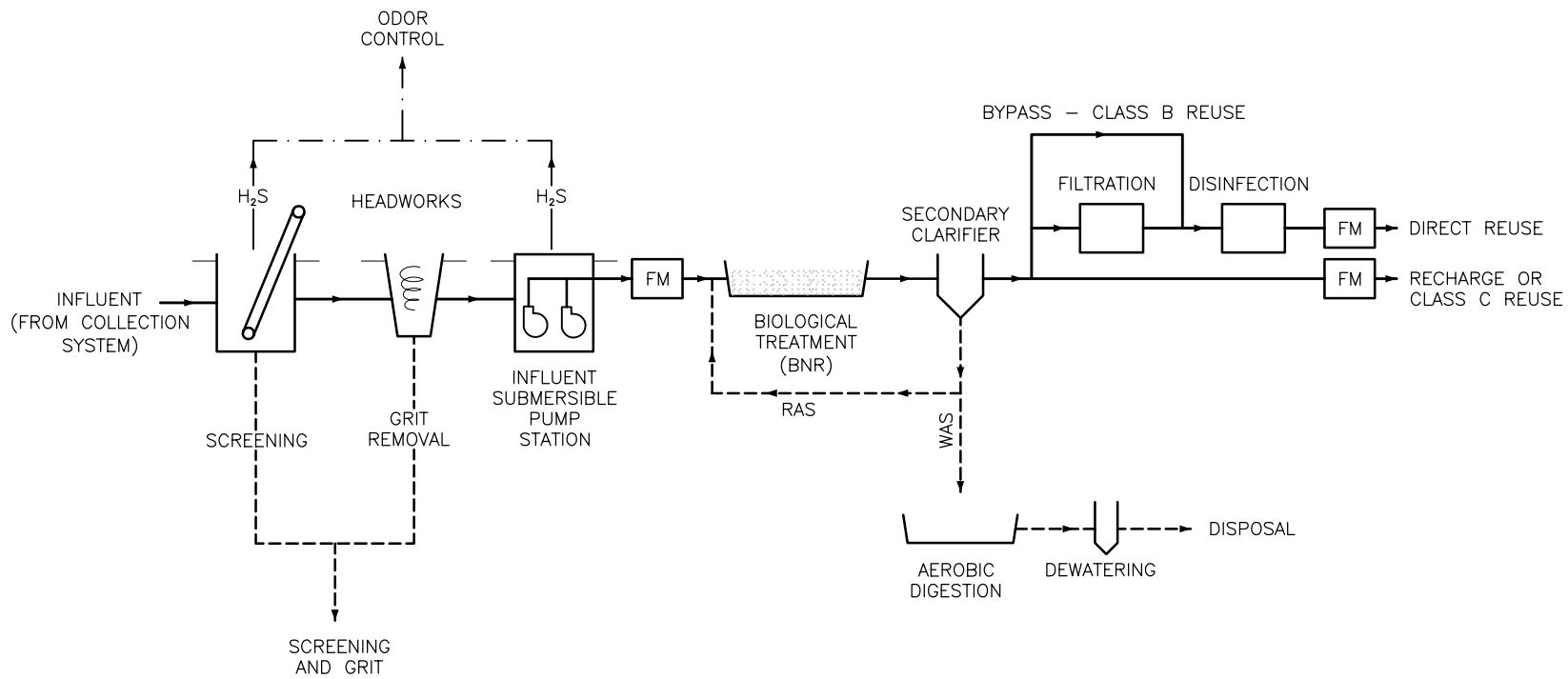
The City of Eloy has identified the following acceptable processes to be utilized for the initial phase of the Regional WRFs. The WRF should only use standard treatment processes and proven technologies, and (at a minimum) should contain the following components:

- Influent pumping
- Screening facilities
- Biological secondary treatment (capable of nutrient removal)
- Secondary clarification
- Tertiary filtration (or future accommodations for filtration)
- Disinfection
- Effluent pumping
- Reclaimed water storage
- Solids processing and disposal

A process flow diagram of the acceptable initial Phase Regional WRF processes is shown in Figure 3.2. The "package plant" type treatment processes will <u>not</u> be acceptable.

Since City will take over ownership and operation of the completed facility, all equipment models and manufacturers must be approved by the City, and the City reserves the right to deny the use of any equipment and/or manufacturer not deemed suitable or preferred by the City.

INITIAL PHASE – REGIONAL WRF PROCESS SCHEMATIC



LEGEND

PROCESS FLOW
RECYCLE OR SOLIDS FLOW
FOUL AIR STREAM

NOTES

INFLUENT PUMPING MAY BE PRIOR TO OR AFTER SCREEN, SITE SPECIFIC ODOR CONTROL MAY BE REQUIRED FOR THE SOLIDS HANDLING AND BIOLOGICAL PROCESS

Figure 3.2

carollo engineers

City of ELOY, Arizona – Sewer Servive Area Study
Technical Memorandum No. 3

3.6.1 Influent Pumping

Influent pumping shall be designed with submersible-type sewage pumps, possibly placed in a wet well or manhole located on the WRF site, and supplied with lift-out rails to allow pump removal without entering the wet well. The firm capacity should be sized by the peak hour design flow and controlled by the wet well (or manhole) level. Online standby capacity should be provided with at least one (1) standby pump of the largest size installed. The influent pump station may be located before or after the headworks (screening and grit removal) depending upon the site-specific hydraulic constraints.

3.6.2 Screening Facilities

Mechanical screening shall be required before the secondary treatment process in order to protect the downstream processes and equipment. Acceptable screens should have a maximum opening size of 0.25 inches. Either one unit with a bypass channel, or two units without bypass, shall be installed. Integral washing and compacting of screenings is also required.

The firm capacity of the screening units and channels should be sized by the peak hour design flow and controlled by the differential level across the screen(s). Due to the corrosive nature of raw wastewater, the screens should be made out of a sufficiently resistant material (typically Type 316 stainless steel).

Arrangements should be made for the screenings to be conveyed and stored in a closed bin, or alternately an open bin in an area that is mechanically ventilated with the exhaust air treated in an odor control system. All screenings shall be transported off-site to a disposal site acceptable to the City.

3.6.3 Biological Secondary Treatment

The most energy consuming, operator attention-intensive, and costly component of the WRF is the biological treatment process. This process shall be easy to operate, produce a good quality effluent, provide tanks of sufficient capacity to absorb shock loadings, and produce a stabilized sludge for disposal. In order to meet the total nitrogen effluent limits, a nitrification-denitrification process shall be required. Acceptable biological treatment processes shall be of extended aeration or oxidation ditch-type only, as described in the proceeding subsections.

A conventional activated sludge process that provides biological nutrient removal (BNR) will be acceptable for larger initial Phased Regional WRFs (treating flows greater than 3 or 4 mgd ADF). In such a case, the conventional activated sludge process shall either be the modified Ludzack-Ettinger (MLE) or membrane bioreactor (MBR) process. The MLE and/or MBR process is the City's preferred biological process for facilities handling flows over 3 or 4 mgd ADF. The proposal to construct an MLE or MBR biological process, during the initial phase, will be handled on a case-by-case basis.

3.6.3.1 Extended Aeration Process

The extended aeration process is a modification of the activated sludge process, which removes biodegradable organic wastes under aerobic conditions. Oxygen required to sustain the aerobic biological process may be supplied mechanically or by diffused aeration. Mixing is also provided by either aeration or mechanical means to maintain the microbial organisms in contact with the dissolved organics. By controlling the pH, the biological processes can be optimized as essential nutrients facilitate growth and ensuing degradation of unwanted components.

The City preferred extended aeration process is the Biolac® process, by Parkson. To meet total nitrogen removal limits, the Wave Oxidation© aeration process from Parkson must also be included. Other extended aeration processes will be approved on an individual basis.

3.6.3.2 Oxidation Ditches

An oxidation ditch, a modified form of the activated sludge process, is an aerated, long-term, complete mix process. Typical oxidation ditch treatment systems consist of a single or multi-channel configuration within a ring, oval or horseshoe-shaped basin. Aerators and/or mixers provide air and circulation and promote oxygen transfer in the oxidation ditch.

Oxidation ditches tend to operate in an extended aeration mode consisting of long hydraulic and solids retention times that allow more organic matter to break down biologically.

The City preferred oxidation ditch processes includes: the Carrousel® process by EIMCO with the Carrousel® denitIR® process for nitrification/denitrification; the Phased Isolation Ditch®, by Krüger; or the Orbal® process by US Filter/Siemens. Other processes will be approved on an individual basis.

3.6.3.3 Typical Design Parameters

Table 3.8 lists some typical design parameters for the two acceptable biological treatment processes - extended aeration and oxidation ditches.

Before introducing the influent wastewater into the aeration tank(s), the wastewater shall be mixed with the return activated sludge (RAS) in a separate tank or compartment designed to maintain anoxic conditions (this tank is also referred to as a selector box). This separate tank or compartment shall be mechanically mixed, and shall have a minimum detention time of 30 minutes. This tank is intended to discourage the growth of filamentous organisms due to the high F/M ratio, as well as provide a zone for denitrification of the nitrates in the RAS stream, which will release alkalinity necessary for nitrification in the aeration tank.

Table 3.8 Typical Design Parameters for Biological Treatment Processes Phased Regional WRF - Design and Construction Guidelines City of Eloy, Arizona		
Wastewater Characteristic	**Extended Aeration**	**Oxidation Ditch**
BOD_5 loading (lb BOD_5/lb MLVSS)	0.05 - 0.15	0.05 - 0.30
Oxygen required, avg. at 20°C (lb/lb BOD_5 applied)	2 - 3	2 - 3
Oxygen required, peak at 20°C (value x avg. flow)	1.5 - 2.0	1.5 - 2.0
MLSS (mg/L)	3,000 - 6,000	3,000 - 6,000
Detention Time (hours)	18 - 36	18 - 36
Volumetric loading (lb BOD_5/day/1,000 ft^3)	10 - 25	5 - 30

The firm capacity of the biological secondary treatment process should be sized by the average day maximum month (ADMM) design flow. It is recommended that two (2) basins be provided, either in separate tanks or integrally combined in a single tank with sufficient separation, and each sized to handle a minimum of 50 percent of the average day maximum month (ADMM) design flow. All basins shall be sized with sufficient freeboard to hydraulically accommodate the peak hour design flow without overtopping the basin (or tank) walls.

3.6.4 Secondary Clarification

Following the biological secondary treatment process, the mixed liquor then flows to a secondary clarifier. Secondary clarification is necessary to separate microorganisms for wasting and/or recycling, and to prepare the biologically treated wastewater for tertiary filtration. A tank set in a quiescent mode is enough to allow solids to settle out into a sludge form that can either be wasted or recycled to a separate treatment unit. The secondary clarifier shall be either circular or rectangular (if integral to the aeration tanks). All clarifiers provided as separate basins shall be circular.

A circular secondary clarifier shall have center feed, peripheral weir, and a mechanical sludge collector. The circular mechanism shall be either bridge-supported or center-supported. The mechanism shall be capable of withstanding twice the maximum operating torque without buckling or bending structural members. An overload device shall be provided to alarm and to trip out the mechanism at high torque.

A rectangular secondary clarifier shall be of the flow-through type with sludge collected at the influent end of the tank. The rectangular mechanism shall be non-metallic chain-and-flight type. Baffles shall be provided in front of the inlet gates to help disperse the inlet flow.

The secondary clarifier shall also include provisions for surface skimming of scum. Provisions shall be made for the collected scum to either be returned to the aeration tanks, or collected in a sump for off-site disposal by vacuum-assisted tanker trucks.

The firm capacity of the secondary clarifier(s) should be sized by the average day maximum month (ADMM) design flow. A minimum of two (2) basins, either in separate tanks or integrally combined in a single tank with sufficient separation and each sized to handle a minimum of 50 percent of the average day maximum month (ADMM) design flow, shall be required. If more than two (2) aeration tanks are provided, a like number of secondary clarifiers shall also be provided. Each basin shall be sized with sufficient freeboard to hydraulically accommodate the peak hour design flow without overtopping the basin (or tank) walls.

Table 3.9 lists the acceptable design parameters for secondary clarifiers. The applicable surface and weir loading rates depend on the quality of the raw wastewater and efficiency of the biological treatment.

Table 3.9 Typical Design Parameters for Secondary Clarifiers
Phased Regional WRF - Design and Construction Guidelines
City of Eloy, Arizona

Parameter	Design Criteria
Surface Overflow Rate (gpd/ft^2)	
Average	400 - 800
Peak	1,000 - 1,600
Weir Loading Rate (gpd/ft)	8,000 - 15,000
Hydraulic Retention Time (hours)	> 2.0
Solids Flux Loading (lbs/day-ft^2)	20 - 30
Minimum Side Water Depth (ft)	12

Sources: Design of Municipal Wastewater Treatment Plants, Manual of Practice No. 8 (MOP-8); Engineering Bulletin No. 11, Arizona Department of Health Services, July 1978

A secondary sludge system shall also be provided to return (recycle) sludge to the aeration tank and to waste excess sludge to aerated sludge storage tank(s). The return activated sludge (RAS) and waste activated sludge (WAS) pumping system should be centrifugal type, integral to the secondary clarification process. Firm capacity for the RAS and WAS pumps shall be 50 to 150 percent of the annual average daily design flow (AADF) . Online standby capacity should also be provided with at least one (1) standby pump of the largest size installed.

RAS flow should be metered and controlled by either a modulating valve or variable frequency drive (VFD). Excess sludge shall also be metered, and shall be designed to be wasted from the system either continuously or on a timed cycle.

3.6.5 Tertiary Filtration

Tertiary filtration shall be required to remove suspended solids (SS) and particulate BOD to optimize the subsequent disinfection process. Acceptable filtration technologies include:

- Cloth media (disk) filter.
- Automatic traveling bridge filter.
- Continuous backwash filter.

The firm capacity of the tertiary filtration process should be sized by the peak day design flow. A minimum of two (2) basins, either in separate tanks or integrally combined in a single tank with sufficient separation and each sized to handle 100 percent of the peak day design flow, shall be required. Each basin shall be sized with sufficient freeboard to hydraulically accommodate the peak hour design flow without overtopping the basin (or tank) walls. Each unit should have a maximum loading rate of 5 gpm/ft^2 sized at peak day flow with one (1) filter out of service. The suggested backwash rate is 15 gpm/ft^2, with backwash flows returned to the influent wet well (or manhole).

3.6.6 Disinfection

To meet BADCT standards and the Class A+ and Class B+ reuse standards, disinfection must be provided. Acceptable disinfection technologies include:

- Ultraviolet (UV) radiation.
- Liquid sodium hypochlorite solution feed. (if chlorine disinfection is pursued, dechlorination will be required).

UV disinfection shall be of the open-channel, gravity type or of the closed-pipe, pressure type. UV dosages shall be as recommended by the manufacturer, suitable for the peak hour design flow. A fully redundant standby train should also be provided in a separate channel or pipe.

The use of liquid sodium hypochlorite for disinfection shall be acceptable based on a dosage of 10 mg/L with a detention time of 15 minutes at peak hour design flow. Acceptable feed system should consist of chemical storage tank, metering pumps, and appropriate appurtenances. Online standby capacity should also be provided with at least one (1) standby pump of the largest size installed. A minimum of 15 days of liquid hypochlorite storage shall be provided. In addition, dechlorination will be required along with monitoring of the chlorine residual (or oxygen reduction potential, ORP) to verify and optimize the dechlorination.

Supplemental chlorination may also be required for the following functions:

- Odor control
- Algae control on tertiary filters
- Chlorination of return activated sludge (RAS) stream
- Chlorine addition to WRF effluent for residual purposes
- Spray down to control foaming in the biological process

To meet the minimum Class C reclaimed water requirements for reuse, the effluent can bypass the tertiary processes (filtration and disinfection). Therefore, disinfection bypass capabilities shall be provided for a disposal based tertiary treatment.

3.6.7 Effluent Pumping

The treated WRF effluent shall be pumped either to a reclaimed water storage reservoir or directly to applicable reuse sites. Effluent pumps shall be either submersible centrifugal or vertical turbine type. Firm capacity should be sized by the peak hour design flow and controlled by the effluent wet well level. Online standby capacity should be provided with at least one (1) standby pump of the largest size installed.

3.6.8 Reclaimed Water Storage

Reclaimed water storage shall be sized to meet the needs for irrigation and reuse. A minimum of five (5) days storage must be available at all times when irrigation is not required. The five days of storage shall be based upon the WRF annual average daily design flow (AADF) capacity. The five-day storage requirement is waived if sufficient effluent disposal can be achieved through recharge without additional effluent disposal methods.

3.6.9 Reclaimed Water Disposal

Disposal of effluent can be achieved by Class A+, Class B+, and Class C uses (refer to A.A.C. R18-11, Table A [and Table 3.1, herein] for the specific direct reuse methods by reuse class); however, the type of disposal method must be approved by the City. The use of recharge basins can be pursued provided the site has adequate infiltration capabilities. Surface recharge disposal design shall be based upon sufficient geotechnical investigations to include, at minimum, backhoe pits, surface percolation tests, at depth percolation tests, and geotechnical borings to determine groundwater depth and lithology. The backhoe pits should be dug to allow the safe entry of a soil scientist, geologist, or engineer trained in soil investigations. The backhoe pits shall be dug to at least 4 feet in depth. The soil horizons shall be logged and location of redox characteristics and caliche shall be noted. The borings and percolation tests shall be sufficient to characterize the entire site earmarked for recharge. Recharge basins shall be sized using the field percolation test results and adjusted to account for plugging and field-testing practices. The Eloy region is known to have caliche (cement-like layers) below the ground surface. This results in poor percolation

and an increased land requirement for recharge basins. It is therefore imperative that adequate site-specific soil investigations be performed at the proposed sites and that the appropriate adjustments are made to the field percolation testing to account for errors in the percolation testing methodology and future plugging. A water balance demonstrating the ability to dispose of the effluent, calculated on a monthly basis, shall be performed.

The ultimate goal of the WRF concept is to reclaim wastewater for beneficial uses. Therefore, disposal techniques that provide a beneficial use are encouraged and may be required by the City for the initial phase. In addition, the reclamation of wastewater could be used to obtain groundwater credits by injecting or recharging the reclaimed water. Discussions should take place with the City during the planning stages to determine if groundwater credits are to be pursued during the initial Phase of each Regional WRF.

3.6.10 Solids Processing and Disposal

Wastewater solids are regulated by the Federal Sewage Sludge Regulations (40 CFR Part 503) and the Arizona Administrative Code (A.A.C.) Title 18, Chapter 9.

The characteristics of the sludge that is produced at the Regional WRFs are dependent on the type of biological treatment chosen. The WRFs should (at a minimum) be equipped with aerated sludge storage tanks, possibly with upstream sludge thickening to maximize storage capability. Final disposal of the WRF sludge should be reviewed and coordinated with the City. Sludge shall be disposed according to the applicable regulations.

The sludge storage tank should have a minimum capacity of ten (10) days storage for waste solids based on the average day maximum month (ADMM) design flow. The sludge storage tank shall be aerated with floor-mounted diffuser assemblies, and outfitted with covers and connected to the odor control system.

Aeration to the sludge storage tanks shall be supplied by low-pressure fans (or blowers). A minimum of two (2) fans shall be provided. Each fan shall be sized to provide a minimum of 75 percent of the maximum oxygen required.

3.7 Odor Control

As identified in Section 3.4 previously, odor control for the WRF shall be required. Acceptable odor control technologies include a wet chemical scrubber, carbon adsorption bed, or biologically active filter (biofilter). Required process units to be covered and/or enclosed and vented to the odor control system shall include (at a minimum) the influent pumping wet well and screenings facilities (channel and/or building). Depending upon the site-specific boundary conditions and proximity to residential, commercial, and industrial facilities, odor control of the biological secondary treatment basin(s), and sludge storage tank(s) may be required. Acceptable covers shall be lightweight fiberglass or aluminum.

3.8 Noise Control

Emergency generators, pumps, blowers, and aerators are all potential sources of noise at a WRF. In addition to the control of noise within the equipment itself, including silencers and vibration dampening, the enclosure of equipment and the use of sound absorbing material placed on walls and ceilings adjacent to noise producing equipment is the best method to reduce and contain noise levels. The use of sound seal gaskets on exterior doors shall also aid in containing noise.

As a minimum requirement, noise control should be provided to allow no more than 45 dBA at the WRF boundary. Refer to Table 3.6, shown previously, for setback requirements.

3.9 Utility and Standby Power

All capital costs associated with providing adequate power to the Regional WRF shall be the responsibility of the developer, who shall coordinate with the local power utility to verify adequate facilities are available. The electrical distribution system shall be designed with the following factors taken into consideration:

- Load determination
- Load demand
- Load diversity
- Reliability of power
- Service voltage
- Distribution and utilization voltage levels
- Short circuit capacity
- Flexibility
- Expansion
- Safety

In general, distribution equipment, motor control centers and motors shall be protected from moisture and liquids. Explosion-proof equipment shall be used in hazardous areas.

- Transformers: Transformers shall be designed to step the incoming utility voltage down to the facility operating voltage. Transformers shall be liquid filled, oil insulated type designed for outdoor installations. It is anticipated that the initial phase of the Regional WRF will operate on 480 volt, 3-phase, 60-hertz power supply.
- Motor Control Centers: Motor control centers shall be rated NEMA 12 for indoor installations and NEMA 4 for outdoor installations.
- Motors: Motors shall be protected on all three phases against overload and short circuit. Large motors shall have low voltage and ground fault protection. Motors shall

have a minimum service factor of 1.15 or a nameplate 15 percent greater than required maximum brake horsepower.

- Conduits: Underground duct banks shall be plastic conduits encased in concrete. Conduit exposed within buildings or outdoor structures may be rigid heavy wall aluminum. For corrosive areas, conduits shall be rigid steel with PVC coating. Minimum conduit size shall be 3/4-inch diameter.

Standby power shall also be required for the facility site, including either a second source from the local utility provider (if available) or an on-site diesel engine driven generator unit, both to include means of automatic transfer if the primary power utility source should fail. The standby source shall be sized sufficiently to operate pump and process equipment necessary to adequately maintain the treatment of wastewater and required effluent quality, including the effluent disinfection system. Standby power shall also be provided for critical ventilation, lighting, and facility instrumentation.

Power shall be supplied to the critical load through a transfer switch upon a power failure. The transfer switch shall automatically transfer from the normal source to the standby source. Vital loads shall be arranged so that either source can operate the required critical equipment.

If an on-site diesel engine driven generator is used for standby service, a minimum of 24 hours of diesel fuel storage shall be provided. Natural gas can be used as an alternative fuel source instead of diesel.

If a second utility source is used for standby service, a double-ended switchgear or motor control center arrangement shall be provided. A second utility source shall either be a separate feeder from a separate substation, or a loop feeder on separate transformers from a common substation.

3.10 Instrumentation, Controls and Alarm Telemetry

Facility controls shall be designed such that the facility can be operated unattended and automatically. Equipment controls shall be at the central control panel and locally at the devices. Automatic control systems shall be provided with manual overrides. Alarms and annunciators shall be provided to indicate equipment malfunctions. Fail-safe controls shall be used where possible. A single failure shall not disable both the control system and the alarm system. Backup controls and instrumentation shall be used for vital components or occurrence that might result in damage in equipment.

Equipment controls shall be designed to restart equipment automatically in the event of a power failure. Timers shall be utilized to stagger the starting times for equipment.

Start-lockout-stop (SLOS) pushbuttons and power disconnect switches shall be installed locally at each device, to allow a positive lockout of equipment for maintenance and relieve the danger of equipment starting automatically during maintenance.

Instrumentation shall be provided for process monitoring and control. A control panel shall be provided to allow for central monitoring control and alarm annunciation at the WRF. Instrumentation shall be provided to monitor and record the following process parameters, using the instruments types listed in Table 3.10.

Table 3.10 Parameters Measured and Suggested Instruments
Phased Regional WRF Design and Construction Guidelines
City of Eloy, Arizona

Parameter	Instrument
WRF Influent Flow	Magnetic Flowmeter
Return Activated Sludge (RAS) Flow	Magnetic Flowmeter
Waste Activated Sludge (WAS) Flow	Magnetic Flowmeter
Aeration Tank Dissolved Oxygen Concentration(1)	Dissolved Oxygen (DO) Meter
Effluent Turbidity(2)	Nephelometer
WRF Effluent Flow and Totalized Water Production	Magnetic Flowmeter
Equipment Running Time	Elapsed Time Meter
Effluent Water pH(1)	pH Meter

Notes:

(1) Hand-held portable instrument may be substituted for permanently mounted equipment with City of Eloy approval.

(2) Turbidity monitoring will only be required if Class A+ reclaimed water is being produced.

(3) Chlorine residual monitoring will be required if chlorine disinfection is pursued.

(4) Alternative flowmeters will be accepted on a case-by-case basis and will be dependent upon the measurement location.

Monitored process parameters shall be continuously recorded, using strip chart recorders or alternate means (digital recording is preferred).

WRF influent, aeration tank effluent, and WRF effluent shall be continuously sampled by an automatic composite refrigerated sampler. The sampler shall be operated either manually, by a timer, or paced on WRF influent flow.

A central panel shall be provided which shall include an alarm annunciator for all alarms. In general, the following parameters shall be alarmed at the WRF:

- All Equipment Failures
- High Liquid Level - Influent and Effluent Pump Stations
- Low Aeration Tank Dissolved Oxygen (if permanently-mounted instrument is provided)
- High Effluent Turbidity (if Class A+ reclaimed water is being provided)
- Ultraviolet Bulb Failure (if UV is provided for disinfection)
- Low Storage Tank Liquid Level (if hypochlorite is provided for disinfection)

- Chlorine residual alarm (in case dechlorination system fails), if chlorine disinfection is pursued

The initial phase of the Regional WRF will normally be unmanned. Therefore, a telemetry system shall also be provided to transmit selected alarms to the City's existing water reclamation facility or another location as chosen by the City. The following alarms shall be transmitted:

- Process Equipment Failure (pumps, aerator and/or blower, clarifier mechanism, filter backwash mechanism, or disinfection units)
- WRF Power Failure

Coordination with the City shall take place to determine other supervisory control and data acquisition (SCADA) requirements. Since the Regional WRF will be a long-term City operated facility, the telemetry and communications between the existing and future WRF is crucial to efficient operations and integration into the existing operation program.

3.11 Utilities, Process Piping and Yard Piping

The following utilities are to be made available at all WRF sites:

- Potable water
- Non-potable water (using disinfected WRF effluent)
- High-pressure air (if necessary)
- Telephone service
- Fire protection
- Computer networking cabling

Process piping shall be of high quality, heavy-duty construction. All process piping that carries water, wastewater, reclaimed water, screenings, sludge, air, or scum shall be of polyvinyl chloride (PVC), ductile iron, or steel construction, as suitable for the intended service. If required, pipelines carrying hypochlorite solution shall be chlorinated polyvinyl chloride (CPVC) material. Ductile iron and steel pipelines shall meet the requirements of the American Water Works Association (AWWA) or the American National Standards Institute (ANSI) standards. PVC and CPVC pipelines shall meet the requirements of AWWA and ASTM standards. Flow velocities shall range from two (2) to six (6) feet per second (fps).

Any piping designed for fluids containing solids shall include the following:

- Minimum diameter of six (6) inches
- Minimize number of fittings
- Use long-radius bends
- Provide quick breakdown (i.e., Victaulic type) fittings in appropriate locations

- Provisions for cleaning by rodding, steaming, or pigging, including the appropriate use fittings, valves, and blind flanges

All piping shall be color-coded. Exposed piping shall have identification markers indicating contents and direction of flow. All non-potable water hose bibs shall be clearly marked "Non-Potable Water - Do Not Drink." Visible electrical conduit shall have markers identifying the contents.

Process piping at all pumps shall include suction and discharge couplings and isolation valves to isolate the pump from the piping system, as well as suction and discharge pressure gauges.

3.12 Valves

Valves shall be constructed of non-corroding materials. Valves shall be designed to operate at the test pressures of the pipelines in which they are installed. Valves in pipelines carrying sludge, screenings, or scum shall be of eccentric plug valves, diaphragm valves, or ball valves. The use of gate, butterfly, or globe valves for this service is unacceptable. Plug valves shall have a minimum port opening of 80 percent. Valve seats shall be nickel.

Butterfly valves are acceptable for use in pipelines carrying clean water or air. Butterfly valves shall be designed in conformance with AWWA C504. Valve seat material shall be selected specifically for the intended service.

All valves shall be equipped with operators. Manual operators shall have a maximum pull to operate the valve of 40 pounds. Valves seven (7) feet or more above an operating floor shall have chain wheel operators.

Where a valve that requires regular operation is not readily accessible, consideration shall be given to providing a motor operator for the valve.

3.13 Applicable Codes and Standards

The detailed design of the initial phase of the Regional WRF shall meet the requirements of the City's applicable codes and standards. The City of Eloy has adopted by ordinance the International Building Code, Uniform Fire and Mechanical Codes, National Electrical Code and Maricopa Association of Governments Standards for Public Works Construction. As these codes are updated, the City periodically will adopt the updated codes. The City will provide a list of the applicable editions of these codes upon request.

3.14 Construction Requirements

Construction of the WRF shall be in conformance with the approved plans and specifications.

3.14.1 Project Contractor

The WRF must be constructed by an experienced, licensed, and bonded Contractor.

3.14.2 Acceptable Manufacturer Requirements

The manufacturer/designer of the WRF must demonstrate successful implementation of existing WRFs of similar size and operating characteristics to the proposed project. For confirmation that the manufacturer/designer has a well-established record of accomplishment, the Engineering Report submittal should include reference contact information for at least five (5) operating WRFs of similar size, each with an operating history of a minimum of one (1) year. In addition, the manufacturer/designer shall provide a summary of operating records for each reference WRF demonstrating compliance with applicable regulatory requirements. The submittal should include a copy of regulatory requirements for each WRF, such as Federal, State, County and/or municipal provisions, and local contacts for the local/state regulatory agency.

3.14.3 Local Facilities and Support

The manufacturer must have local representation to attend to the City's needs with regards to design, construction, start-up, and operation. The local contact should have all available means of contact, including electronic mail, telephone, and facsimile access.

3.14.4 Equipment Installation Oversight

Equipment installation shall be supervised by a qualified representative of the manufacturer. The manufacturer's representative shall supervise all field performance tests and checkouts.

3.14.5 Training

A comprehensive training program shall be provided to train City personnel in the operation and maintenance of the WRF. Training in the overall WRF operation shall be given by the WRF Design Engineer. Training in equipment operation and maintenance shall be given by the specific equipment manufacturers.

3.15 Submittal Requirements

The following engineering documents shall be submitted to the City for review and approval:

- Engineering Report: This report must be complete and address all of the requirements and stipulations as described previously in these guidelines.
- Preliminary Design Drawings and Specifications: Submitted when final design is approximately 60 percent complete.
- Final Design Drawings and Specifications.

The Engineering Report shall include applicable geotechnical, structural, mechanical, and electrical design criteria and requirements. A site-specific soils investigation shall be required, with adequate soils information obtained to provide applicable design and construction data. The structural basis of design shall include a description of all structures, loads, soils investigations, design assumptions, and materials specifications. All design calculations, reports, plans and specifications shall be signed and sealed by a Professional Engineer licensed in the State of Arizona. The specifications shall provide enough information for the City to approve of the proposed equipment. A separate equipment and manufacturers lists including cross-references to the specifications is encouraged to expedite the City review process. This list can be created for major items such as pumps, screens, clarifiers, etc.

The City will review all submitted documents. Any question or comments shall be resolved to the City's satisfaction prior to the City issuing of a permit for construction of said facilities.

3.16 Operations and Maintenance Manual

A comprehensive O&M Manual shall be prepared for submittal to the City post-construction and pre-startup. The O&M Manual shall be complete and meet the requirements of A.A.C. Title 18, Chapter 9. A total of five (5) copies of the O&M Manual shall be prepared and turned over to the City.

3.17 Spare Parts

Spare parts shall be provided for all equipment. Spare parts shall be selected to meet the normal requirements of equipment operation and maintenance and to allow emergency repairs without excessive downtime. Spare parts shall be delivered securely wrapped or boxed, indexed and tagged with complete information for use and re-ordering. The required spare parts and tools, based on manufacturer requirements, shall be delivered to the site. A complete inventory shall be given to the City.

As noted in Section 3.4.4 previously, sufficient spare parts shall be provided, in accordance with manufacturer's recommendations, to repair or replace any critical process equipment within 24 hours.

3.18 Applicable Permits

The developer shall be responsible for the development, preparation, and submittal of all pertinent permit applications as listed in Table 3.11.

Table 3.11 Permits Required for Regional WRF Phased Regional WRF Design and Construction Guidelines City of Eloy, Arizona	
Responsible Agency	**Permit/Approval**
Arizona Department of Environmental Quality (ADEQ)	Aquifer Protection Permit (APP)
Pinal County	Air Quality Permit
City of Eloy(1)	Any relevant building permits, etc.
Arizona Department of Water Resources(2)	Recharge Permit, etc.

Notes:

(1) City will provide an overall "Approval to Construct" permit as part of their review process.

(2) Underground storage or storage and recovery approaches will require a permit(s) from ADWR.

(3) Water reclamation will require reclaimed water permit(s) obtained from ADEQ.

3.19 Insurance Requirements

Insurance shall be provided and shall remain in force from the start of construction until WRF acceptance by the City. The following minimum insurance coverage shall be provided:

- Workers Compensation: Coverage as required by the State of Arizona
- Employer's Liability: $1,000,000 each occurrence
- Comprehensive Automobile Liability Insurance: $1,000,000 combined single limit for each occurrence
- Commercial General Liability Insurance: $1,000,000 combined single limit for each occurrence (and general aggregate)
- Umbrella Liability Insurance: $2,000,000 combined single limit for each occurrence (and general aggregate)
- Property (Builder's Risk) Insurance: Full replacement cost
- Design Errors and Omissions Insurance: $1,000,000 minimum

The City of Eloy shall be named as additional insured on all insurance policies.

3.20 Warranties and Guarantees

All warranties for equipment shall be transferred to the City upon acceptance of the WRF. Warranties for equipment shall be for a minimum of one (1) year from the date of acceptance.

A one (1) year guarantee against defective workmanship and materials for the entire facility shall be provided to the City from the date of acceptance. The guarantee shall be as described in Section 108 of the MAG Standard Specifications.

In addition, the treatment process manufacturer shall be available for one (1) year after start up of the WRF to assist in process-related issues.

3.21 WRF Acceptance by City

Before the acceptance of the WRF by the City, the following conditions must be met.

3.21.1 Completion of Construction

All construction activities shall be completed. A final inspection by the City (or City-appointed representative) will be performed to confirm that the final facility is in conformance with the approved Plans and Specifications, as well as any additional requirements by ADEQ and/or Pinal County.

3.21.2 Equipment Performance Test

All equipment shall be tested to indicate that it will operate as specified and that all controls are functioning (including overloads and alarms). A copy of any Field Test Reports performed during construction shall be available during the equipment performance tests.

3.21.3 Facility Performance Test

It shall be demonstrated for a period of three (3) months that the WRF is capable of producing an effluent that meets the specified standards. The WRF operation and maintenance shall be performed by the developer or manufacturer during this time. WRF operating records shall be submitted to the City on a weekly basis. A representative of the City may be periodically on site during this time to observe the performance of the WRF.

3.21.4 Resolution of All Disputes, Claims and Legal Actions

The City will take over the WRF when the title is clear. A waiver of all liens from the Contractor and his subcontractor(s) and supplier(s) shall be provided. Any legal actions or claims that are outstanding that might affect the City shall be resolved prior to acceptance.

3.21.5 Transfer of Documents

The following sets of documents shall be transferred to the City:

- Five (5) sets of record drawings and specifications.
- One (1) reproducible set of record drawings on Mylar.
- Five (5) copies of the completed O&M Manual.
- Five (5) copies of the approved shop drawings.
- Two (2) sets of all construction meeting notes.
- Two (2) sets of all equipment and material tests.

4.0 RECLAIMED WATER SYSTEM

This section presents a description of the criteria to be used for future reclaimed water distribution systems. The ultimate goal of the reclaimed water distribution system is to provide reliable delivery at adequate system pressures. Reliability in a distribution system is typically accomplished by providing system redundancy in the form of looping, extra pumps, and additional storage. In general, the level of system reliability is a function of the reliability of the individual system components.

4.1 Supply, Storage and Pumping

The future reclaimed water system supply will be related to the influent flow to the future Regional WRFs. Reclaimed water from the WRFs, and potentially groundwater pumped from recovery wells, will comprise the source water for distribution to the reclaimed water system.

System storage reservoirs may be provided at the Regional WRFs to serve mainly as "day tanks" to assist in maximizing reclaimed water utilization by capturing excess flow during diurnal peaking. The reservoirs are not intended to function as storage to meet abnormally high or extended demand periods. Additional storage located in the system such as individual large user storage facilities and possibly water from recovery wells, may be utilized to meet peak demands.

Pump stations associated with the reclaimed water system should have the capability to consistently meet maximum day system demands with the largest pump out of service (firm capacity).

4.2 Transmission and Distribution

The reclaimed water distribution system piping will serve to deliver water from the Regional WRFs and storage reservoirs to users throughout the system. A series of performance criteria have been developed for the proposed reclaimed water distribution systems, which has been based upon typical pressurized system design standards. These standards are provided as follows:

- System pressures must be maintained between 20 and 85 pounds per square inch (psi) throughout the reclaimed water distribution system. The maximum allowable pressure in the reclaimed water distribution is set at 85 psi, in order to protect any future PVC pipelines that are installed. At system pressures less than 20 psi, users may not have adequate pressure to operate sprinkler irrigation systems (for example), which will lead to complaints. Consequently, the minimum allowable pressure at any point in the reclaimed water distribution system is to be set at 20 psi. It is the end user's responsibility to provide additional boosting capability to meet pressure requirements exceeding 20 psi.

- Velocity Criteria under maximum day demand conditions:

  Velocity ≤ 5 feet per second (fps) for pipes < 36 inches in diameter (H_L = 2 – 7 ft / 1,000 ft)
- The City will allow the installation of PVC for future reclaimed water mains. The Hazen-Williams design coefficient of roughness for PVC will be 140. (The design coefficient of roughness for ductile iron will be 120.)

4.3 Criteria Summary

Table 3.12 summarizes the criteria that will be used for the reclaimed water system.

Table 3.12 Reclaimed Water System Criteria Summary
Phased Regional WRF - Design and Construction Guidelines
City of Eloy, Arizona

Description	Criteria
Materials	PVC or Ductile Iron
Transmission/Distribution – Velocity/ Headloss Pipe < 36 " in diameter	≤ 5 fps (HL = 2 to 7 ft / 1,000 ft)
System Pressure Criteria	≥ 20 psi ≤ 85 psi
Supply Delivery	In general, customers with on-site storage will be supplied during the day. Direct use customers will be supplied in the evening. It is recommended that flow control valves be used to control contractual deliveries to individual customers.

4.4 Construction Requirements

Reclaimed water systems shall be constructed per the water distribution system standards set forth in the "Uniform Standard Specifications for Public Works Construction" as published by the Maricopa Association of Governments (MAG). However, when crossing potable water supplies, reclaimed water shall be considered equal to sewer in terms of clearance and protection of potable water supplies.

Requirements for construction, submittals, insurance, warranties and guarantees, and transfer of documents shall be in accordance with Section 3.0 herein.

5.0 WASTEWATER COLLECTION SYSTEM

This section describes the capacity requirements of future wastewater collection system improvements. The capacities of gravity sewers, force mains, and lift stations shall be based on the performance and design criteria presented herein. In addition, Appendix A contains the ADEQ requirements for wastewater collection systems and lift station, taken directly from A.A.C. R18-9-E301.

5.1 Pipe Capacities

Sewer capacities are dependent on many factors. These include roughness of pipe, maximum allowable depth of flow, and limiting velocity and slope. The Continuity Equation and Manning's Equation are typically used for steady-flow hydraulic calculations. The Manning's coefficient 'n' is a friction coefficient that varies with respect to pipe material, size of pipe, slightly with depth of flow, smoothness of joints, root intrusion, and other factors. For gravity sewers, the Manning's coefficient shall be set at an 'n' value of 0.013 as this is a typical observed gravity sewer field value. No deviations from this value will be accepted by the City.

5.2 Flow Depth (d/D)

When designing sewers, it is common practice to adopt variable flow depth criteria for various pipe sizes. This criterion is expressed as a ratio of maximum depth of flow to pipe diameter (d/D). Design d/D ratios typically range from 0.5 to 1.0, with the lower values typically used for smaller pipes that may experience flow peaks greater than planned or may experience blockages from debris.

The flow depth criterion for new sewers is 0.5 for diameters less than 12 inches, and 0.75 for diameters 12 inches and greater. However, existing sewers will be evaluated based on a flow depth criteria of 0.9 at peak flows because there are fewer unknowns, especially in established, built-out areas, and because there is no need to replace or provide relief for an existing sewer until flows are at the design capacity of the pipe. The hydraulic criteria used for sizing the proposed gravity sewers will have a greater factor of safety than the criteria used to evaluate the capacity of the existing system due to the uncertainties in making projections of future flows. The proposed difference between the design criteria and the existing system criteria allows full use of the existing sewer capacities and prevents unnecessary pipe replacement. This approach avoids the problem of replacing or upgrading existing sewers prematurely.

In order to minimize the settlement of solids in the flow and promote scour, it is standard design practice to specify that a minimum velocity of 2 feet per second (fps) be maintained when the pipe is flowing half full. At this velocity, the sewer flow will typically provide self-cleaning for the pipe. Due to the hydraulics of a circular pipe, the velocity for half pipe flow approaches the velocity of nearly full pipe flow. Table 3.13 lists the minimum slopes for maintaining self-cleaning velocities with d/D = 0.5. The minimum slope listed in the table is 0.0008 ft/ft, which is the minimum practical slope for gravity sewer construction. Greater slopes are desirable if they are compatible with existing topography, as long as the velocity does not exceed 8 fps.

Table 3.13 Recommended Minimum Slopes for Circular Pipes Phased Regional WRF - Design and Construction Guidelines City of Eloy, Arizona			
Pipe Size (inches)	Minimum Slope(1) (2) (ft/ft)	Pipe Capacity(3)	
		(mgd)	(cfs)
8	0.0034	0.45	0.70
10	0.0025	0.70	1.09
12	0.0020	1.02	1.57
14	0.0016	1.38	2.14
15	0.0015	1.59	2.45
16	0.0014	1.80	2.79
18	0.0012	2.28	3.53
20	0.0010	2.82	4.36
21	0.0010	3.11	4.81
24	0.0008	4.06	6.28

Notes:
(1) Slopes are calculated using Manning's Equation for full pipe flow with a minimum velocity of 2 fps.
(2) Sewers larger than 24 inches should have a slope $\geq$ 0.0008.
(3) Pipe Capacity based on full pipe flow.

5.3 Changes in Pipe Size

When a smaller sewer joins a larger sewer, the invert of the larger sewer will be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the d/D 0.8-depth point of both sewers at the same elevation. Since Geographic Information System data is available for the City's wastewater system, this information will be used for the sewer inverts. For master planning purposes, proposed sewer crowns will be matched at manholes when a smaller sewer joins a larger one.

5.4 Lift Stations

All lift stations (permanent, temporary or "package" type) will require City approval prior to construction. Lift stations to be constructed within the City must conform to the standards set forth herein, as follows:

- Arizona Administration Code R18-9-E301 D, provided in the Appendix.
- Engineering Bulletin No. 11, Chapter V - Minimum Requirements for Design, Submission of Plans and Specifications of Sewage Works, ADEQ, July 1978.
- Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details, latest version.

5.4.1 Lift Station Approval Process

Any lift station design submittal to the City shall include an Engineering Report, signed and sealed by a professional engineer licensed in the State of Arizona; which, must include the following minimum information before submitting for City review and approval:

- Specifications including the manufacturer and model of all equipment.
- Construction drawings.
- Sizing of all major components, pump and system curves, etc.
- Geotechnical report signed and sealed by a professional civil or structural engineer, or a professional geologist, licensed in the State of Arizona.

In addition to the above minimum requirements the following must also be addressed in the Engineering Report:

- Adequate land shall be provided to accommodate potential expansions to the lift station due to future upstream developments and/or expansion of the development served by the lift station. The Wastewater Master Plan and the City should be consulted to determine the potential buildout flows at the proposed lift station location.
- Adequate land shall be provided for future odor control measures, if future conditions dictate odor control. The space for odor control shall be based upon the ultimate lift station capacity (see item above).
- All equipment that requires periodic maintenance shall be easily accessible by City staff. For example, all isolation and check valves shall be placed outside the wet well in a below-grade vault structure that is accessible from grade.
- Unless otherwise directed by the City, a firm capacity equal to three times the average daily flow shall be used to determine the pumping capacity of lift stations. The lift station must be able to provide the "firm" pumping capacity with the largest pump out-of-service.

5.4.2 Temporary and/or "Packaged" Lift Stations

Temporary and/or "packaged" lift station may be acceptable on a case-by-case basis, as determined by the City. Temporary and/or "packaged" lift stations must follow the Lift Station Approval Process and conform to the standards as defined above. If a temporary and/or "packaged" lift stations is approved by the City, the following minimum design standards should be met:

- Temporary or "packaged" lift stations shall be a wet well submersible pump configuration.
- Wet well shall be a circular concrete and may be a manhole conforming to MAG standards. Wet well shall be lined or coated (using T-Lock® or another City approved lining or coating material) to protect the concrete.

- Wet well shall be sized to accommodate the pumps, pump separation (per manufacturer's recommendations), and conform to the sizing requirements in A.A.C. R18-9-E301 D.
- Access cover shall be sized to allow removal of the submersible pumps, lockable, and include a safety grate inside the access cover to reduce the potential of falls into the wet well.
- Duplex (two) submersible non-clog pumps capable of passing a three-inch solid. Triplex (three) pump configuration can also be used if necessary to meet the flow requirements.
- Lifting chain for removal of pumps.
- Pump rails to aid in ease of pump removal.
- Water level control shall be provided to operate pumps and provide high-level alarm. Water level devices shall include a back-up means to ensure high-level alarm operation.
- Influent gravity line shall not free fall into the wet well. A drop pipe or tee (to reduce the potential for odors, surface vortices, and air entrainment) shall be placed on the influent gravity line.
- Lift station shall include a concrete anchoring for a portable lifting hoist in order to remove the submersible pumps. Lifting hoist shall be provided to the City.
- Lift station shall include an audible and visual alarm for high-high alarms.
- Lift station shall include a standby generator capable of operating the lift station during sustained power outages. Alternatively, a portable generator can be used if a standby generator is not warranted. If a portable generator is to be provided the control panel must be capable of relaying a power outage alarm to the City operations personnel.
- Potable water service shall be provided at the lift station.
- Temporary and/or "packaged" lift station must conform to Bulletin No. 11, A.A.C. R18-9-E301 D, MAG Standards, and the requirements as defined this Secion 5.4 Lift Stations.

5.4.3 Normal Operation

Lift station wet well sizing takes into consideration the fill time, based on average flow, and the minimum pump cycle time. The volume of the wet well should provide a retention period not to exceed 30 minutes of average daily design flow. When selecting the minimum cycle time, the pump manufacturer's duty cycle recommendations shall be utilized. Starting and stopping more than seven times an hour for any one pump is not recommended. Refer to A.A.C. R18-9-E301 D and Bulletin No. 11 Chapter V page V-3 for further information on wet well sizing requirements.

5.4.4 Emergency Operation

The objective of emergency operation is to protect public health by preventing sewer back-ups and subsequent discharge into streets and other public or private property. The most

common emergency would be a power outage. Permanent back-up generators and/or portable generators should be considered for each lift station location. The need for a permanent back-up generator shall be considered on a case-by-case basis. If a portable generator is selected to meet standby power needs, the control panel shall be capable of sending a power outage alarm to City operation personnel.

5.4.5 Lift Station Design References

It is recommended that all lift station designs follow "typical" design practices, examples and methodology are provided in the following references:

- Pump Station Design, Sanks
- Hydraulic Institute Standards
- Design Recommendations - Pumping with Large Submersible Centrifugal Pumps, Flygt Systems Engineering.

The Hydraulic Institute Standards should be referenced with care since some recommendations address clean water applications and are not appropriate or require additional accommodations for handling wastewater.

5.5 Force Mains

Lift stations shall conform to the following requirements and standards:

- Arizona Administration Code R18-9-E301 D, provided in the Appendix.
- Chapter V of the Engineering Bulletin No. 11 - Minimum Requirements for Design, Submission of Plans and Specifications of Sewage Works, ADEQ, July 1978.
- Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details, latest version.

In addition, force mains should have a minimum diameter of 6 inches. The velocity should be between 3 and 7 fps to provide scour velocity so that the solids deposited while the pumps are off will be transported when the pumps are operating.

5.6 Gravity Sewer Planning Guidelines

Gravity sewers should be designed and constructed to have a minimum 5 feet of cover or sufficient depth to serve the ultimate drainage area.

Gravity sewers should be designed and constructed with a minimum 4 feet of separation between the flowline of irrigation ditches and the crown of the sewer.

Gravity sewers and force mains should have a minimum separation of 6 feet from potable water mains unless they are encased in concrete as per Arizona Department of Environmental Quality requirements.

Manholes with sewers intersecting at greater than or equal to 90-degree angles should provide 0.2 feet of invert drop across the manhole. Other manholes should provide a minimum 0.1 feet of invert drop.

5.7 Criteria Summary

Table 3.14 summarizes the performance and design criteria used to evaluate existing wastewater collection features and for planning new wastewater collection system features.

Table 3.14 Wastewater System Criteria Summary
Phased Regional WRF - Design and Construction Guidelines
City of Eloy, Arizona

Description		Criteria	
Pipe Size (inches)	**Minimum Slope[(1)(2)] (ft/ft)**	**Pipe Capacity[(3)]**	
		(mgd)	**(cfs)**
8	0.0034	0.45	0.70
10	0.0025	0.70	1.09
12	0.0020	1.02	1.57
14	0.0016	1.38	2.14
15	0.0015	1.59	2.45
16	0.0014	1.80	2.79
18	0.0012	2.28	3.53
20	0.0010	2.82	4.36
21	0.0010	3.11	4.81
24	0.0008	4.06	6.28
Maximum Velocity		≤ 7 feet per second	
Flow Depth, d/D			
d/D for New Sewer Pipes with Diameters less than 12 inches		= 0.5	
d/D for Designing New Sewer Pipes 12 inches and Higher		= 0.75	
d/D for Evaluating Existing Mains in Developed Areas		= 0.90	
Headloss in Existing Pipes			
Gravity Pipes		Manning's n = 0.013	
Pressure Pipes		Hazen William's C = 120	
Changes in Pipe Size			
When a smaller sewer joins a larger one:		Sewer crowns will be matched.	
Headloss at Manholes			
Manholes with pipelines intersecting at 90 degrees or greater		Provide 0.2' Invert Drop	
Manholes with pipelines intersecting at less than 90 degrees		Provide 0.1' Invert Drop	

Notes:
(1) Slopes are calculated using Manning's Equation for pipes flowing full with a minimum velocity of 2 fps.
(2) Sewers larger than 24 inches should have a slope ≥ 0.0008.
(3) Pipe Capacity based on full pipe flow.

Appendix A

SEWAGE COLLECTION SYSTEM REQUIREMENTS (A.A.C. R18-9-E301)

PART E. TYPE 4 GENERAL PERMITS

R18-9-E301. 4.01 General Permit: Sewage Collection Systems

A. A 4.01 General Permit allows a new sewage collection system or an expansion of an existing sewage collection system involving new construction.
   1. A sewer collection system includes all sewer lines and associated structures, devices, and appurtenances that:
      a Are owned or controlled by a public or private sewer utility extending from the treatment works to the upstream points in the system where private owners assume ownership or control; or
      b Serve multiple private users from the upstream points where the individual users assume ownership or control to the downstream point where the sewer delivers wastewater to a sewage collection system owned or controlled by a public or private sewer utility, or to a sewage treatment facility.
   2. A sewer collection system repair is not an expansion of the system that requires a Notice of Intent to Discharge. Repairs include work performed in response to deterioration of existing structures, devices, and appurtenances with the intent to maintain or restore the system to its original operational characteristics.

B. Performance. An applicant shall design, construct, and operate a sewage collection system so that it:
   1. Provides adequate wastewater flow capacity for the planned service;
   2. Minimizes sedimentation, blockage, and erosion through maintenance of proper flow velocities throughout the system;
   3. Prevents sanitary sewer overflows through appropriate sizing, capacities, and inflow and infiltration prevention measures throughout the system;
   4. Protects water quality through minimization of exfiltration losses from the system;
   5. Provides for adequate inspection, maintenance, testing, visibility, and accessibility; and
   6. Maintains system structural integrity.

C. Notice of Intent to Discharge. In addition to the Notice of Intent to Discharge requirements specified in R18-9-A301(B), an applicant shall submit the following information:
   1. A statement, signed by the owner or operator of the sewage treatment facility that treats or processes the sewage from the proposed sewer collection system.
      a The owner or operator shall affirm that the additional volume of wastewater delivered to the facility by the proposed sewer collection system will not cause any flow or effluent quality limits of the individual permit for the facility to be exceeded.
      b If the facility is classified as a groundwater protection permit facility under A.R.S. § 49-241.01(C), or if no flow or effluent limits are applicable, the owner or operator shall affirm that the design flow of the facility will not be exceeded.
   2. If the proposed sewage collection system delivers wastewater to a downstream sewer collection system under different ownership or control, a statement, signed by the owner or operator of the downstream sewer collection system, affirming that the downstream system can maintain the performance required by subsection (B) if it receives the increased flows associated with the new system or the expansion;
   3. A general site plan showing the boundaries and key aspects of the project;
   4. Construction quality drawings that provide overall details of the site and the engineered works comprising the project including:
      a Relevant plans and profiles of sewer lines, force mains, manholes, and lift stations with sufficient detail to allow Department verification of design and performance characteristics;
      b Relevant cross sections showing construction details and elevations of key components of the sewer collection system to allow Department verification of design and performance characteristics, including the slope of each gravity sewer segment stated as a percentage; and
      c Drainage features and controls, and erosion protection as applicable, for the components of the project.
   5. Documentation of design flows for significant components of the sewage collection system and the basis for calculating the design flows;
   6. An operation and maintenance plan if the project has a design flow of more than 10,000 gallons per day;
   7. Drawings, reports, and other information that are clear, reproducible, and in a size and format specified by the Department. The applicant may submit the drawings in a Department-approved electronic format; and
   8. Design documents, including plans, specifications, drawings, reports, and calculations that are signed and sealed by an Arizona-registered professional engineer unless prohibited by law. The designer shall use good engineering judgement following engineering standards of practice, and rely on appropriate engineering methods, calculations, and guidance.

D. Design Requirements.

1. General Provisions. An applicant shall ensure that the design, installation, and testing of a new sewage collection system or an expansion to an existing sewage collection system involving new construction complies with the following rules. An applicant shall:

   a Base design flows for components of the system on unit flows specified in Table 1, Unit Daily Design Flows. If documented by the applicant, the Department may accept lower unit flow values in the served area due to significant use of low flow fixtures.

   b Use the "Uniform Standard Specifications for Public Works Construction," referenced in this Section and published by the Maricopa Association of Governments, revisions through 2000, or the "Pima County Wastewater Management," November 1994 Edition, as the applicable design and construction criteria, unless the Department approved alternative design standards or specifications authorized by a delegation agreement under A.R.S. § 49-107.

   c Use gravity sewer lines, if appropriate. The applicant shall design gravity sewer lines and all other sewer collection system components, including force mains, manholes, lift stations, and appurtenant devices and structures to accommodate maximum sewage flows as determined by the method specified in subsections (D)(1)(c)(i) or (D)(1)(c)(ii) that yields the greatest calculated flow:

      i. Any point in a sewer main when flowing full can accommodate an average flow of 100 gallons per capita per day for all populations upstream from that point, or

      ii. Any point in a sewer collection system can accommodate a peak flow for all populations upstream from that point as tabulated below:

Upstream Population	Peaking Factor
100	3.62
200	3.14
300	2.90
400	2.74
500	2.64
600	2.56
700	2.50
800	2.46
900	2.42
1000	2.38
1001 to 10,000	$PF = (6.330 \times p^{-0.231}) + 1.094$
10,001 to 100,000	$PF = (6.177 \times p^{-0.233}) + 1.128$
More than 100,000	$PF = (4.500 \times p^{-0.174}) + 0.945$
PF = Peaking Factor p = Upstream Population	

   d Ensure the separation of sewage collection system components from drinking water distribution system components under R18-4-502.

   e Request review and approval of an alternative to a design feature specified in this Section by following the requirements of R18-9-A312(G).

2. Gravity sewer lines. An applicant shall:

   a Ensure that any sewer line that runs between manholes, if not straight, is of constant horizontal curvature with a radius of curvature not less than 200 feet;

   b Cover each sewer line with at least three feet of backfill meeting the requirements of subsection (D)(2)(h)(i). The applicant shall:

      i. Include at least one note specifying this requirement in construction plans;

      ii. If site-specific limitations prevent three feet of earth cover, provide the maximum cover attainable, and construct the sewer line of ductile iron pipe or other materials of equivalent or greater tensile and compressive strength;

      iii. If ductile iron pipe is not used, design and construct the sewer line pipe with restrained joints or an equivalent feature; and

      iv. Ensure that the design of the pipe and joints can withstand crushing or shearing from any expected load. Construction plans shall note locations requiring these measures.

c If sewer lines cross floodways, place the lines at least two feet below the 100-year storm scour depth and construct the lines using ductile iron pipe or pipe with equivalent tensile strength, compressive strength, shear resistance, and scour protection. The applicant shall ensure that sewer lines constructed in this manner extend at least 10 feet beyond the boundary of the 100-year storm scouring. Construction plans shall note locations requiring these measures.

d Ensure that each sewer line is eight inches in diameter or larger except:

i. The first 400 feet of a dead end sewer line with no potential for extension may be six inches in diameter if the design flow criteria specified in subsection (D)(1)(c) are met. If the line is ever extended, the applicant seeking the extension shall replace the entire length with larger pipe to accommodate the new design flow; or

ii. The sewer lines for a sewage collection system for a manufactured home, mobile home, or recreational vehicle park are not less than four-inches in diameter for up to 20 units, five-inches in diameter for 21 to 36 units, and six-inches in diameter for 37 to 60 units.

e Design sewer lines with at least the minimum slope calculated from Manning's Formula using a coefficient of roughness of 0.013 and a sewage velocity of two feet per second when flowing full.

i. An applicant may request a smaller minimum slope under R18-9-A312(G) if the smaller slope is justified by a quarterly program of inspections, flushings, and cleanings.

ii. If a smaller minimum slope is requested, the slope shall not be less than 50% of that calculated from Manning's formula using a coefficient of roughness of 0.013 and a sewage velocity of two feet per second.

f Design sewer lines to avoid a slope that creates a sewage velocity greater than 10 feet per second. The applicant shall construct any sewer line carrying a flow with a normal velocity of greater than 10 feet per second using ductile iron pipe or pipe with equivalent erosion resistance, and structurally reinforce the receiving manhole or sewer main.

g Design and install sewer lines, connections, and fittings with materials that meet or exceed manufacturer's specifications not inconsistent with this Chapter to:

i. Limit inflows, infiltration, and exfiltration;

ii. Resist corrosion in the project electrochemical environment;

iii. Withstand anticipated live and dead loads; and

iv. Provide internal erosion protection.

h Indicate trenching and bedding details applicable for each pipe material and size in the design plans. Sewer lines shall be placed in trenches and bedded following the specifications established in subsections (D)(2)(h)(i) and (D)(2)(h)(ii). This material is incorporated by reference and does not include any later amendments or editions of the incorporated matter. Copies of the incorporated material are available for inspection at the Department of Environmental Quality and the Office of the Secretary of State, or may be obtained from the Maricopa Association of Governments, 302 N. 1st Avenue, Suite 300, Phoenix, Arizona 85003, or from Pima County Wastewater Management, 201 N. Stone Avenue, Tucson, Arizona 85701-1207.

i. "Trench Excavation, Backfilling, and Compaction" (Section 601), published in the "Uniform Standard Specifications for Public Works Construction," published by the Maricopa Association of Governments, revisions through 2000; and

ii. "Rigid Pipe Bedding for Sanitary Sewers" (WWM 104), and "Flexible Pipe Bedding for Sanitary Sewers" (WWM 105), published by Pima County Wastewater Management, revised November 1994.

i Perform a deflection test of the total length of all sewer lines made of flexible materials to ensure that the installation meets or exceeds the manufacturer's recommendations and record the results.

j Test each segment of the sewer line for leakage using the applicable method below and record the results:

i. "Standard Test Method for Installation of Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air" published by the American Society for Testing and Materials, (F 1417-92), reapproved 1998;

ii. "Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method" published by the American Society for Testing and Materials, (C 924-89), reapproved 1997;

iii. "Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines" published by the American Society for Testing and Materials, (C 828-98), approved March 10, 1998; or

iv. The material listed in subsections (D)(2)(j)(i), (D)(2)(j)(ii), and (D)(2)(j)(iii) is incorporated by reference and does not include any later amendments or editions of the incorporated matter. Copies of the incorporated material are available for inspection at the Department of Environmental Quality and the Office of the Secretary of State, or may be obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, Conshohocken, PA 19428-2959.

k Test the total length of the sewer line for uniform slope by lamp lighting, remote camera or similar method approved by the Department, and record the results.

3. Manholes.
   a An applicant shall install manholes at all grade changes, all size changes, all alignment changes, all sewer intersections, and at any location necessary to comply with the following spacing requirements:

Sewer Pipe Diameter (inches)	Maximum Manhole Spacing (feet)
4 to less than 8	300
8 to less than 18	500
18 to less than 36	600
36 to less than 60	800
60 or greater	1300

   b The Department shall allow greater manhole spacing following the procedure provided in R18-9-A312(G) if documentation is provided showing the operator possesses or has available specialized sewer cleaning equipment suitable for the increased spacing.
   c The applicant shall ensure that manhole design is consistent with "Pre-cast Concrete Sewer Manhole" (#420), "Offset Manhole for 8" - 30" Pipe" (#421), and "Brick Sewer Manhole and Cover Frame Adjustment" (#422), 1998, including revisions through 2000, published by the Maricopa Association of Governments; and "Manholes and Appurtenant Items" (WWM 201 through WWM 211), Standard Details for Public Improvements, 1994 Edition, published by Pima County Wastewater Management.
   d The material specified in subsection (D)(3)(c) is incorporated by reference and does not include any later amendments or editions of the incorporated matter. Copies of the incorporated material are available for inspection at the Department of Environmental Quality and the Office of the Secretary of State, or may be obtained from the Maricopa Association of Governments, 302 N. 1st Avenue, Suite 300, Phoenix, Arizona 85003, or from Pima County Wastewater Management, 201 N. Stone Avenue, Tucson, Arizona 85701-1207.
   e The applicant shall not locate manholes in areas subject to more than incidental runoff from rain falling in the immediate vicinity unless the manhole cover assembly is designed to restrict or eliminate storm water inflow.
   f The applicant shall test manholes using one of the following test protocols:
      i. Watertightness testing by filling the manhole with water. The applicant shall ensure that the drop in water level does not exceed 0.001 of total manhole volume in one hour.
      ii. Air pressure testing using the "Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test," published by the American Society for Testing and Materials, (C 1244-93), approved August 15, 1993. This material is incorporated by reference, does not include any later amendments or editions of the incorporated matter, and is on file with the Office of the Secretary of State. The material may be viewed at the Department of Environmental Quality, Water Quality Division, or obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, Conshohocken, PA 19428-2959.
   g The applicant shall perform manhole testing under subsection (D)(3)(f) after installation of the manhole cone to verify watertightness of the manhole from the top of the cone down.
      i. Upon satisfactory test results, the applicant shall install the manhole ring and any spacers, complete the joints, and seal the manhole to a watertight condition.
      ii. If the manhole cone, spacers, and ring can be installed to final grade without disturbance or adjustment by later construction, the applicant may perform the testing from the top of the manhole ring on down.
   h The applicant shall locate a manhole to provide adequate visibility and vehicular maintenance accessibility after the manhole has been built.
4. Force mains. If it is impractical to install a gravity sewer line system, an applicant may install a force main if it meets the following design, installation, and testing requirements. The applicant shall:
   a Design force mains to maintain a minimum flow velocity of three feet per second and a maximum flow velocity of seven feet per second.
   b Ensure that force mains have the appropriate valves and controls required to prevent drainback to the lift station. If drainback is necessary during cold weather to prevent freezing, the control system may allow manual or automatic drainback.
   c Incorporate air release valves or other appropriate components in force mains at all high points along the line to eliminate air accumulation. If engineering calculations provided by the applicant demonstrate that air will not accumulate in a given high point under typical flow conditions, the Department shall waive the requirement for an air release valve.
   d Provide thrust blocks or restrained joints if needed to prevent excessive movement of the force main. Construction plans shall show thrust block or restrained joint locations and details. The documentation submitted to the Department for verification of the general permit shall include calculations and analysis

of water hammer potential and surge control measures and shall be signed and sealed by an Arizona-registered professional engineer.

e If a force main is proposed to discharge directly to a sewage treatment facility without entering a flow equalization basin, include in the Notice of Intent to Discharge a statement from the owner or operator of the sewage treatment facility that the design is acceptable.

f Design a force main to withstand, and upon completion test the force main for leakage, at a pressure of 50 pounds per square inch or more above the design working pressure.

g Supply flow to a force main using a lift station that meets the requirements of subsection (D)(5).

5. Lift stations. An applicant shall:

a Secure a lift station to prevent tampering and affix on its exterior, or on the nearest vertical object if the lift station is entirely below grade, at least one warning sign that includes the 24-hour emergency phone number of the owner or operator of the collection system;

b Protect lift stations from physical damage from a 100-year flood event. Construction of a lift station is prohibited in a floodway;

c Lift station wet well design. The applicant shall:

i. Ensure that the minimum wet well volume in gallons shall be 1/4 of the product of the minimum pump cycle time, in minutes, and the total pump capacity, in gallons per minute;

ii. Protect the wet well against corrosion to provide at least a 20-year design life;

iii. Ensure that wet well volume does not allow the sewage retention time to exceed 30 minutes unless the sewage is aerated, chemicals are added to prevent or eliminate hydrogen sulfide formation, or adequate ventilation is provided. Notwithstanding these measures, the applicant shall not allow the septic condition of the sewage to adversely affect downstream collection systems or sewage treatment facility performance;

iv. Ensure that excessively high or low levels of sewage in the wet well trigger an audible or visual alarm at the wet well site and at the system control center; and

v. Ensure that a wet well designed to accommodate more than 5000 gallons per day has a horizontal open cross-sectional area of at least 20 square feet.

d Equip a lift station wet well with at least two pumps. The applicant shall ensure that:

i. The pumps are capable of passing a 2.5-inch sphere or are grinder pumps;

ii. The lift station is capable of operating at design flow with any one pump out of service; and

iii. Piping, valves, and controls are arranged to allow independent operation of each pump.

e Not use suction pumps if the sewage lift is more than 15 feet. The applicant shall ensure that other types of pumps are self-priming and that pump water brake horsepower is at least 0.00025 times the product of the required discharge, in gallons per minute, and the required total dynamic head, in feet;

f For safety during operation and maintenance, design lift stations to conform with all applicable state and federal confined space requirements; and

g For lift stations receiving an average flow of more than 10,000 gallons per day, include a standby power source in the lift station design that may be put into service immediately and remain available for 24 hours per day.

E. Additional Verification of General Permit Conformance requirements. An applicant shall:

1. Supply a signed and sealed Engineer's Certificate of Completion, unless prohibited by law, in a format approved by the Department that provides the following:

a Confirmation that the project was completed in compliance with the requirements of this Chapter, as described in the plans and specifications corresponding to the Provisional Verification of General Permit Conformance issued by the Director, or with changes that are reflected in as-built plans submitted with the Engineer's Certificate of Completion;

b As-built plans, if required, that are properly identified and numbered; and

c Confirmation of satisfactory test results from deflection, leakage, and uniform slope testing.

2. Provide any other relevant information required by the Department to determine that the facility conforms to the terms of this general permit; and

3. If the project has a design flow of more than 10,000 gallons per day, provide a final operation and maintenance plan that includes the 24-hour emergency number of the owner or operator of the system.

F. Operation and maintenance requirements.

1. The permittee of a sewage collection system that includes a force main and lift station or that has a design flow of more than 10,000 gallons per day shall maintain, and revise as needed, an operation and maintenance plan for the system at the system control center.

2. The permittee shall ensure that the operation and maintenance plan is the basis for operation and continuing maintenance of the sewer collection system.

Historical Note

New Section adopted by final rulemaking at 7 A.A.R. 235, effective January 1, 2001 (Supp. 00-4).

Appendix D

TECHNICAL MEMORANDUM NO. 4
SOFTWARE SELECTION,
MARCH 2006

City of Eloy
Sewer Service Area Study

TECHNICAL MEMORANDUM NO. 4
SOFTWARE SELECTION

DRAFT
March 2006

3033 NORTH 44TH STREET, SUITE 101 • PHOENIX, ARIZONA 85018 • (602) 263-9500 • FAX (602) 265-1422

City of Eloy
Sewer Service Area Study

TECHNICAL MEMORANDUM
NO. 4
SOFTWARE SELECTION

TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION 4-1

2.0 SOFTWARE VENDORS 4-1

3.0 HYDRAULIC MODELING SOFTWARE CHARACTERISTICS 4-2
- 3.1 Hydraulic Calculations 4-2
  - 3.1.1 Hydrology Calculations for Wastewater Collection 4-4
  - 3.1.2 Complex Hydraulic Calculations 4-4
  - 3.1.3 Contaminant and Corrosion Potential Modeling 4-4
- 3.2 GIS Interface 4-5
- 3.3 Embedding Modeling Software within CAD, GIS Software 4-6
- 3.4 Customer Service and Support 4-6

4.0 SOFTWARE EVALUATION 4-8
- 4.1 Critical Evaluation Criteria 4-8
- 4.2 Preliminary Evaluation 4-9
- 4.3 Software Selection 4-9

Appendix A "Selecting the Right Model to Analyze Collection System Flows and Hydraulics" by Dent, et al.

LIST OF TABLES

Table 4.1 Software Selection 4-10

1.0 INTRODUCTION

The City of Eloy (City) is planning to purchase wastewater modeling software that will be used to evaluate the distribution and collection systems from the current configurations through buildout. The City is expected to have rapid growth between now and buildout. Consequently, having the ability to effectively plan how the distribution and collection systems should grow is a priority. Specific goals for the software include:

- Provide a reasonable approximation of hydraulic behavior in the networks.
- Be able to create and maintain the model successfully using GIS data.
- Have a user interface that is intuitive and relatively easy to understand.

Carollo Engineers has been asked to provide a recommendation on the software to be purchased for the wastewater collection system model. The purpose of this technical memorandum is to do the following:

- Determine the software functionality that will be required to satisfy the requirements of this project, as well as the software functionality useful to the City.
- Compare tangible and intangible software features to determine an appropriate software vendor.
- Make a software recommendation.

All modeling software packages have a mix of strengths and weaknesses, and no software is perfect, or error free. Each software program is developed to fulfill the vision that the software company has for the software, and the vision each software company has is influenced by the collective experience of the company and client base for that software. Therefore, a software package may be stronger for some applications than for others. Software vendors also have different views on how to provide good software and good support.

This document summarizes information about each vendor, explains software features in relation to the City's needs, and makes a software recommendation.

2.0 SOFTWARE VENDORS

The following wastewater modeling software packages were evaluated:

- H_2OMAP Sewer by MWH Soft.
- InfoSewer by MWH Soft.
- Hydra by Pizer, Inc.
- Infoworks CS by Wallingford Software.

- Mouse by the Danish Hydraulic Institute.
- MIKE SWMM by the Danish Hydraulic Institute.
- XP-SWMM by XP Software, Inc.
- SewerCAD by Haestad/Bentley, Inc.

Both MWH Soft and Haestad/Bentley offer modeling software that uses the EPA-SWMM hydraulic engine. However, these software programs were not considered in this analysis because both vendors offer modeling software that is more appropriate for the City.

Software packages that did not provide dynamic or quasi-dynamic modeling capabilities were not considered in this evaluation.

Background information on each software company is listed below.

MWH Soft is a subsidiary of Montgomery Watson Harza, Inc. MWH Soft is headquartered in Broomfield, Colorado.

Wallingford Software is a British software company.

The Danish Hydraulic Institute (DHI) is a hydraulic research institution that began developing software for internal use, and then began selling the software to outside parties.

Pizer, Inc. is owned by Alan Peyser, who left CH2MHill to form his own company to create modeling software.

XP-Software, Inc. is a spin-off from an Australian engineering company that developed software for internal use, and then began selling the software commercially. XP-SWMM provides an interface for the EPA-SWMM software.

Haestad/Bentley, Inc. is a software company with headquarters in Waterbury, Connecticut. Haestad develops hydraulic modeling software for water, wastewater, and storm water systems. Haestad was purchased by Bentley Systems and the software suite is being incorporated into the Bentley software suite.

3.0 HYDRAULIC MODELING SOFTWARE CHARACTERISTICS

3.1 Hydraulic Calculations

A comparison of the different calculation methods for sewer models is given in the paper "Selecting the Right Model to Analyze Collection System Flows and Hydraulics" by Dent, et al. This paper is provided in Appendix A. This paper provides more detailed information on different hydraulic calculation methods.

There are three categories of collection system hydraulic engines that perform hydraulic calculations. Within each category, the vendors often use slightly different methods of performing these calculations, or handle boundary conditions in a different manner. Each

algorithm has a set of advantages and disadvantages with regard to performance, stability, and accuracy. The main three categories are as follows:

- Steady state calculations that assume normal depth for open channel pipeline flow. Extended period models make steady state calculations at specified time intervals throughout a simulation.
- Quasi-dynamic calculations that route flow using a simplification of the Saint Venant equations that neglect the momentum term in the equations.
- Fully dynamic calculations that solve the full Saint Venant equations, and can calculate the full dynamic behavior of water in a collection system.

A **Steady State** model assumes that the flow through the pipe is at normal depth, and water depth in the pipe is calculated assuming completely steady conditions. Prior to the hydraulic calculations, the amount of flow through each pipe is calculated by summing up the loads on the upstream pipes and manholes. Peaking factors can be applied to the loads. A steady state model is useful for sizing mains in simple collection systems during an initial design. Software programs that include steady state calculation features are SewerCAD, InfoSewer, and H_2OMAP.

A **Quasi-dynamic** model routes flows through the collection system using a method of dynamic calculations. The momentum term in the Saint Venant equation is neglected, so the effects of inertia are not considered. Therefore, if the flow hydrograph results in reverse flow, spilling manholes in a pressurized system, or dynamic storage, the hydraulic calculations are not as accurate. Neglecting the momentum term often gives a more conservative solution. A quasi-dynamic model is used where it is necessary to route flow through the collection system, aggregating the peak flows, as well as attenuation. Modeling software with a quasi-dynamic algorithm include Hydra, InfoSewer, H_2OMAP, and SewerCAD. XP-SWMM also has a quasi-dynamic option.

A fully **Dynamic** model calculates the full inertial effects of water in a collection system or drainage system. These models will predict reverse flow, manhole overflows, and changes in storage volumes in large mains. A fully dynamic model is used for combined sewer/ drainage systems, areas with high water tables, high rainfall, and flat elevations. Collection systems in these environments must be able to predict reverse flow, and route these storm flows through the collection system. Dynamic models are much more complex than other models, and require more data. The fully dynamic models are Mouse, Infoworks CS, XP-SWMM, Info SWMM, H_2OMAP SWMM, and MIKE SWMM.

The City collection system is relatively simple in comparison with the collection systems of large cities, particularly where the annual precipitation is high. Model studies to size future mains do not require an analysis of flow conditions using dynamic model functionality. The City is located in an arid climate and does not have a high water table. Inflows from relatively infrequent storm events are expected to be minor, so there is no need for sophisticated software functionality to handle storm events. The purpose of the future

planning scenarios that will be analyzed using the model is to size mains in a way that surcharging in manholes does not take place. Therefore, the fully dynamic modeling functionality would most likely not provide more value than a quasi-dynamic model in sizing mains or in understanding the hydraulic behavior in the network.

The quasi-dynamic model is appropriate for the City because it will route flows through the collection system to simulate the time varying effects of the wastewater hydrograph to verify that the maximum allowable depth in the mains is not exceeded and because it provides an accuracy that will provide good results.

3.1.1 Hydrology Calculations for Wastewater Collection

Some software packages are designed to be used for sanitary systems, combined systems, and drainage systems. Therefore, the software includes the capability to calculate runoff flows and time of concentration using the SCS method or a number of other calculation methods. The software packages that provide the option of this functionality include Hydra, Mouse, Infoworks CS, XP-SWMM, H_2OMAP, InfoSewer, and MIKE SWMM.

The City sanitary system is not a combined system; therefore, overland flows do not need to be estimated and routed through the collection system. Therefore, the hydrology calculations available in some software packages may be useful, but are not required.

3.1.2 Complex Hydraulic Calculations

Some software packages have the ability to use multiple friction loss equations to predict the head loss through a variety of conduits. The software packages that have this functionality include Hydra, Mouse, Infoworks CS, XP-SWMM, Info SWMM and MIKE SWMM. The Mannings Equation is considered to be adequate to predict friction losses in open channel pipes. The Hazen-Williams or Colebrook - White Equation is adequate for pressurized pipe friction loss calculations.

The City presumably has only circular conduits, so the software functionality that calculates flow and depth in a wide variety of channel shapes would not be needed to model the collection system.

3.1.3 Contaminant and Corrosion Potential Modeling

Some software packages have the ability to track contaminant concentrations for the purpose of evaluating pretreatment options. Algorithms are also available to predict likely areas of high hydrogen sulfide concentrations. H_2OMAP Sewer and InfoSewer have these capabilities.

3.2 GIS Interface

Some of the software packages have the ability to read GIS shape files and translate this data to a format used by the modeling software using a separate or embedded data translation routine (SynerGEE, Mike Net, Water/Sewer CAD, Hydra, XP-SWMM, Mouse). These translation routines allow the user to map the shape file data fields to fields in the databases or flat files used by the modeling software. Some of these interfaces require separate, customized data conversion routines.

The H_2OMAP software stores data directly in GIS shape files. Data from shape files, Excel files, or AutoCAD files can be converted to the shape file format using an embedded data translation routine. In addition, the model results are also stored in shape files, or databases that can be joined to shape files. Therefore, model data and model results can be used directly by Arc View, and all data entry, cleanup, and display capabilities in GIS software is available for modeling projects. This GIS interface is more direct, and simplified than other software packages.

Most of the software packages have limited ability to clean up GIS data with topology flaws. Data must be cleaned up completely in the GIS before that data can be extracted to the model. Modeling software that can identify and help clean up GIS data benefits the modeler because the GIS data does not need to be perfect at the time it is imported into the model. Data diagnostic and cleanup tools within the modeling software save time and simplify the model creating and updating processes. Infoworks and H_2OMAP have the ability to find and resolve topology problems as well as missing data in the modeling software itself. Water GEMS InfoSewer and InfoWater utilize native GIS functionality to perform data cleanup tasks. Water CAD has routines that are useful to locate topology problems so that they can be fixed manually. Once cleaned up, this information can be sent back to the GIS using these software packages.

Infoworks for water and sewer provides a considerable amount of GIS functionality within the modeling software. Their philosophical view seems to be that modeling is the "center" of infrastructure management activities and therefore the model database is updated and maintained as the source of asset information. This contrasts with a more prevalent view that the GIS database is the central database of spatially related asset information for a utility. Many applications, including modeling, extract GIS data as required for the application, but the data is maintained and updated primarily in the GIS. Infoworks WS, therefore, has GIS functionality to perform tasks that could be completed by using a copy of Arc View, at a much lower price.

Although Eloy currently does not have infrastructure data in a GIS format, the existing mains in the Eloy system will be digitized using GIS software because this is the most efficient way to convert data on paper maps to a digital form. A spin-off benefit of digitizing this data for the model will be that this same data can be used for creating maps, asset

management, and other GIS related tasks. Therefore, it is advantageous to have software that works well with GIS data.

3.3 Embedding Modeling Software within CAD, GIS Software

The software packages run either in Arc GIS (InfoWater, InfoSewer, and Water GEMS), or as stand-alone software packages (H_2OMAP, Hydra, Mouse, XP-SWMM). There are advantages as well as disadvantages in having modeling software running inside a third party software package. Software costs may be higher if additional copies of Arc GIS must be purchased to do modeling analysis.

Modeling software that runs inside Arc GIS is intended for users that work frequently with Arc GIS. The advantage of this software is that GIS data manipulation, analysis, and display functionality can be used directly in the modeling environment. GIS data formats such as geodatabases that are used with ESRI's Arc GIS products can also be used directly. Software performance however is not as fast, and when Arc GIS is updated, increased costs, delays, and hassles can result as the modeling software is updated with the GIS software.

Stand-alone modeling software has the advantage of being independent of the complexities and problems that are inherent with embedding modeling software within third party software. Our experience has been that stand-alone software tends to have fewer errors, and it is easier for the software vendor to maintain the software and associated modules. The interface with GIS is not compromised when model data and results can be saved directly in file formats that are read directly by GIS software. The full power of the GIS is therefore available for modeling applications.

Carollo recommends a stand-alone modeling software package to avoid the complications that are caused by embedding modeling software in third party software packages.

3.4 Customer Service and Support

An evaluation of customer service and support provided by software vendors is subjective at best, since the evaluation is influenced by the specific personalities of both parties, the relationship that may exist between the parties, and the time constraints that the vendor may be under during the time that contact is made. Anecdotal information obtained from other software users is subject to biases as well. However, establishing and maintaining a good working relationship with the vendor can be very helpful to maximize the benefits obtained from the software. Maintaining a good personal relationship with the software vendor is probably the most effective way to obtain extra support and software enhancements when needed. During the software evaluation process, experiences with each vendor are explained below.

Haestad/Bentley – Anecdotal information obtained from other users was mixed. With the recent Bentley acquisition, turnover with support staff has resulted in inexperienced staff. Also, Bentley has demonstrated a focus on promoting their combined product suite, which does not necessarily serve the interests of modeling software clients.

Wallingford Software – Expertise of the more experienced support staff are based on European practices, which are different from U.S. practices in some areas. The U.S. based office of Wallingford Software was probably the least responsive of all the vendors contacted. Anecdotal information gathered about customer support in the U.S. was not complimentary.

Danish Hydraulic Institute – DHI Software is based in Denmark, but has four offices in the U.S. to provide support and project work. Mike Net is scheduled to be updated in the future to an integrated water/wastewater package called Mike Urban. Mike Urban is expected to be integrated in some fashion with ESRI's Arc GIS software. However, this upgrade has been delayed, and is not available in time for this project. Anecdotal information gathered about this vendor's software and support was complimentary.

MWH Soft – Experience has shown that this vendor is very responsive to clients needing support and is able to quickly provide enhancements when needed. Anecdotal information gathered from other users of this software was complimentary and consistent with Carollo's experience.

The City should select a vendor that has a good chance of a stable future to reduce the chance that the model would need to be converted to work with a different software package. With intense competition and the rapidly changing computer and information technology environment that we live in today, there are no guarantees that any vendor will always remain the preferred choice. Historically, those vendors that were leaders in supplying water modeling software ten years ago are not necessarily the same vendors that are perceived to be leaders today. Traits of software vendors that improve the chances for future viability include the following:

- Company leadership, clear direction for the software products.
- Strong focus on applying or creating new technology to make the software better than competitors.
- Emphasis on changing and adapting to meet clients needs and expectations.
- Open software architecture that allows information to be passed easily between related software and information systems.

4.0 SOFTWARE EVALUATION

4.1 Critical Evaluation Criteria

Carollo believes that the following list summarizes the most important criteria for selecting the software:

1. The hydraulic computation algorithms should represent the current state of the art in hydraulic modeling.

2. The software should run on commonly available hardware and operating systems.

3. The software should have an open architecture and use standard data formats so that data can be easily imported into the software, and so that model results can be exported in a variety of forms to effectively communicate simulation results. The software should have the ability to edit, clean, and improve data so that imperfect data can easily be improved to a model ready quality. Because GIS data is increasingly used to store spatial data, the software should be designed specifically to work with GIS data.

4. The software vendor should be consistently profitable, be a leader in the field, and have a vision for how the software will develop and improve. In this rapidly changing marketplace, the software company must remain current with technology and have a meaningful portion of the market share in order to have the resources to update, enhance, and support the software. A larger user base also provides the company with more ideas to improve the software.

5. The software should be well supported with responsive staff that can quickly help the modeler, or improve the software to meet the client's software requirements. When the vendor staff are available and responsive, the modeler can establish personal relationships with the vendor that helps the vendor to effectively meet the modeler's needs.

6. The software user interface should be intuitive and easy to use. This includes easy to use toolbars, menus, displays, scenario management, output tables, graphs, queries, and selection capabilities.

7. The software should provide the best value for the money in helping the City manage a capital improvement program.

4.2 Preliminary Evaluation

The first step in selecting the software is to eliminate the software packages that cannot meet the criteria listed above after a cursory comparison of the software capabilities against the criteria list in 4.1 above. Based on this comparison, the following software packages were eliminated from further consideration for the reasons stated below:

Wastewater Modeling Software:

- Hydra - No. 3 - Although an interface with the GIS is provided, it is limited and awkward to use. Some data formats are proprietary and there is no easy or automated way to manage the many files required for the software. No. 4 and 6 - The software vendor has not maintained a user interface that utilizes the features available with current technology. No. 7 - A water model is not offered. No 8 - No compelling value for the money.
- XP-SWMM - No. 3 - The data interface with GIS is more limited when compared with other vendors. No. 6 - The software interface appears outdated. No. 7 - A companion water modeling software package is not offered. No. 8 - No compelling value for the price.
- Infoworks – No. 5 - The software is marketed by Wallingford software in England and support has sometimes been less than desired. The software has been designed for European practice, which has differences from U.S. practice. No. 7 - Although rich in features, this software is very expensive and less expensive software provides all the functionality that is needed for the City.
- Mouse - No. 7 - This software is rich in features but offers no compelling value for the price for the City's relatively small collection system.

Stand -alone software is recommended for the City, so InfoSewer and INFO SWMM have been eliminated from consideration.

4.3 Software Selection

Table 4.1 shows a summary of features for sewer modeling software. H_2OMAP Sewer has a load allocation module and data cleanup tools that Sewer CAD does not have. In addition, H_2OMAP Sewer has advantages over Sewer CAD such as an open database, lower price, more sophisticated hydraulic engine, good support, and industry leadership. For these reasons, H_2OMAP Sewer is recommended for the City.

H_2OMAP Sewer is used by other Arizona communities including Chandler, Prescott Valley, Show Low, Casa Grande, Eloy, Prescott, Gilbert, Mesa, Goodyear, Scottsdale, and Avondale.

Table 4.1 Software Selection
City of Eloy Sanitary Sewer System Model

	H_2OMAP Sewer, MWH Soft	InfoSewer by MWH Soft	SewerCAD, Haestad /Bentley	Hydra, Pizer	XP-SWMM, XP Software	MIKE SWMM, DHI Software	Mouse, DHI Software	Infoworks, Wallingford Software
Company Characteristics								
Number of current software licenses of sewer modeling product with active support agreements in the U.S.	1,000+	hundreds	~3,900	~1,000	~1,000	~1,000	~500	~150
Provides companion water modeling software	yes	yes	yes	no	no	yes	yes	yes
Provides storm water drainage modeling capabilities or companion software	yes	yes	yes, in a separate package	yes	yes	yes	yes	yes
Customer support	very good	very good	good	fair	good	good	good	fair
Price, assuming 5,000 pipes	$8,000	$8,000	$13,500	$4,500	$11,000	$5,000	$14,000	$32,000
Price of additional modules	$1,000	$1,000	$0	$0	$1,000	$4,400	$4,400	$0
Total M & S annual fee	$2,000	$2,000	$3,800	$1,250	$1,000	$450	$2,000	$5,000
Software training provided by the vendor, per person	$1,200	$1,200	$1,500 regular, $995 special	$1,200	$1,000	varies, $500 (web based)	varies, $500 (web based)	free if by June 30
Floating or network licenses	yes	yes	yes	no	yes	yes	yes	yes
Company stability	good	good	good	fair	fair	good	good	good
Additional modules required	load generation	load generation	none	included	GIS Interface	GIS Interface	GIS Interface	none

Table 4.1 Software Selection
City of Eloy Sanitary Sewer System Model

	Usefulness to Eloy 3 = essential, 2 = useful, 1 = possible value, 0 = no value	H_2OMAP Sewer, MWH Soft	InfoSewer by MWH Soft	SewerCAD, Haestad/ Bentley	Hydra, Pizer	XP-SWMM, XP Software	MIKE SWMM, DHI Software	Mouse, DHI Software	Infoworks, Wallingford Software
Technical Characteristics									
Compatible with Windows 2000, MS Office 2000	3	yes	yes	yes	yes	yes	yes	yes	yes
Compatible with Arc View 9.1 (geodatabases)	2	yes	yes	yes	no	no	no	no	no
Hydraulic engine source	n/a	proprietary	proprietary	proprietary	proprietary	Modified SWMM	SWMM	proprietary	proprietary
Steady state, normal depth hydraulic calculation	2	yes	yes	yes	no	no	yes	yes	no
Quasi-dynamic hydraulic calculation	3	yes	yes	yes	yes	yes	yes	yes	no
Fully dynamic	1	no	no	no	no	yes	yes	yes	yes
Storm water runoff and time of concentration hydrology calculations	0	yes	yes	no	yes	yes	yes	yes	yes
Reads and writes to shape files directly	3	yes	yes	no	no	no	no	no	no
Converts shape file data using an interface	2	no	no	yes	yes	yes	yes	yes	yes
Tools to fix GIS data topology problems	2	yes	yes	partial	no	no	yes	yes	yes
Database driven	3	yes	yes	yes, proprietary	no	no	yes	yes	yes
Automatically sizes new mains	2	yes	yes	yes	no	no	no	yes	no
Calculates pipe replacement costs	2	yes	yes	yes	no	no	no	no	no
Calculates loads based on land use	3	yes	yes	via Arc View	yes	no	yes	yes	yes
Estimates elevations of intermediate manholes when missing	2	yes	yes	no	no	no	yes	yes	yes
Tracks source, age, or water quality parameters	1	yes	yes	no	no	no	no	no	yes

Table 4.1 Software Selection
City of Eloy Sanitary Sewer System Model

	Usefulness to Eloy 3 = essential, 2 = useful, 1 = possible value, 0 = no value	**H_2OMAP Sewer, MWH Soft**	**InfoSewer, by MWH Soft**	**SewerCAD, Haestad/ Bentley**	**Hydra, Pizer**	**XP-SWMM, XP Software**	**MIKE SWMM, DHI Software**	**Mouse, DHI Software**	**Infoworks, Wallingford Software**
User Interface									
Scenario manager	3	yes	yes	yes	no	no	no	yes	yes
Customizable tabular reports	2	yes	yes	yes	no	yes	yes	yes	yes
Graphically compares the results of multiple simulations	2	yes	yes	yes	no	no	yes	yes	yes
Displays GIS data layers on screen	2	yes	yes	no	no	no	yes	yes	yes
Export tabular data to Excel	3	yes	yes	yes	yes	yes	yes	yes	yes
Update existing elements from GIS shapefiles	2	yes	no	no	no	no	no	no	yes
Information libraries	1	no	no	yes	no	no	no	no	yes

Appendix A

"SELECTING THE RIGHT MODEL TO ANALYZE COLLECTION SYSTEM FLOWS AND HYDRAULICS"

by Dent, et al.

SELECTING THE RIGHT MODEL TO ANALYZE COLLECTION SYSTEM FLOWS AND HYDRAULICS

Shawn Dent, P.E.*, Len Wright, PhD, P.E.[1], Jason Nikaido[1]
*Carollo Engineers P.C., **sdent@carollo.com**
[1]Carollo Engineers P.C.

ABSTRACT

There are a wide variety of public domain and commercial sewer system models available today. It can be challenging to select a model that meets the goals of a specific project due to the myriad of features now available in most software packages. The purpose of this paper is to provide a guide for selecting a model to analyze flows and hydraulics within a collection system network. A variety of core model features are detailed including dry and wet weather flow estimation, and hydraulics. The computational algorithms that are used in many models, such as the Saint-Venant equations, are also summarized. Other features are discussed that allow for the efficient management of data and the effective display of results. Various model application levels including gross planning, detailed planning, and design are also addressed.

KEY WORDS

Model, Collection System, Flow Estimation, Hydrology, Hydraulics, Infiltration and Inflow, Commercial Software

INTRODUCTION

The purpose of this paper is to provide a guide for selecting a model to analyze flows and hydraulics within a collection system network. There are a wide variety of public domain and commercial models available; some commercial models were developed by private software companies, while others are simply repackaged versions of public domain models and are sold by software companies with value-added support services. Still others are hybrids, they had their genesis as public domain models but subsequently private software companies have made significant additions and improvements. With the many choices on the market today, it can be challenging to select a model that meets the goals of a specific project and budget.

There are a wide variety of features available in most models today, including sophisticated interfaces, database and Geographic Information Systems (GIS) links and several different computational options. This paper cannot hope to cover details of every model, however the fundamental features in most models can be divided into understandable components. This paper will describe these core components of collection system models, delve into the specifics of generating both dry weather flow (DWF) and wet weather flow (WWF), compare the different hydraulic algorithms used to route flows through a pipe network, and include methods to select the right model for an individual system. This paper identifies specific commercial models, but attempts to compare these models based on only the core hydraulic features without taking into account the myriad of other features that may play into the selection of a specific model.

WHAT IS A MODEL?

A model is a schematic description of a system, theory, or phenomenon that accounts for its known or inferred properties and may be used for further study of its characteristics (dictionary.com). Frequently the most convenient and useful system models are mathematical in nature, and are solved with computer algorithms in software packages. This is what constitutes a "model" for most water resource engineers, and is the working definition for this paper. Every model is a simplification of the real system. The applicability of a given model depends on the degree of simplification that can be applied while still representing the system in a meaningful way to solve a problem. The accuracy and precision required dictates the amount of simplification the model should compromise from reality for a given project (e.g. planning level vs. design level). A model can be as simple as a spreadsheet with calculations for peaking factors of sanitary sewer flows and Manning's equation for calculations of depth and velocity in a single pipe. Or a model can be a complex, fully dynamic model that accurately simulates a sewer network with thousands of basins and pipes in a sophisticated software suite of programs.

Models can be classified in many different ways. Some of the basic classifications are included as applicable to collection system models. This paper deals strictly with sanitary and combined sewer system models, although many of the model traits are also applicable to storm water models. Some common ways of classifying models include:

- *Hydrologic vs. Hydraulic* – a hydrologic model estimates flow quantity over time, while a hydraulic model estimates properties of flow (typically depth and velocity) as it travels through a channel or a network of pipes. For the purposes of this paper, a hydrologic model will also be referred to as a flow estimation model since sewer modeling usually requires estimates of both DWF and WWF.
- *Deterministic vs. Stochastic* – deterministic models produce identical outputs for a given set of inputs while stochastic models produce different outputs for a given set of inputs (Nix, 1994). Stochastic models contain random variables usually defined by a probability density function, are used for probabilistic hydrologic projections, and are sometimes referred to as statistical models. Stochastic models will not be covered in this paper.
- *Lumped vs. Distributed* – these terms are applied to both hydrologic as well as hydraulic models. A lumped hydrologic model assumes that all characteristics are constant over a watershed or sewer basin, while a distributed hydrologic model accounts for spatial variability as a function of position in a watershed (Nix, 1994). In a lumped hydraulic model, the flow is calculated as a function of time alone at a particular location, while in a distributed hydraulic model, routing of flow is calculated as a function of space and time throughout the system (Chow et al, 1988).
- *Static vs. Dynamic* – a static simulation usually refers to a steady-state analysis of a single flow rate (e.g. a peak flow), while a dynamic simulation refers to time-variable flows typically over at least a day's period for sewer related analyses.
- *Single-Event vs. Continuous* – both single-event and continuous refer to a dynamic simulation (i.e. variation in flow characteristics are estimated over time). However for single-

event simulations, one event is analyzed based on some "event definition". This could include an "event" defined as one day of DWF, or a single WWF event based on a minimum dry antecedent period. Continuous simulation refers to an analysis of both wet and dry periods in chronological sequence; the flow response of dry as well as wet periods is simulated. Continuous simulation is commonly used to estimate the probability of peak flows or volumes.

Most modern collection system models are deterministic and contain both hydrologic (or flow estimation) and hydraulic modules. Most models utilize lumped hydrologic processes, while hydraulic calculations can be either lumped or distributed. The majority of models simulate single-event projections, while some are also able to accommodate continuous simulations. For large collection systems, continuous simulation usually requires a more simplified model than single event analyses warrant, in order to reduce model run times.

WHY USE A MODEL?

It is always important to step back and ask if a model is necessary for a specific project. Many times the answer to this question is "yes", even if that model is a spreadsheet with simple calculations. In fact, deciding on the degree of model sophistication required to solve a problem can be most challenging. All to often it is tempting to use the most sophisticated hydraulic model complete with GIS interfaces and a myriad of other features to model every pipe in a collection system. However the cost of this comprehensive modeling is frequently high, and many problems are more aptly, and cost-effectively accommodated using a more simplified model coupled with decision analysis tools (e.g. cost effectiveness models, uncertainty analysis and multiple objective optimization). This is especially true for planning level analyses. Assuming the project warrants analyses beyond what can be done in a spreadsheet, then some reasons to consider more sophisticated modeling software include:

- *Limitations in flow measurement* – Flow measurements should be included in any collection system modeling effort, but there are two major drawbacks to only using flow measurements for analysis of a collection system. First, you can only measure so much. Accurate flow monitoring is expensive, and unless the smallest project is considered, monitoring cannot fully describe the flows and hydraulics in a system. Second, the sewers and flows change over time. For example, service areas grow, pipes get rerouted, and new pipes age and deteriorate thus causing more infiltration and inflow (I/I) to enter the system. All of these factors could cause measured flows to be out of date within a few years.
- *Ability to predict* – one of the main reasons to model a system is to examine "what-if" scenarios once a model is calibrated and accurately predicting results. A model can provide spatial predictions of future DWF (based on changes in land use or population). A model can predict whether an improvement in a section of pipeline will be adequate. Many of today's commercial models allow for scenario management to allow the modeler to test an almost unlimited amount of alternatives.
- *Stakeholder education* – many models today include impressive graphical displays of information in a variety of formats (e.g. graphs, dynamic "movies", maps, etc.). Model output can be directly used to educate stakeholders at all levels within an organization, including board members, managers, engineers, and even operators. It is very useful to verify

model results with field observations from operators. This may also help in the future by demonstrating to operators system performance during unobserved, infrequent events, e.g. where to look for future Sanitary Sewer Overflows (SSOs), effects of major wet weather events on pump station failures, etc.

Assuming a model needs to be used, the real question then is… How detailed should the analysis be to efficiently and accurately solve the problem? To address this issue, the core components of a model will be examined, followed by more detailed descriptions of the flow estimation and hydraulic algorithms of a collection system model.

COMPONENTS OF A MODEL

The basic components of a model include input data, computational algorithms, output data, and a graphical user interface (GUI). Input data are included to describe the physical geometry of the system, define boundary conditions (i.e. at outfalls), and delineate time series that drive the system (e.g. rainfall, flow rates, etc).

The computational algorithms make up the "engine" that drives a model. Unfortunately, like engines in an automobile, model engines can be easily misunderstood and forgotten about when all that is seen is the "shiny exterior." The computational algorithms will be discussed in detail below in the flow estimation and hydraulics sections. Output are the results of the computational algorithms and may include time series (e.g. flow, velocity, depth for given pipes), scatter graphs (i.e. velocity vs. depth), volumes, hydraulic grade lines (HGL's), pipes that surcharge, nodes that overflow, depth to diameter (d/D) ratios of flow in pipes, and other statistics. Model output can be voluminous, so it is important that a model utilize some type of GUI that helps the user manage large quantities of information efficiently.

The purpose of a GUI is to facilitate efficient data input, execute the model runs, and present the results. It is easy to become enamored with all the features in today's models GUI's, and loose sight of what is happening "inside" the model; the computational algorithms that produce the results. Ultimately the decisions that will be made based on model results are inextricably tied to the features that today's model GUI's provide, which makes it is easier than ever to misapply a model to a given project. Typical features that are common to many model GUI's for management of both input and output are:

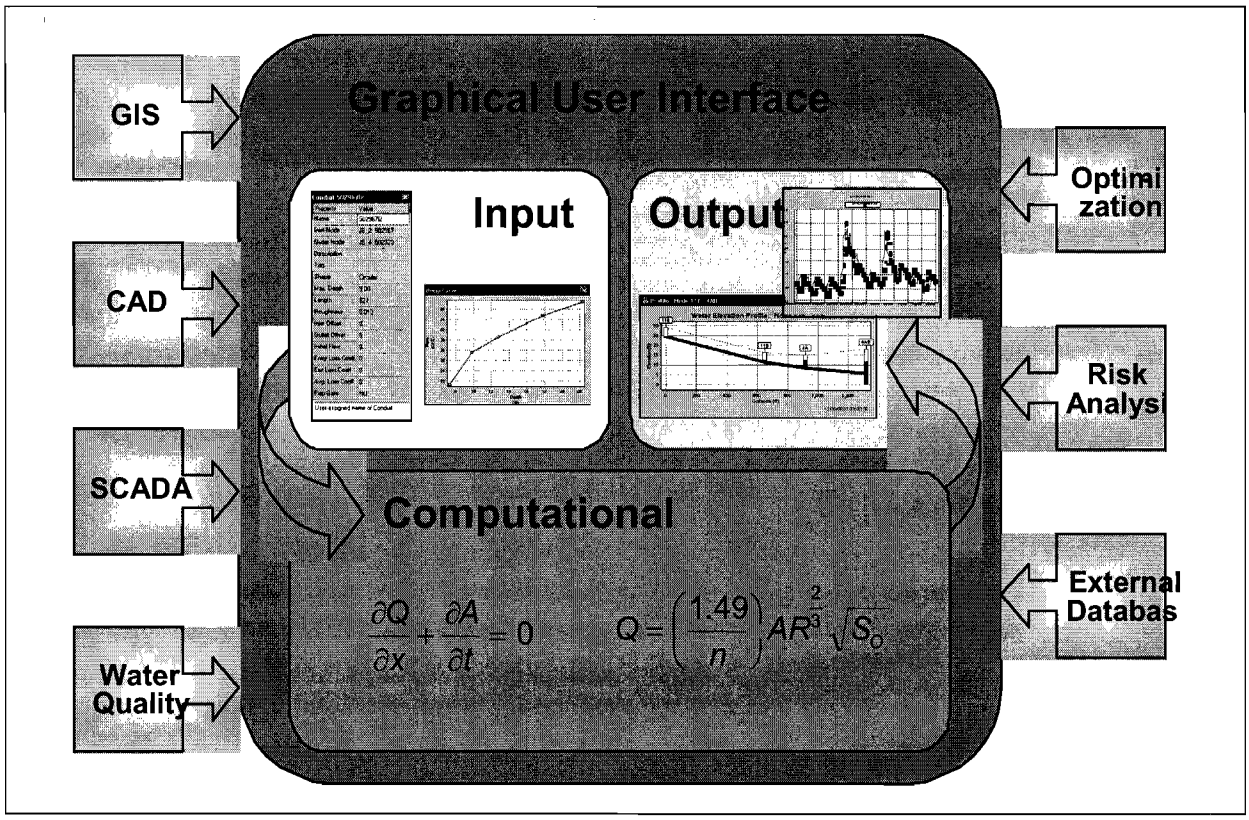
- *Time series database with tabular and graphic capabilities* – used to manage variables (e.g. hydrographs)
- *Spatial database with tabular and mapping capabilities* – used to manage structures and connectivity within the system (e.g. what pipes connect to what junctions)
- *Scenario manager* –manages multiple model runs in a structured format (otherwise model runs need to be managed at a file level by the modeler).
- *Model execution* – allows for starting a run and observing errors.
- *Dynamic displayer* – allows for dynamic display of results in either plan view or profile view. Plan view is typically a map were pipes and nodes change in size or color depending

on certain output variables. A profiler displays a pipeline segment with a varying HGL as it changes throughout the model simulation.

The spatial database feature can either be built into the model, or can be separate Geographic Information System (GIS) software. Many collection system models are moving toward integrating the model with a GIS (e.g. ArcView, ESRI). This provides the advantage of utilizing the graphical and database features of the GIS (without reprogramming them into the model). This structure leverages the many features within GIS and does not require the model to import or export data to a GIS since the data structure is already within the GIS. This feature significantly increases efficiency in inputting data as well as displaying results. The downside of this structure is that the GIS software has to be purchased along with the commercial model.

There are a variety of other model features too numerous to list. However, it's worth noting some linkages that now can be made relatively easily between modeling software and other software to expand the model's capabilities. Certain models now provide linkages to GIS, Computer Aided Design (CAD) software, Supervisory Control And Data Acquisition (SCADA) software, water quality models, optimization and risk analysis software, and external databases. **Figure 1** illustrates a conceptual layout of model components.

Figure 1 – Conceptual Layout of Model Components



FLOW ESTIMATION

Flow estimation is sometimes an overlooked aspect of collection system modeling. However, it is just as important as hydraulics in sizing improvements. If flows are not correctly estimated, the results from the hydraulic calculations will be inappropriate for estimating new or improved pipeline sizes. Flow estimation in a collection system model can be divided into DWF and WWF estimation. DWF is generated by domestic, commercial and industrial wastewater flows throughout a collection system. WWF represents the hydrology of the system and is a factor of the rainfall that enters a collection system either through designed sources, as is the case with combined sewers, or thorough deteriorated facilities or illicit connections, as is the case with sanitary sewers.

Dry Weather Flow

Depending on the complexity of the model, DWF's can either be directly entered into the model or calculated using GIS techniques. A simple approach could consist of calculating an Average Dry Weather Flow (ADWF) for a sewer basin, then applying a peaking factor (typically based on ADWF, sewer basin area, or population) to estimate a peak instantaneous DWF. This single flow value could then be used to calculate the hydraulic capacity required for a pipeline (i.e. steady-state analysis where variability in flow rate is taken into account in the conservativeness of the assumptions underlying ADWF and the peaking factor).

Land use, demographic data (population and employment), and water-use records are typically used to estimate DWF. Population and employment projections may be available as Transportation Analysis Zone (TAZ) data or Census data. Land use information may be available from local planning departments. Water use records may be available from local water agencies (however, water services boundaries may not directly overlap with sewer service boundaries and adjustments must be made). To efficiently utilize this spatial data, especially if it is available at a parcel level, a GIS is a necessity.

Some models, especially those that are integrated with GIS, have the capability of converting this information into Average Dry Weather Flow (ADWF) buy applying unit flow factors (e.g. gallons per capita per day, or gallons per acre per day) directly in the model software. This feature can save significant time and effort especially if multiple years need to be analyzed (e.g. current, buildout, etc.). If a model does not have this capability, the calculations can be done externally in a GIS or a spreadsheet, and then imported into the model. If a dynamic model is used, the ADWF then needs to be converted to a diurnal pattern by applying percentages for each time unit (e.g. every hour). Certain models can also use more than one diurnal pattern to account for day-today changes in the diurnal pattern (e.g. weekday vs. weekend, month by month variations, etc.). This will facilitate a more accurate simulation of DWF patterns over an extended period of time.

DWF's are usually calibrated by adjusting unit flow factors to match modeled volumes to measured volumes and adjusting the diurnal pattern to match the corresponding DWF model hydrograph (e.g. timing, shape, peak flow and minimum flow). Options exist to compare DWF hydrographs graphically, along with goodness-of-fit statistics (e.g. comparison of minimums,

maximums, averages, R^2, etc.). Some modeling software packages calculate and graph these statistics directly. If this feature doesn't exist, then it's the responsibility of the modeler to complete these calculations externally. Automated methods for performing the DWF calibration process are not typically available as a built-in feature in most modeling software. However external optimization software can be used to perform the calibration. In cases where collection systems experience very little I/I, calibration of DWF along with the inclusion of some base I/I may be all that is needed for estimation. However, many systems suffer from significant I/I and require explicit modeling of WWF's.

Wet Weather Flow

Combined sewer systems (CSS's) are designed to accommodate WWF's up to the point of discharging out designed overflow points within the system – or Combined Sewer Overflows (CSO's). In this case WWF may include I/I as well as direct, purposeful stormwater connections. I/I is usually defined as extraneous flows that are not desirable in a sanitary collection system, while CSSs were originally designed to accommodate direct storm water drainage. However, the distinction is blurred, as many sanitary sewers also suffer from excessive I/I that result in SSOs that behave similarly to CSSs. In fact, some coastal systems have experienced wet weather peaking factors (peak wet weather flow divided by average dry weather flow) that approach the peaking factor of some CSS's. Therefore, it is extremely important that WWF be estimated as accurately as possible for analyzing and designing improvements for these types of systems.

I/I is a hydrologic component of both combined and separate sanitary systems. Combined systems are generally dominated by storm water that is in effect the same as sanitary inflow. Separate systems can be dominated by either inflow or infiltration. When portions of a combined sewer system are separated, the storm water contribution is greatly diminished, but infiltration may still be a significant component of flow, and may in turn exhibit characteristics of a sanitary system with significant I/I. In either case (a partially separated combined system or a sanitary system with significant I/I), infiltration can be the most difficult portion of the wet weather hydrograph to model, as well as one of the more challenging components of WWF to remove.

Modeling inflow is usually straightforward because the inflow response is a direct result of the rainfall pattern and the amount of impervious area that is tributary to the sewer system (it behaves very similarly to an urban storm water response to rainfall). Most collection system models adequately model inflow. However, infiltration is much more difficult to model than inflow since it can be an indirect response to rainfall and can be heavily influenced by groundwater conditions, which nearly always introduce a tremendous amount of uncertainty into any hydrologic analysis. Infiltration generally can be categorized in two ways:

- Near surface infiltration
- Groundwater infiltration

Near surface infiltration usually starts a few hours after the beginning a rain event and subsides within generally a day or two as the saturated soils return to normal. Groundwater infiltration is caused by groundwater that raises due to saturated soil conditions to a point where the groundwater table elevation exceeds that of the local collection system. This type of infiltration

can be an issue for coastal communities or those located near lakes and rivers were the groundwater table is normally very close to sewer inverts. Groundwater infiltration will not necessarily influence a sewer system until multiple rainfall events saturate the soils and start to increase the groundwater table, but when it does, it can contribute infiltration that last for weeks or months. Also, certain systems directly adjacent to the ocean or estuaries can experience diurnal groundwater infiltration due to tidal fluctuations that directly affect the water table.

Modeling of WWF generally falls into these categories (Wright and Dent, 2001):

- Rational Method - calculation of an individual peak flow or volume using the simplistic equation Q=CiA, or R-values (which are calculated the same way, but "C" is replaced by an "R")
- Unit Hydrograph – includes SCS curve number methods, the RTK method (triple unit triangular hydrographs), and regression analysis (linear or non-linear)
- Physically based - Non-linear reservoir, multiple non-linear reservoirs (when groundwater is included in the model)

The Rational Method should only be used in the case of calculating inflow for small, highly impervious areas. R-values are easy to calculate but can be applied beyond their accurate limits, and should only be used as a first check to see if sanitary sewer basins suffer from significant I/I. To adequately model wet weather flow hydrographs, a unit hydrograph or physically based method should be applied. These methods are more complex and take more time and experience to apply properly. If groundwater is a significant issue, and if there is the possibility that storage facilities are going to be sized to manage excess I/I, a physically based multiple non-linear reservoir method should be applied. For a more in-depth discussion on modeling wet weather flows, refer to Dent et al (2000) and Wright et al (2000).

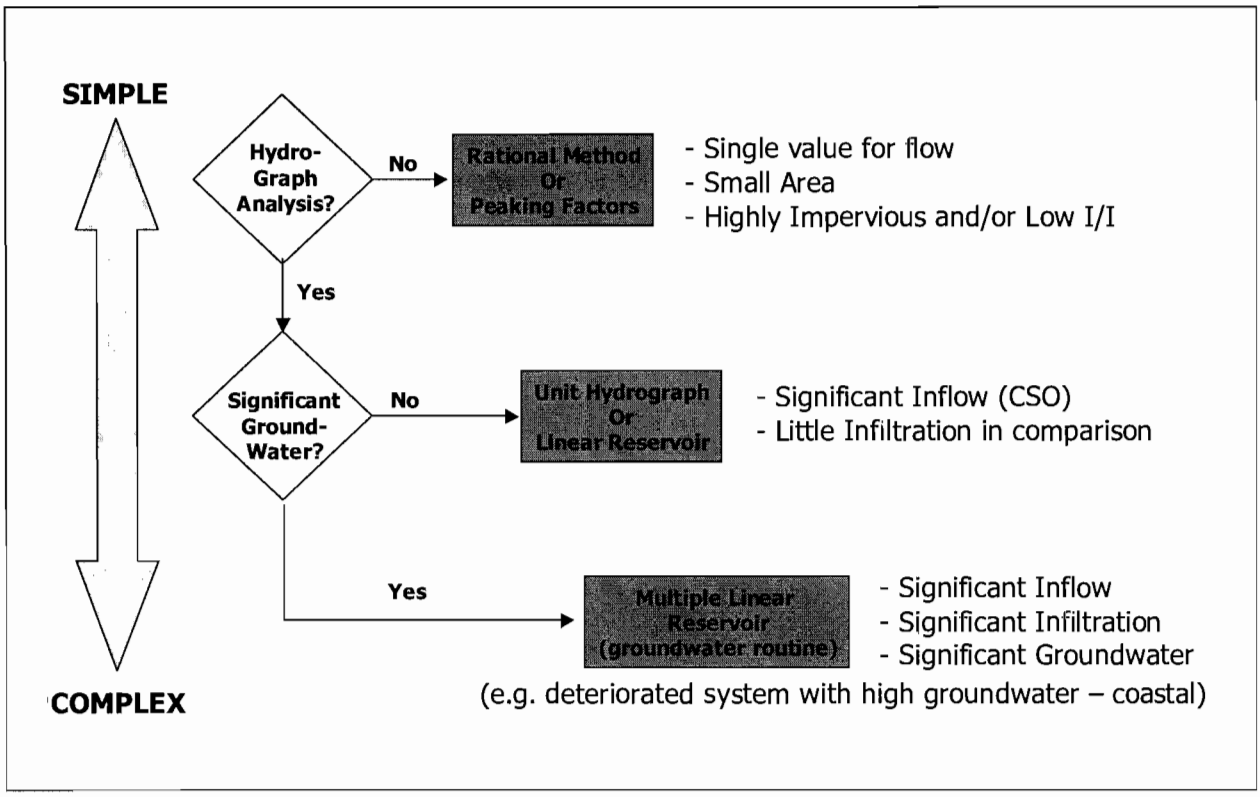
There are usually a variety of wet weather flow estimation options available in most public domain and commercial models, so no specific model or models will be discussed since the topic is too extensive for this paper. However, it is worth noting that automated calibration of WWF's is beginning to be explored in certain commercial collection system models. There also exists the opportunity to link external optimization software to efficiently run iterative calculations for WWF calibration in public domain models (Dent et al, 2004). **Figure 2** illustrates a flowchart to help chose a wet weather flow estimation method.

HYDRAULICS

Hydraulics, and the application of hydraulics, are often misunderstood. Many books are available that explain hydraulic theory and application, but few if any exist that provide a consolidated summary of hydraulic modeling for practical purposes. This explanation of hydraulics hopefully provides this consolidated review.

Due to the wide variety of flow conditions that may exist in an open channel, a complete but sometimes confusing nomenclature has developed to describe the fundamental properties of fluid flow. Yen (2001) provides a simple breakdown of these terms for overland and open-channel flow in terms of variation with time and space.

Figure 2 – Flowchart for Choosing a Wet Weather Flow Estimation Method



Flow variation with time is commonly referred to as either:

- Steady (time invariant), or
- Unsteady (dynamic flow)

A steady state model only uses a single flow within the analysis. A peak flow is a common way to analyze the capacity of a pipe. An unsteady, or dynamic flow model, uses a time series of flows. A hydrograph is commonly used in a dynamic model and can range from several values (e.g. diurnal DWF's over 24 hours) to millions of flow values (e.g. long term continuous simulation). Both steady and unsteady flow will be discussed below as they relate to flow variation in space.

Flow variation in space, or flow along the length of a channel, is referred to as either:

- Uniform, or
- Nonuniform (gradually or rapidly varied)

Uniform flow is the simplest type of open channel flow and the governing equations give unique flow rates as a function of depth. One simple way to envision this type of flow is a pipeline

where the slope of the hydraulic grade line (HGL) is parallel to the slope of the pipe. Under this regime the two forces acting on the flow, gravity and friction, are balanced, and there is no acceleration of the flow in any dimension. Under uniform flow the friction slope is equal to the pipe bed slope (i.e. $S_f = S_0$). By definition, uniform flow must exhibit uniform depth along the length of a pipeline. This depth is commonly referred to as normal depth (Chaudry, 1993).

Steady Flow (Uniform and Nonuniform)

Steady flow models, those where only a single flow is used, are solved for depth and velocity using uniform or nonuniform techniques. When considering flow in time and space, the simplest type of flow is steady uniform flow. The flow rate does not change with time, the depth of flow does not change in space, and the streamlines are all parallel. All acceleration terms are zero, e.g. friction and gravity are in perfect balance. Manning's equation (developed by Robert Manning in 1891) is frequently used to determine the flow rate or velocity for uniform flow because under uniform flow conditions the depth of flow and flow rate are related by a unique rating curve (i.e. the flow rate is a unique function of depth). **Figure 3** illustrates Manning's equation expressed in customary US units.

Figure 3 – Manning's Equation

$$Q = \left(\frac{1.49}{n}\right) A R^{\frac{2}{3}} \sqrt{S_O}$$

where:

Q = Flow (cfs)
n = *Manning's roughness coefficient (unitless)*
A = Area (ft^2)
R = Hydraulic Radius
S_o = Pipe Slope

Manning's equation is an empirical equation (i.e. derived from field and laboratory experimental observations) and is appropriate if the conditions mentioned above for uniform flow exist in the pipeline that is being analyzed. If flow in a sewer pipe approaches a steady uniform condition, then Manning's equation may give reasonable results. However, actual sewer pipelines frequently experience a variety of flow conditions where the uniform flow principle is violated and the more complete nonuniform solution techniques are required.

Nonuniform conditions take into account that a single flow will usually exhibit different depths along a length of pipeline. Nonuniform flow is typically categorized as gradually varied and rapidly varied flow. Rapidly varied flow will not be covered in this paper since sewer flows rarely exhibit this flow condition, and no models covered in this paper solve for this condition. Therefore, from now on, this paper will refer to nonuniform flow only in terms of gradually varied flow.

Gradually varied flow can be either steady or unsteady in time. Steady, gradually varied flow, requires calculations beyond Manning's equation to solve for depth and velocity in a open channel (unsteady gradually varied flow will be addressed in detail later in this paper). The Step Method has been developed to solve the gradually varied flow equation. Numerical integration is necessary because the equations are not generally explicitly soluble (Henderson, 1966). Two common solutions of this method include the Standard and Direct Step Method. These methods can be used to solve for changing depths and velocities for a given flow along the length of an open channel (or pipeline if the flow does not surcharge beyond the crown of the pipe). Two commercial models that utilize the Direct Step Method include SewerCAD and StormCAD both by Haestad Solutions (Bentley Systems).

Unsteady Gradually Varied Flow

The most computationally complex type of one-dimensional open channel flow is unsteady flow, which is, for practical purposes, also nonuniform (Chaudry 1993). Unsteady gradually varied flow can be solved using distributed flow routing models where flow rate and water level are computed as functions of space and time, rather than space alone (such as the Standard Step Method discussed above) or time alone (such as spatially lumped models which are not covered in this paper) – (Chow et al, 1988). Most of the unsteady sewer models on the market today utilize distributed flow routing and solve a form of the Saint-Venant equations. These equations are covered in detail in many publications including, but not limited to, Chow et al (1988), Bedient and Huber (1992), Chaudry (1993), Yen (2001), and Henderson (1966).

The Saint-Venant equations, first developed by Barre de Saint-Venant in 1871, describe one-dimensional unsteady open channel flow where depth and velocity only vary in the longitudinal direction of the channel, the bottom slope of the channel is small, and Manning's equation can be used to describe resistance effects (Chow et al, 1988). So why are these equations so important in distributed flow routing models? One primary reason why these equations are needed are because a wave (a variation in energy in time and space) can are propagated upstream and downstream in unsteady gradually varied flow. Waves cannot be accounted for in the simplified forms of the St. Venant equations that do not consider changes in acceleration over time and space. The Saint-Venant equations generally consist of equations of continuity and momentum and are able to estimate wave celerity (the velocity of a wave along the channel). These partial differential equations are summarized in **Figure 4** (adapted from Chow et al, 1988).

The kinematic wave solution, as shown in Figure 4, balances the gravity and frictional forces and assumes the flow does not accelerate appreciably. The diffusion wave solution is the kinematic solution with the pressure term included which takes into account the change in water pressure with depth along the channel. The Quasi-Dynamic wave solution is the diffusion wave solution with the inclusion of the convective acceleration term which describes the change in momentum due to the change in velocity along the channel. The Fully Dynamic solution includes all terms in the momentum equation including the local acceleration term, which describes the change in momentum due to the change in velocity over time.

Figure 4 – Saint-Venant Equations

Continuity Equation: $$\frac{\partial Q}{\partial x} + \frac{\partial A}{\partial t} = 0$$

Momentum Equation:

$$\frac{1}{A}\frac{\partial Q}{\partial t} + \frac{1}{A}\frac{\partial}{\partial x}\left(\frac{Q^2}{A}\right) + g\frac{\partial y}{\partial x} - g\left(S_o - S_f\right) = 0$$

Local Acceleration	Convective Acceleration	Pressure Force	Gravity & Friction Force	
				Kinematic Wave
				Diffusion Wave
				Quasi-Dynamic Wave
				Fully Dynamic Wave

where:
Q = Flow
A = Area
t = Time
x = Distance
y = Depth
S_o = Pipe Slope
S_f = Friction Slope (slope of hydraulic grade line)

The Saint Venant equations are partial differential equations that describe one dimensional, unstready, gradually varied flow. Unfortunately they are not amenable to analytical solution methods and therefore must be solved using numerical approximations. A common method for approximating the solution of these equations, although not covered in detail here, is the finite-difference method. This method can employ either an explicit scheme (where unknown values are solved for sequentially) or implicit scheme (where unknowns are solved for simultaneously). The explicit method is iterative and somewhat simpler to implement in a computer program, but can produce unstable results. The implicit method is more complicated from a programming perspective, but generally provides a more stable solution and can provide faster simulation times than the explicit method. Explicit solutions were applied in the past, but implicit methods are more commonly used in today's distributed flow models.

Another mathematical solution issue, which may seem somewhat esoteric, but is necessary to understand because of how certain sewer models are marketed, include the way the equations are

applied to solve for surcharge flow (when flows exceed the crown of a pipe and transition into pressure flow). There are two ways to simulate unsteady surcharged flow in sewer models and include the standard transient flow approach and the hypothetical piezometric open slot approach. The hypothetical piezometric open slot approach, is also known as the Priessmann slot approach. According to Yen (2001), both solution techniques have their own pros and cons and it is not clear whether one method is superior in all cases, regardless of how some commercial software is marketed.

Generally, the more terms of the Saint-Venant equations that are included in the solution, the more computational intensive the model can become and the slower the simulation times become. Excessive run times can still be a problem (even with the computational power of today's computers) if the sewer network becomes large enough. Therefore, some models standard solution routine applies the kinematic wave solution, such as the Hydra software by Pizer, or provides this solution technique as an option, as is the case with the US EPA Storm Water Management Model - SWMM5. This simplification of the Saint-Venant equations will provide very efficient simulation run times. However, the kinematic wave routine does have some significant limitations in that flow is routed only in a downstream direction, only open channel flow (or gravity flow as it is sometimes called) can be simulated (no surcharge), and flow in looped pipes (e.g. cross connections) cannot be directly calculated.

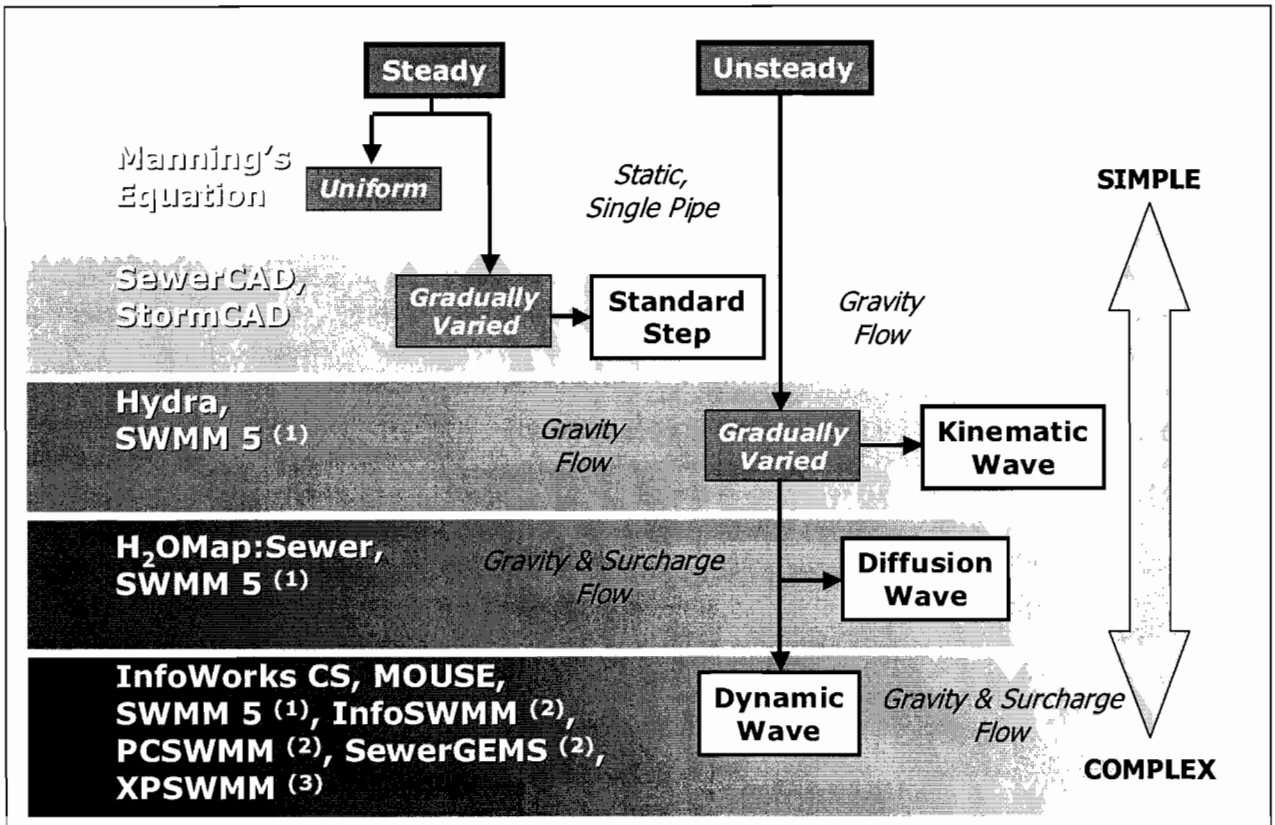
Many distributed flow routing models on the market today include fully dynamic wave solutions as well as options to model only quasi-dynamic or diffusion wave solutions for sewer networks. H2Omap:Sewer (MWH Soft) includes a diffusion wave solution routine. Other models such as SWMM5, MOUSE (Danish Hydraulic Institute – DHI), InfoWorks CS (Wallingford Software), and XPSWMM (XP Software) include fully dynamic wave solutions and may offer options for diffusion and quasi-dynamic wave solutions. PCSWMM (Computational Hydraulic Institute – CHI), InfoSWMM (MWH Soft), and SewerGEMS (Haestad Methods/Bentley Solutions) utilize the SWMM5 engine but provide a more comprehensive GUI than the standard SWMM5 package. **Figure 5** provides a graphical characterization of hydraulic solution methods along with a summary of which models apply which routines.

OTHER MODEL FEATURES

What about the other features that are available in today's public domain or commercial models? The core features of today's models are described above, but it is also necessary to investigate other model features that may influence the choice of selecting one model over another. The following list is by no means comprehensive, but hopefully provides some features that should be investigated before an individual model is chosen or upgraded:

- Who will be the model users (consultant vs. client, full-time vs. part time, experienced with hydrology and hydraulics)
- Cost (both initial purchase as well as yearly service contracts for technical support and upgrades)

Figure 5 – Characterization of Hydraulic Solution Methods



Notes:

(1) SWMM 5 has four solution routine options, which include kinematic wave, diffusion wave, quasi-dynamic wave, and fully dynamic wave. The dynamic wave section of this graphic encompasses both the quasi and fully dynamic wave solutions.

(2) PCSWMM, InfoSWMM and SewerGEMS utilize the SWMM 5 engine.

(3) XPSWMM utilizes a modified SWMM engine.

- Database and Engine structure (ability to work with 3rd party software, ability to easily extract model input/output from model)
- Estimate DWF from population or landuse
- Utilize monitored data for calibration
- Perform automated calibration
- Efficiently complete continuous simulation modeling
- Perform automated pipe sizing (upgrades or parallel pipelines under open channel and surcharge conditions)
- Water quality (i.e. hydrogen sulfide) and sediment transport modeling
- Simulate Real Time Controls (RTC) at pumps, weirs, orifices, etc.
- Link with SCADA software to provide real time modeling capabilities

Many of the options mentioned in the above list can be found in some of the models listed previously in this paper. However, two features that would be extremely helpful in sewer system model, but aren't available (to the authors knowledge) include:

(1) Ability to directly distribute WWF's into unmonitored areas of the system

(2) Ability to analyze capacity of sewer pipes based on a comparison of the HGL to the slope of the sewer pipe

Feature (1) addresses the need to provide a modeler with a mechanism to distribute WWF's throughout sewer basins even when basins are not monitored for flow (which is typically the case). Statistical methods do exist (see Wright et al, 2005) but could be included as an option in software packages.

Feature (2) is related to automated pipe sizing, but seems to be feature that has been overlooked. If a model could illustrate, during a dynamic simulation, which pipes in a network have an HGL equal to, greater than, or less than the slope of the pipe, the modeler would be able to easily identify which pipes need to be upgraded. This is especially true when pipes become surcharged. For example, if a pipe has an HGL slope greater than the slope of the pipe, and portion of the pipe is surcharged, then that pipe has a capacity restriction for the modeled flow and needs be upgraded (e.g. larger diameter or parallel pipeline). Likewise, if a pipe has an HGL slope less than the slope of the pipe, and the pipe is surcharged, the pipe does not represent a restriction (and the restriction is somewhere downstream). This relatively simple feature would provide the modeler with invaluable information to identify deficiencies within a sewer network and help focus capacity improvements.

MODEL APPLICATION

Selection of any model always comes back to what type of project the model is being used for, and what accuracy is needed in the results. Three examples, or levels of sewer system modeling include:

- Gross Planning Level
- Detailed Planning Level
- Design Level

Gross planning level modeling can be accomplished in several ways. One example of gross planning level modeling is the use of hydrologic routines to simulate the overall WWF response of a sewer system. For example, if a municipality wants to identify the I/I response of a sewer system upstream of some critical point (e.g. a pump station or wastewater treatment plant), a model could be constructed by simplifying the entire sewer network upstream of that point into one or more sewer basins. Measured WWF can then be used to calibrate the models I/I response and design flow events can be projected (either using design storms or continuous simulation techniques). This simplified technique, although it does not provide information on the detailed hydraulics of the upstream sewer system, can provide invaluable information regarding the

management of WWF at a pump station or wastewater treatment plant. If a sophisticated model is used to perform this simplified effort (such as SWMM), the model can always be expanded at a later time to include the detailed upstream sewer hydraulics.

Detailed planning level modeling would be considered for existing systems when the flows (both DWF and WWF) are estimated throughout a sewer network, and the flows are routed through the sewer network to a downstream point. This type of modeling is typically performed during master planning projects. In selecting a model for detailed planning level investigations, it is necessary to not only identify the core hydrologic and hydraulic features of a model, but also all the options that might be necessary to provide an efficient analysis of a complex system (see the Other Model Features above). When selecting a model based on core features, the model should simulate what the system is experiencing (i.e. surcharge, looped connections, complex pump stations and forcemains, etc). Also, many times the optional features tend to be the discriminating factors in selecting a model when the core features are very similar (e.g. PCSWMM, InfoSWMM, and SewerGEMS – which all have the same SWMM5 engine, but different GUI's).

Design level models are used to design new facilities, but may not need to be as sophisticated as models used for detailed planning. If new pipes are being designed that do not surcharge, then less sophisticated hydraulic routines may be adequate (e.g. models that utilize the Step Method or the Kinematic wave method). These models are very useful for designing sewers for new developments or even completing detailed planning level modeling if an existing system is not hydraulically complex and any surcharging will be relieved with upsized or paralleled pipelines. However, the results from these types of models are not typically satisfactory for combined sewer systems or sanitary sewer systems that experience extensive I/I (i.e. if surcharging could occur).

CONCLUSIONS

Too simple of a model does not adequately represent reality and can lead to inappropriate decisions. Too complex of a model may be difficult to use (including interpretation of results) and my lead to abandonment. Modeling software packages have a variety of strengths and weaknesses. Each software company has developed its own software package based on its vision, experience, and client base. Therefore, a software package may be stronger for some applications than for others. A model should only be used to assist in informed decision-making. Since all models include some simplification of the actual system, the engineer or operator should make the final decision, not the model.

REFERENCES

Bedient, P. B., and Huber, W.C. (1992). *Hydrology and Floodplain Analysis*, 2nd ed. Addison-Wesley Publishing, Reading, MA.

Chaudry, M.H. (1993). *Open Channel Flow*. Prentice Hall, Englewood Cliffs, NJ.

Chow, V.T., Maidment, D.R., Mays, L.W., (1988). *Applied Hydrology*, McGraw-Hill, New York, NY.

Dent, S., Hanna, R.H., Wright, L.T. (2004), Automated Calibration using Optimization Techniques with SWMM RUNOFF, Chapter 18 in: *Innovative Modeling of Urban Water Systems*, Monograph 12. W. James, Ed., CHI, pp385-408.

Dent, S.A., Wright, L.T., Mosley, C., Kadota, P., and Djebbar, Y. (2000). Comparison of Wet Weather Flow Estimation Techniques, Water Environment Federation Technical Conference & Exposition, Anaheim, CA.

Henderson, F. M., (1966), *Open Channel Flow*, Macmillian Publishing Co., Inc., New York, NY.

Maidment, D. R. (ed.), (1993), *Handbook of Hydrology*, McGraw-Hill, New York, NY.

Nix, S. J. (1994), *Urban Stormwater Modeling and Simulation*, Lewis Publishers, Boca Raton, FL.

Wright, L.T., Heaney, J.P., Dent, S. (2005), Prioritizing sanitary sewers for rehabilitation using least-cost classifiers. ASCE Journal of Infrastructure Management, *accepted.*

Wright, L.T., Dent, S.A. , Mosley, C., Kadota, P., and Djebbar, Y. (2000), Comparison of Rainfall Dependent Inflow and Infiltration Simulation Methods, Chapter in: *Stormwater and Urban Water Systems Modeling*, Monograph 9, W. James, (ed.), CHI, Guelph, Ontario, Canada.

Yen, B. (2001). Hydraulics of Sewer Systems. In Mays, L. W. (ed.), *Stormwater Collection Systems Design Handbook*, McGraw-Hill, New York, NY.

Appendix E

COST SUMMARY DOCUMENTATION

PROJECT SUMMARY		ESTIMATE CLASS:	Conceptual
PROJECT :	City of Eloy - Wastewater Master Plan	ENR Index at Estimate[1]	7691
JOB # :	7266B.00	DATE :	06/29/06
LOCATION :	City of Eloy	BY :	ACG
ELEMENT :	PROJECT SUMMARY	REVIEWED:	RAW

	DESCRIPTION		TOTAL PROJECT COST
	PHASE I		
	IA - HEADWORKS EXPANSION		$3,742,000
	IB -SECONDARY TREATMENT EXPANSION		$7,872,000
	IC - SOLIDS HANDLING FACILITIES		$13,869,000
	ID - TERTIARY TREATMENT[2]		$5,332,000
	PHASE I - TOTAL PROJECT COST		$30,815,000
	PHASE II		$71,660,000
	BUILD OUT		$77,350,000

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

Notes:

1. ENR Construction Cost Index (CCI) at the time of this estimate is based upon the 20 Cities Average Value for May 2006
2. Tertiary treatment expansion may not be required during the Phase 1 expansion if the current BADCT waiver, due to soil aquifer treatment, is continued by ADEQ.
3. All costs listed herein are based upon May 2006 ENR dollars. Future costs should be escalated out to the mid-point of construction. Assume an annual infiltration rate of approximately 5% or City approved rate of escalation.

CONCEPTUAL COST ESTIMATE

PROJECT : **City of Eloy - Wastewater Master Plan**
JOB # : **7266B.00**
LOCATION : **Eloy, Arizona**
ELEMENT : **Phase 1 - Headworks**

DATE : 06/29/06
BY : ACG
REVIEWED BY: RAW

	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	INSTALL FACTOR	TOTAL
	Influent Pump Station (IPS)						
	Pumps (12 mgd firm, 4,200 gpm each)	3	EA	$65,000	$195,000	1.65	$322,000
	Concrete	200	CY	$850	$170,000	1.0	$170,000
	Earthwork	1,500	CY	$25	$37,500	1.0	$38,000
	Screening						
	Screens, compactor, and washer	1	EA	$150,000	$150,000	1.65	$248,000
	Manually cleaned screen	1	EA	$15,000	$15,000	1.65	$25,000
	Screening channels concrete	400	CY	$850	$340,000	1.0	$340,000
	Covers	250	SF	$35	$8,750	1.65	$15,000
	Odor control (2,000 cfm biofilter treating headspace channels and wet well)	1	LS	$200,000	$200,000	1.65	$330,000
	Grit separator, washer, dewatering, etc.	0	EA	$80,000	$0	1.65	$0
	Headworks building	0	SF	$130	$0	1.0	$0
	Yard piping (3%)	1	LS	$45,000	$45,000	1.65	$75,000
						SUBTOTAL	**$1,563,000**
	Electrical, Controls, and Instrumentation					**20%**	$313,000
						SUBTOTAL	$1,876,000
	Contingency					**30%**	$563,000
	TOTAL DIRECT COST WITH CONTINGENCY					**SUBTOTAL**	**$2,439,000**
	General Conditions					**15%**	$366,000
						SUBTOTAL	$2,805,000
	Contractor OH&P					**10%**	$244,000
						SUBTOTAL	$3,049,000
	Sales Tax					**5.6%**	$69,000
						SUBTOTAL	$3,118,000
	TOTAL ESTIMATED CONSTRUCTION COST						**$3,118,000**
	Engineering, Legal, and Administrative Fees					**15%**	$468,000
	Owners Change Order Reserve					**5%**	$156,000
	TOTAL ESTIMATED PROJECT COST						**$3,742,000**

Notes:
1. For purposes of this estimate, the sales tax has been applied to 50% of the Total Direct Cost estimated value.

CONCEPTUAL COST ESTIMATE

PROJECT : City of Eloy - Wastewater Master Plan
JOB # : 7266B.00
LOCATION : City of Eloy - Wastewater Master Plan
ELEMENT : Phase 1 - Secondary Treatment (4 mgd AADF)

DATE : 06/29/06
BY : ACG
REVIEWED BY: RAW

	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	INSTALL FACTOR	TOTAL
	Splitter structure modifications	1	LS	$40,000	$40,000	1.65	$66,000
	Aeration Basins						
	Biolac equipment and fees (2 mgd)	1	LS	$785,500	$785,500	1.65	$1,297,000
	60 mil. geosynthetic liner (36" sections)	7,000	LF	$2.20	$15,400	1.65	$26,000
	Concrete (integral clarifiers & separation wall)	750	CY	$850	$637,500	1.0	$638,000
	Earthwork	21,000	CY	$25	$525,000	1.0	$525,000
	Blower enclosure modifications	1,500	SF	$90	$135,000	1.00	$135,000
	Recharge basin piping and modifications	1	LS	$25,000	$25,000	1.65	$42,000
	Recharge basin earthwork (onsite)	41,000	CY	$6	$246,000	1.0	$246,000
	Yard piping (3%)	1	LS	$90,000	$90,000	1.65	$149,000
	Standby generator set	1	LS	$100,000	$100,000	1.65	$165,000
						SUBTOTAL	**$3,289,000**
	Electrical, Controls, and Instrumentation					**20%**	$658,000
						SUBTOTAL	$3,947,000
	Contingency					**30%**	$1,185,000
	TOTAL DIRECT COST WITH CONTINGENCY					**SUBTOTAL**	**$5,132,000**
	General Conditions					**15%**	$770,000
						SUBTOTAL	$5,902,000
	Contractor OH&P					**10%**	$514,000
						SUBTOTAL	$6,416,000
	Sales Tax					**5.6%**	$144,000
						SUBTOTAL	$6,560,000
	TOTAL ESTIMATED CONSTRUCTION COST						**$6,560,000**
	Engineering, Legal, and Administrative Fees					**15%**	$984,000
	Owners Change Order Reserve					**5%**	$328,000
	TOTAL ESTIMATED PROJECT COST						**$7,872,000**

Notes:

1. For purposes of this estimate, the sales tax has been applied to 50% of the Total Direct Cost estimated value.

2. For purposes of this estimate, it is assumed no odor control is required for the secondary treatment system and the existing blowers will not require relocation, that the City will obtain a setback waiver from the adjacent property owner.

CONCEPTUAL COST ESTIMATE

PROJECT :	**City of Eloy - Wastewater Master Plan**		
JOB # :	**7266B.00**	**DATE :**	06/29/06
LOCATION :	**City of Eloy - Wastewater Master Plan**	**BY :**	ACG
ELEMENT :	**Phase 1 - Solids Handling**	**REVIEWED BY:**	RAW

	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	INSTALL FACTOR	TOTAL
	Aerobic Digesters (Two)						
	Concrete	750	CY	$850	$637,500	1.0	$638,000
	Diffusers and distribution	2	EA	$100,000	$200,000	1.65	$330,000
	Blowers	3	EA	$50,000	$150,000	1.65	$248,000
	Covers	0	SF	$35.00	$0	1.65	$0
	Earthwork	10,000	CY	$25	$250,000	1.0	$250,000
	Demo existing solids handling basin	1	LS	$250,000	$250,000	1.65	$413,000
	Sludge transfer pumps	2	EA	$15,000	$30,000	1.65	$50,000
	Polymer blending system	1	LS	$150,000	$150,000	1.65	$248,000
	Thickening equipment	2	EA	$300,000	$600,000	1.65	$990,000
	Dewatering equipment	2	EA	$500,000	$1,000,000	1.65	$1,650,000
	Solids handling building	2,500	SF	$130	$325,000	1.0	$325,000
	Odor control	0	LS	$400,000	$0	1.65	$0
	Standby generator set	1	LS	$100,000	$100,000	1.65	$165,000
	Yard piping (3%)	1	LS	$155,000	$155,000	1.65	$256,000
							$5,563,000
	Electrical, Controls, and Instrumentation					**25%**	$1,391,000
						SUBTOTAL	$6,954,000
	Contingency					**30%**	$2,087,000
	TOTAL DIRECT COST WITH CONTINGENCY					**SUBTOTAL**	**$9,041,000**
	General Conditions					**15%**	$1,357,000
						SUBTOTAL	$10,398,000
	Contractor OH&P					**10%**	$905,000
						SUBTOTAL	$11,303,000
	Sales Tax					**5.6%**	$254,000
						SUBTOTAL	$11,557,000
	TOTAL ESTIMATED CONSTRUCTION COST						**$11,557,000**
	Engineering, Legal, and Administrative Fees					**15%**	$1,734,000
	Owners Change Order Reserve					**5%**	$578,000
	TOTAL ESTIMATED PROJECT COST						**$13,869,000**

Notes:

1. For purposes of this estimate, the sales tax has been applied to 50% of the Total Direct Cost estimated value.

2. For purposes of this estimate, it is assumed no odor control is required for the solids handling system and the existing blowers will not require relocation, that the City will obtain a setback waiver from the adjacent property owner.

carollo engineers

CONCEPTUAL COST ESTIMATE

PROJECT : City of Eloy - Wastewater Master Plan
JOB # : 7266B.00
LOCATION : City of Eloy - Wastewater Master Plan
ELEMENT : Phase 1 - Tertiary Treatment

DATE : 06/29/06
BY : ACG
REVIEWED BY: RAW

	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	INSTALL FACTOR	TOTAL
	Disinfection						
	Chlorine contact channel concrete	500	CY	$850	$425,000	1	$425,000
	Earthwork	1,750	CY	$25	$43,750	1.0	$44,000
	Bulk chlorine tank (12,000 gal)	1	LS	$15,000	$15,000	1.65	$25,000
	Chlorinator	1	LS	$5,000	$5,000	1.65	$9,000
	Metering pumps	3	EA	$1,000.00	$3,000	1.65	$5,000
	Dechlorination equipment	1	LS	$25,000	$25,000	1.65	$42,000
	Filtration						
	Disk filters	1	LS	$750,000	$750,000	1.65	$1,238,000
	Splitter structure	1	LS	$25,000	$25,000	1.65	$42,000
	Concrete	1	LS	$250,000	$250,000	1.0	$250,000
	Polymer feed system	1	LS	$40,000	$40,000	1.0	$40,000
	Reuse Pump Station						
	Clearwell	0	LS	$75,000	$0	1.65	$0
	Vertical turbine pumps	0	EA	$35,000	$0	1.65	$0
	Yard piping (3%)	1	LS	$64,000	$64,000	1.65	$106,000
						SUBTOTAL	**$2,226,000**
	Electrical, Controls, and Instrumentation					**20%**	$446,000
						SUBTOTAL	$2,672,000
	Contingency					**30%**	$802,000
	TOTAL DIRECT COST WITH CONTINGENCY					**SUBTOTAL**	**$3,474,000**
	General Conditions					**15%**	$522,000
						SUBTOTAL	$3,996,000
	Contractor OH&P					**10%**	$348,000
						SUBTOTAL	$4,344,000
	Sales Tax					**5.6%**	$98,000
						SUBTOTAL	$4,442,000
	TOTAL ESTIMATED CONSTRUCTION COST						**$4,442,000**
	Engineering, Legal, and Administrative Fees					**15%**	$667,000
	Owners Change Order Reserve					**5%**	$223,000
	TOTAL ESTIMATED PROJECT COST						**$5,332,000**

Notes:
1. For purposes of this estimate, the sales tax has been applied to 50% of the Total Direct Cost estimated value.

CAROLLO engineers

CONCEPTUAL COST ESTIMATE

PROJECT : City of Eloy - Wastewater Master Plan
JOB # : 7266B.00
LOCATION : City of Eloy - Wastewater Master Plan
ELEMENT : Phase 2 - 7 mgd, AADF

DATE : 06/29/06
BY : ACG
REVIEWED BY: RAW

	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	INSTALL FACTOR	TOTAL
	Headworks						
	Influent Pump Station (IPS)						
	Pumps (21+ mgd firm, two 6,400 gpm, remove one Phase I pump)	2	EA	$75,000	$150,000	1.65	$248,000
	Concrete	200	CY	$850	$170,000	1.0	$170,000
	Screening						
	Screens, compactor and washer	1	EA	$150,000	$150,000	1.65	$248,000
	Concrete	0	CY	$850	$0	1.0	$0
	Odor control (expand to 6,000 cfm)	2	LS	$155,000	$310,000	1.65	$512,000
	Grit separator, washer, and dewatering equipment.	1	EA	$115,000	$115,000	1.65	$190,000
	Headworks building	2,500	SF	$130	$325,000	1.0	$325,000
						Headworks Subtotal	***$1,693,000***
	Secondary Treatment						
	Splitter structure no. 1	100	CY	$850	$85,000	1.0	$85,000
	Anoxic / Aerobic Basins (7 mgd)						
	Concrete	8,000	CY	$850	$6,800,000	1.0	$6,800,000
	Blowers	3	EA	$250,000	$750,000	1.65	$1,238,000
	Diffusers, mixers, and distribution system	2	EA	$350,000	$700,000	1.65	$1,155,000
	Earthwork	45,000	CY	$25	$1,125,000	1.0	$1,125,000
	Covers	25,000	SF	$35	$875,000	1.65	$1,444,000
	MLR pumps	2	EA	$30,000	$60,000	1.65	$99,000
	Blower and electrical building	3,600	SF	$130	$468,000	1.00	$468,000
	Splitter structure no. 2	100	CY	$850	$85,000	1.0	$85,000
	Secondary Clarifiers (three 110' diameter)						
	Concrete	1,200	CY	$850	$1,020,000	1.0	$1,020,000
	Earthwork	31,500	CY	$25	$787,500	1.0	$788,000
	Equipment, mechanism, etc.	3	EA	$165,000	$495,000	1.65	$817,000
	Scum pump station	3	EA	$50,000	$150,000	1.65	$248,000
	Covers - dome	3	EA	$150,000	$450,000	1.65	$743,000
	RAS/WAS pumps	5	EA	$20,000	$100,000	1.65	$165,000
	RAS/WAS sump	1	LS	$50,000	$50,000	1.65	$83,000
	Odor control (carbon)	1	LS	$200,000	$200,000	1.65	$330,000
						Secondary Process Subtotal	***$16,693,000***
	Tertiary Treatment						
	Disinfection						
	Chlorine contact channel concrete	200	CY	$850	$170,000	1.0	$170,000
	Earthwork	500	CY	$25	$12,500	1.0	$13,000
	Bulk chlorine tank (12,000 gal)	0	LS	$15,000	$0	1.65	$0
	Chlorinator	0	LS	$5,000	$0	1.65	$0
	Metering pumps	1	EA	$5,000.00	$5,000	1.65	$9,000
	Dechlorination equipment	0	LS	$25,000	$0	1.65	$0
	Filtration						
	Disk filters	1	LS	$500,000	$500,000	1.65	$825,000
	Splitter structure no. 3	1	LS	$25,000	$25,000	1.65	$42,000
	Concrete	1	LS	$150,000	$150,000	1.00	$150,000
	Polymer feed system	1	LS	$40,000	$40,000	1.0	$40,000
	Reuse Pump Station						
	Clearwell	1	LS	$150,000	$150,000	1.65	$248,000
	Vertical turbine pumps	3	EA	$35,000	$105,000	1.65	$174,000
						Tertiary Process Subtotal	***$1,671,000***
	Solids Handling						
	Aerobic Digesters						
	Concrete	0	CY	$850	$0	1.0	$0
	Diffusers and distribution	0	EA	$100,000	$0	1.65	$0
	Blowers	0	EA	$50,000	$0	1.65	$0
	Covers	4,000	SF	$35	$140,000	1.65	$231,000
	Earthwork	0	CY	$25	$0	1.0	$0
	Demo existing solids handling basin	0	LS	$250,000	$0	1.65	$0
	Sludge transfer pumps	0	EA	$15,000	$0	1.65	$0
	Polymer blending system	0	LS	$150,000	$0	1.65	$0
	Thickening equipment	0	EA	$300,000	$0	1.65	$0
	Dewatering equipment	0	EA	$500,000	$0	1.65	$0
	Solids handling building	0	SF	$130	$0	1.0	$0
	Odor control (6,000 cfm biofilter)	1	LS	$400,000	$400,000	1.65	$660,000
						Solids Handling Subtotal	***$891,000***

	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	INSTALL FACTOR	TOTAL
	Miscellaneous						
	Access and site roadways	1	LS	$750,000	$750,000	1.0	$750,000
	Perimeter wall and fencing	7,000	LF	$30	$210,000	1.65	$347,000
	Standby generator set	1	LS	$500,000	$500,000	1.65	$825,000
	Recharge basin earthwork (offsite location)	260,000	CY	$10	$2,600,000	1.0	$2,600,000
	Recharge basin pipeline - 24" (from WRF to offsite basins)	10,000	LF	$120	$1,200,000	1.65	$1,980,000
	Demolition	1	LS	$250,000	$250,000	1.0	$250,000
	Yard piping and valves (5%)	1	LS	$1,048,000	$1,048,000	1.0	$1,048,000
	Administration and laboratory building	0	SF	$180	$0	1.0	$0
						Miscellaneous Items Subtotal	***$7,800,000***
						SUBTOTAL	**$28,750,000**
	Electrical, Controls, and Instrumentation					**25%**	$7,188,000
						SUBTOTAL	$35,938,000
	Contingency					**30%**	$10,782,000
	TOTAL DIRECT COST WITH CONTINGENCY					**SUBTOTAL**	**$46,720,000**
	General Conditions					**15%**	$7,008,000
						SUBTOTAL	$53,728,000
	Contractor OH&P					**10%**	$4,672,000
						SUBTOTAL	$58,400,000
	Sales Tax					**5.6%**	$1,309,000
						SUBTOTAL	$59,709,000
	TOTAL ESTIMATED CONSTRUCTION COST						**$59,709,000**
	Engineering, Legal, and Administrative Fees					**15%**	$8,957,000
	Owners Change Order Reserve					**5%**	$2,986,000
	TOTAL ESTIMATED PROJECT COST						**$71,660,000**

Notes:
1. For purposes of this estimate, the sales tax has been applied to 50% of the Total Direct Cost estimated value.
2. Offsite recharge basin does not include any riparian preserve type features, such as buildings, public access, urban fishing lake, etc.

CONCEPTUAL COST ESTIMATE

PROJECT : City of Eloy - Wastewater Master Plan
JOB # : 7266B.00
LOCATION : City of Eloy - Wastewater Master Plan
ELEMENT : Buildout - 14 MGD, AADF

DATE : 06/29/06
BY : ACG
REVIEWED BY: RAW

	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	INSTALL FACTOR	TOTAL
	Headworks						
	Influent Pump Station (IPS)						
	Pumps (42 mgd firm, 12,200 gpm each, remove one Phase I pump, 4 duty pumps one backup)	2	EA	$95,000	$190,000	1.65	$314,000
	Concrete	0	CY	$850	$0	1.0	$0
	Screening				$0		
	Screens, compactor and washer	2	EA	$150,000	$300,000	1.65	$495,000
	Concrete	75	CY	$850	$63,750	1.0	$64,000
	Odor Control (expand to 9,000 cfm)	1	LS	$155,000	$155,000	1.65	$256,000
	Grit separator, washer, and dewatering equipment	1	EA	$115,000	$115,000	1.65	$190,000
	Headworks building	1,000	SF	$130	$130,000	1.0	$130,000
						Headworks Subtotal	***$1,449,000***
	Secondary Treatment						
	Splitter structure no. 1	0	CY	$850	$0	1.0	$0
	Anoxic / Aerobic Basins (7 mgd)						
	Concrete	8,000	CY	$850	$6,800,000	1.0	$6,800,000
	Blowers	2	EA	$250,000	$500,000	1.65	$825,000
	Diffusers, mixers, and distribution system	2	EA	$350,000	$700,000	1.65	$1,155,000
	Earthwork	45,000	CY	$25	$1,125,000	1.0	$1,125,000
	Covers	25,000	SF	$35	$875,000	1.65	$1,444,000
	MLR pumps	2	EA	$30,000	$60,000	1.65	$99,000
	Blower and electrical building	1,800	SF	$130	$234,000	1.0	$234,000
	Splitter structure no. 2	0	CY	$850	$0	1.0	$0
	Secondary clarifiers (two 110' diameter)						
	Concrete	800	CY	$850	$680,000	1.0	$680,000
	Earthwork	31,500	CY	$25	$787,500	1.0	$788,000
	Equipment, mechanism, etc.	2	EA	$165,000	$330,000	1.65	$545,000
	Scum pump station	2	EA	$50,000	$100,000	1.65	$165,000
	Covers - dome	2	EA	$150,000	$300,000	1.65	$495,000
	RAS/WAS pumps	3	EA	$20,000	$60,000	1.65	$99,000
	RAS/WAS sump	1	LS	$50,000	$50,000	1.65	$83,000
	Odor control (carbon)	1	LS	$200,000	$200,000	1.65	$330,000
						Secondary Process Subtotal	***$14,867,000***
	Tertiary Treatment						
	Disinfection						
	Chlorine contact channel	500	CY	$850	$425,000	1.0	$425,000
	Earthwork	1,750	CY	$25	$43,750	1.0	$44,000
	Bulk chlorine tank (12,000 gal)	1	LS	$15,000	$15,000	1.65	$25,000
	Chlorinator	1	LS	$5,000	$5,000	1.65	$9,000
	Metering pumps	1	EA	$5,000.00	$5,000	1.65	$9,000
	Dechlorination equipment	1	LS	$25,000	$25,000	1.65	$42,000
	Filtration						
	Disk filters	1	LS	$1,250,000	$1,250,000	1.65	$2,063,000
	Splitter structure no. 3	0	LS	$25,000	$0	1.65	$0
	Concrete	1	LS	$300,000	300000	1.65	$495,000
	Polymer feed system	1	LS	$70,000	$70,000	1.0	$70,000
	Reuse pump station						
	Clearwell	0	LS	$150,000	$0	1.65	$0
	Vertical turbine pumps	2	EA	$35,000	$70,000	1.65	$116,000
						Tertiary Process Subtotal	***$3,298,000***
	Solids Handling						
	Aerobic Digesters (Two)						
	Concrete	500	CY	$850	$425,000	1.0	$425,000
	Diffusers and distribution	2	EA	$100,000	$200,000	1.65	$330,000
	Blowers	2	EA	$50,000	$100,000	1.65	$165,000
	Covers	4,000	SF	$35	$140,000	1.65	$231,000
	Earthwork	10,000	CY	$25	$250,000	1.0	$250,000
	Demo existing solids handling basin	0	LS	$250,000	$0	1.65	$0
	Sludge transfer pumps	2	EA	$15,000	$30,000	1.65	$49,500
	Polymer blending system	1	LS	$150,000	$150,000	1.65	$247,500
	Thickening equipment	2	EA	$300,000	$600,000	1.65	$990,000
	Dewatering equipment	2	EA	$500,000	$1,000,000	1.65	$1,650,000
	Solids handling building	0	SF	$130	$0	1.0	$0
	Odor control	0	LS	$400,000	$0	1.65	$0
						Solids Handling Subtotal	***$4,338,000***

	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	INSTALL FACTOR	TOTAL
	Miscellaneous						
	Access and site roadways (24' wide)	1	LS	$500,000	$500,000	1.0	$500,000
	Perimeter wall and fencing	0	LF	$30	$0	1.65	$0
	Standby generator set	1	LS	$500,000	$500,000	1.65	$825,000
	Recharge basin earthwork (offsite location)	260,000	CY	$10	$2,600,000	1.0	$2,600,000
	Recharge basin piping - 24" (from WRF to offsite basins)	0	LF	$120	$0	1.65	$0
	Demolition	1	LS	$250,000	$250,000	1.0	$250,000
	Yard piping and valves (5%)	1	LS	$1,198,000	$1,198,000	1.0	$1,198,000
	Administration and laboratory building	11,000	SF	$200	$2,200,000	1.0	$2,200,000
						Miscellaneous Items Subtotal	***$7,073,000***
						SUBTOTAL	**$31,030,000**
	Electrical, Controls, and Instrumentation					**25%**	$7,758,000
						SUBTOTAL	$38,788,000
	Contingency					**30%**	$11,637,000
	TOTAL DIRECT COST WITH CONTINGENCY					**SUBTOTAL**	**$50,425,000**
	General Conditions					**15%**	$7,564,000
						SUBTOTAL	$57,989,000
	Contractor OH&P					**10%**	$5,043,000
						SUBTOTAL	$63,032,000
	Sales Tax					**5.6%**	$1,412,000
						SUBTOTAL	$64,444,000
	TOTAL ESTIMATED CONSTRUCTION COST						**$64,450,000**
	Engineering, Legal, and Administrative Fees					**15%**	$9,668,000
	Owners Change Order Reserve					**5%**	$3,223,000
	TOTAL ESTIMATED PROJECT COST						**$77,350,000**

Notes:
1. For purposes of this estimate, the percentage factors are applied to the Total Direct Cost estimated value.
2. For purposes of this estimate, the sales tax has been applied to 50% of the Total Direct Cost estimated value.