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BEFORE THE ARIZONA CORPORATION COMMISSION

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IN THE MATTER OF THE APPLICATION OF ARIZONA-AMERICAN WATER COMPANY, INC., AN ARIZONA CORPORATION, FOR APPROVALS ASSOCIATED WITH A PROPOSED TRANSACTION WITH MARICOPA COUNTY MUNICIPAL WATER CONSERVATION DISTRICT NUMBER ONE TO ALLOW THE CONSTRUCTION OF A SURFACE WATER TREATMENT FACILITY KNOWN AS THE WHITE TANKS PROJECT.	DOCKET NO. W-01303A-05-0718 **COMMENTS OF THE MARICOPA WATER DISTRICT**

Arizona Corporation Commission
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The Maricopa County Municipal Water Conservation District Number One, commonly known as the Maricopa Water District ("District" or "MWD")[1], respectfully submits these comments regarding the Revised Application filed by Arizona-American Water Company ("Arizona-American") and the Staff Report filed in this matter.

I. Preliminary Statement.

Arizona-American presents the Commission with a stark choice. Due to its financial weakness, Arizona-American asks this Commission to approve: (1) a massive increase in hook-up fees; and (2) a radical abandonment of traditional ratemaking principles. Arizona-American claims that unless it gets this special treatment, its customers and the environment will suffer as

[1] The District is a political subdivision of the state and is considered a municipal corporation under Article 13, Section 7 of the Arizona Constitution. It is governed by an elected board. Its boundaries are approximately Grand Avenue to the north, Interstate 10 to the south, the Beardsley Canal (191st Avenue) to the west, and Reems Road (155th Avenue) to the east. The District boundaries largely mirror those of Arizona-American's Agua Fria service territory.

groundwater supplies run low in its service area. But this is a false choice. The District is a better, cheaper alternative. The District has been the surface water provider for this area for decades, and the District can use its experience and resources to provide an integrated, regional surface water solution. It can do this at a lower cost, and any margin (profit) will be returned to the District's landowners, rather than being sent to Arizona-American's distant shareholders. Moreover, by seeking to shoulder the extra burden of building the regional surface water treatment plant, Arizona-American risks further damage to its precarious financial situation. In contrast, the District has sound finances.

II. Background.

On October 11, 2005, Arizona-American Water Company ("Arizona-American") filed an Application in this case for approvals related to building and financing a regional surface water treatment plant known as the White Tanks Plant in conjunction with the District. The Application contemplated that the White Tanks Plant would be "financed, built and owned by" the District.[2] Arizona-American gave public notice of this Application. However, Arizona-American later asked that the procedural schedule in this case be suspended. The case then sat dormant for months.

On September 1, 2006, Arizona-American filed a Revised Application. Although the Revised Application is radically different than the original application, Arizona-American has never provided public notice of the Revised Application. Under the Revised Application, Arizona-American proposes to cut the District out of the process and build the White Tanks Plant by itself. The original Application proposed a capital lease with a small increase in hook-up fees, while the Revised Application proposed a much larger increase in hook-up fees.

The Revised Application also seeks approval to depart in significant ways from well-established ratemaking principles. For example, Arizona-American wants to accrue an "allowance for funds used during construction" or "AFUDC" on certain plant after it is placed in service. This is a departure from normal practice, which as the name implies, is that AFUDC can be accrued only

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[2] Revised Application of Arizona-American filed September 1, 2006 at page 1 (describing original application).

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during construction, and certainly not when the plant is in service. The extra AFUDC will be placed in rate base, eventually raising rates. Arizona-American also seeks permission to not record hook-up fees as contributions until the related plant is in service. Again, this is contrary to well-established practice and serves to inflate rate base.

III. Arizona-American's revised application is inaccurate.

The District believes that the Revised Application is inaccurate in a number of respects. For example, the Revised Application states that "MWD no longer wishes to build, finance, and own the White Tanks Plant."[3] This is flatly wrong. The Revised Application also states that the "alternative to the White Tanks Plant would be business as usual – continuing to rely on groundwater supplies."[4] This is also flatly wrong. The District stands ready, willing, and able to build the White Tanks Plant. The Revised Application presented two financing options for the White Tanks Plant. However, it left out another option Arizona-American was well aware of: the plant could be financed and built by the District. And as a public entity, the District has access to low-cost financing, which would eliminate the need for hook-up fees.

On October 27, 2006, Staff filed a Staff Report supporting Arizona-American, and recommending that hook-up fees be substantially increased. However, Staff was likely unaware that the statements made by Arizona-American were inaccurate. Indeed, Staff stated that "circumstances have changed and MWD no longer wishes to finance, build, and own the White Tanks Plant."[5] The District appreciates Staff's support for the use of surface water – support that goes so far as to recommend the extraordinary special treatment demanded by Arizona-American. Based on the information available to Staff at the time, this is an understandable, even commendable choice. But the information provided to Staff was incorrect, and there is no need for such extraordinary measures. The Commission need not abandon its ratemaking principles to encourage surface water use – it can have the best of both worlds.

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[3] Id. at 2.

[4] Id. at 7.

[5] Staff Report dated October 27, 2006 at 1.

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IV. The District is the better, cheaper choice.

A. The District has a long track record with surface water.

The District has served the West Valley for more than 75 years. The District provides the West Valley with an average of more than 30,000 acre-feet of surface water per year from the Agua Fria River. The District also owns and operates the Beardsley Canal – the only means to transport surface water to the region. The District transports more than 50,000 acre-feet of water per year though the Beardsley Canal. This includes substantial amounts of CAP water as well as the Agua Fria water provided by the District. The District has been intimately involved in water conservation efforts and studies throughout the West Valley, including the study that led to the White Tanks Plant idea. In contrast to the District's 75-year commitment to surface water, Arizona-American has used only groundwater to serve its customers.[6]

B. The District's plan is cheaper.

The District, being responsible to its landowner voters, is cost-conscious. Therefore, cost issues have played an important role in its planning. As part of this planning process, the District worked closely with local cities. The District retained Malcolm Pirnie – a well-respected, national firm – to prepare a preliminary engineering study for the District's proposed surface water treatment plant. The study is attached as Exhibit A. The study contemplates a treatment plant with a total capacity of up to 80 million gallons a day ("MGD"). The first phase will provide up to 20 MGD in capacity. The projected cost of the phase one is about $47 million.[7] In contrast, phase one of Arizona-American's proposed plant will cost more than $67 million.[8] Though it will cost more, Arizona-American's phase one will provide much less treatment – only 13.5 MGD[9] compared to 20 MGD.

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[6] Arizona-American Utilities Division 2005 Annual Report at page 11 (Water Use Data Sheet for Agua Fria division).

[7] Malcolm Pirnie's study recommended four least cost approaches, which are each projected to cost $47 million or less. See Exhibit A at Table 4-4 (Page 4-15).

[8] Staff Report at Schedule JJD-1, line 8.

[9] Arizona-American Revised Application, Page 7, line 4 (13.5 MGD phase one costs $67,325,000).

And it is not only the District's up-front costs that are lower. Staff recognizes that a regional plant can "achieve significant economies of scale".[10] The District's first phase is larger than Arizona-American's first phase, so the District is more likely to realize economies of scale. With its close relationship with local cities and its existing surface water infrastructure and experience, the District is more likely to build additional phases and thus achieve even greater efficiencies. Although the Staff Report mentions the possibility that Arizona-American might attract wholesale customers for its plant, this is unlikely. Arizona-American's rates do not include a tariff for firm, potable water on a wholesale basis.[11] It may have to charge its full, retail price for potable water. For customers that use more than 13,000 gallons a month (as a wholesale customer would), Arizona-American's price is $2.4870 per 1,000 gallons.[12] There are likely to be few takers at that price.

The District, as a public entity, has access to low cost debt. In contrast, Arizona-American will have to borrow at higher rates. As a for-profit company, Arizona-American must provide its investors with a return on their investments in order to attract capital. Thus, the profits from Arizona-American's plant will be sent to its out-of-state shareholders. But the District does not need to earn a margin (profit) on its activities, and any margin it does earn is returned to its landowners.

The District has other cost advantages. It already owns the land for the plant site. It will never have to pay property tax on this site, or on the plant's equipment. Arizona-American must pay property tax on both the plant site and the equipment. These extra taxes will be passed on to its customers. In addition, as a municipal power provider, the District has access to low-cost power, while Arizona-American will have to pay full price for the electricity to operate its plant.

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[10] Staff Report at 6.

[11] Arizona-American Agua Fria District Tariff, issued July 1, 2004.

[12] Id. at Sheet No. 1, General Water Rate G-1.

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C. The District has other advantages.

The District has advantages beyond price. It has decades of experience with surface water. With the Beardsley Canal and its portfolio of surface water, it has the infrastructure and resources to provide to provide integrated, full-service surface water solutions to the region. As its own rate-setting authority responsible to its voters, the District has the flexibility to respond quickly to changing circumstances. Arizona-American lacks both the resources and the flexibility that the District can bring to the table.

V. Arizona-American's plan will only result in more financial weakness.

Arizona-American essentially proposes to fund the White Tanks Plant entirely through hook-up fees. Given its weak financial condition, Arizona-American's proposal raises concerns. Arizona-American's equity ratio is only 34.2%, well under the minimum target of 40%.[13] Arizona-American has an "equity plan" to get up to 40%. Ironically, the plan includes the construction of the White Tanks Plant "that MWD will build and own."[14] The plan also includes unlikely Commission actions such as recovery of an acquisition premium and increased costs of equity.[15] Even Arizona-American says that "it will be challenging" to meet the 40% goal.[16] While a 34.2% equity ratio is troublesome enough, the true situation is even worse because the equity ratio does not include the effects of the hook-up fees.

Further, the hook up fees will be treated as contributions in aid of construction ("CIAC").[17] Staff recently explained the danger of too much CIAC and advances in aid of construction ("AIAC"): "Historically, Staff has recommended limiting AIAC and CIAC funding to 30 percent of total capital. Over reliance on AIAC or CIAC creates undercapitalized water and wastewater

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[13] Staff Report at page 5; see also Arizona-American "Notice of Filing Capital Structure Report" dated May 5, 2006 in Docket No. W-01303A-05-0280.

[14] See "Arizona-American Water Company's Compliance Filing of Equity Plan", filed on November 30, 2005 in Docket No. W-01303A-05-0280 at page 6.

[15] Id. at 5.

[16] Id. at 8.

[17] Staff Report at page 3.

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providers."[18] Staff goes on to explain that AIAC and CIAC are not included in the capital structure, and they are thus not reflected in the equity ratio. Thus, a company could have a 40% equity ratio but in reality be very weak.[19]

This is just such a case. Arizona-American's AIAC and CIAC already far exceed its equity. It has $180 million in AIAC and CIAC but only $116 million in equity.[20] Allowing it to add $132 million more CIAC[21] without any more equity makes little sense.

VI. **Other concerns weigh against quickly approving Arizona-American's requests.**

There is a substantial level of interest in this case. Many entities have requested intervention. And the word is only now getting out, because Arizona-American did not provide public notice of its Revised Application. As more people find out about Arizona-American's extraordinary proposals, the level of interest and participation will likely grow. Given this level of interest, it is not prudent to quickly approve Arizona-American's requests.

Moreover, Arizona-American's conduct in this case is troubling. It is aggressively opposing participation by a public agency (the District) and by the landowners in its service area. Further, Arizona-American is making threats against those who dare oppose it. When Pulte voiced its opinion on these matters, Arizona-American stated that it would try to stall the CC&N application it filed for a Pulte development.[22] And Arizona-American threatened a moratorium that would affect all landowners including Pulte.[23] The Commission should not tolerate such "hardball" tactics, especially from monopoly utilities with an obligation to serve the public.

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[18] Staff Report in Docket No. W-00000C-06-0149 dated October 6, 2006 at page 6.

[19] See Id., and the example shown on Schedule JJD-2 of that Staff Report.

[20] Arizona-American Utilities Division 2005 Annual Report at page 6.

[21] See Staff Report in this docket at Schedule JJD-1, showing (in 2012) $132 million in Hook-up fees collected, of which $67 million will fund the White Tanks Plant.

[22] Arizona-American Response to Pulte Home Corporation's Response to Staff Report and Staff Recommended Order, filed November 13, 2006 at page 3, lines 1-3.

[23] Id. at page 2, lines 23-24.

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These tactics are part of a pattern. Arizona-American's case is built around a threat that if its demands are not met, Arizona-American will fail to fulfill its obligation to serve its certificated area. The Commission should expect every water utility to fulfill its service obligation – without special treatment. Moreover, Arizona-American's claims of urgency are likely overstated. It is obvious that growth is slowing as part of the current slow-down in the real estate market. And Arizona-American certainly has the option of adding more wells in the short term.

Moreover, the District is prepared to move quickly with its project. However, Arizona-American may not be able to move as quickly, because it may face legal challenges to the validity of the hook-up fees upon which it relies. The Commission considers hook-up fees to be rates.[24] Because hook-up fees are rates, increasing them here may require: (1) a fair value finding under Article XV, Section 14 of the Arizona Constitution; and (2) a hearing under A.R.S. § 40-250. Moreover, Arizona-American's proposals violate the Commission's finding that hook-up fees cannot be imposed outside of a rate case unless the fee: (1) is revenue-neutral; and (2) is recorded as CIAC.[25] The special treatment for AFUDC and CIAC requested by Arizona-American violate these findings. And Arizona-American cannot claim ignorance of these findings, because the findings were made in a previous hook-up fee case for Arizona-American's Agua Fria district.

VII. Conclusion.

The Staff Report was based on mistaken information provided by Arizona-American. The District stands ready to build, own and operate the White Tanks Plant. It can do so better and at a lower cost than Arizona-American. As the District urbanizes, its landowners are rapidly becoming residential consumers. Why should these landowners be forced to pay an excessive and unnecessary hook-up fee when they can instead pay nothing and earn a refund? There is no reason. Nor is there any reason to grant Arizona-American the radical and unprecedented ratemaking

[24] See Decision No. 66512 (Nov. 10, 2003) at Conclusion of Law No. 4.

[25] See Decision No. 66512 (Nov. 10, 2003) at Finding of Fact No. 10.

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principles it requests in place of those traditionally used by this Commission. Accordingly, Arizona-American's Revised Application should be denied.

RESPECTFULLY SUBMITTED this 16th day of November 2006.

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EXHIBIT

"A"

Maricopa Water District
Water Treatment Plant Planning
Preliminary Engineering Study

Final Report - August 2006

Prepared by: Malcolm Pirnie

5165-002

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Abbreviations

%	Percent
AACE	Association for the Advancement of Cost Engineering
af/y	Acre-feet per year
CAP	Central Arizona Project
CRSP	Colorado River Storage Project
DAF	Dissolved air flotation
DBP	Disinfection byproduct
du/ac	Dwellings per acre
EBCT	Empty bed contact time
ft	Feet
ft^2	Square feet
GAC	Granular activated carbon
gpm	Gallons per minute
GRIC	Gila River Indian Community
kWh	Kilowatt hour
M	Million
M$	Million dollars
mgd	Million gallons per day
min	Minutes
MWD	Maricopa Water District
NOM	Natural organic matter
O&M	Operation and maintenance
RWI	Raw water impoundment
SBF	Sand ballasted flocculation
T&O	Taste and odor
TDS	Total dissolved solids
TOC	Total organic carbon
WESTCAPS	West Valley CAP Subcontractors
WTP	Water Treatment Plant

Executive Summary

Maricopa Water District (MWD) is pursuing the construction of a water treatment plant (WTP) to provide potable water to wholesale customers in the surrounding area. The WTP will treat surface water from the Beardsley Canal, which conveys Colorado River water delivered via the Central Arizona Project (CAP) Canal. MWD believes they can provide a cost-effective solution for the surrounding communities to cooperate with each other and participate in a regional water treatment project.

The MWD Board authorized a Preliminary Engineering Study to determine the potential customer base (and treatment capacity) for the proposed WTP, identify potential sites for the WTP, and select a treatment process train for the WTP. The findings of this Preliminary Engineering Study are documented in this report and summarized below:

- **Treatment Capacity Evaluation** (Section 2) – Several potential customers within five miles of MWD boundaries have been identified. The known surface water allocations (CAP and Agua Fria) total 58.7 mgd. The City of Goodyear, which is the largest potential customer and the customer that has expressed the most interest in partnering with MWD, currently has a CAP allocation of 3.2 mgd and will be receiving an additional 12.7 mgd through a lease with the Gila River Indian Community (6.3 mgd) and through a reallocation of CAP water (6.4 mgd).
- **Site Selection** (Section 3) – Five sites along the Beardsley Canal on land already owned by MWD were investigated as potential locations for the WTP. Based on the technical feasibility of locating a WTP at each site and land use planning information from MWD, two sites were identified as preferred locations: Site 2A (East of the Canal, between Northern and Olive Avenues) and Site 3 (East of the Canal, between Glendale and Northern Avenues).
- **Treatment Process Recommendation** (Section 4) – Several possible unit process alternatives were evaluated for implementation at the proposed WTP. Several unit processes were determined to be infeasible for the site, and the remaining unit processes were combined into 24 potential treatment process trains. Using the WTP treatment goals along with order of magnitude capital and operating costs for the proposed treatment trains, the process train consisting of a raw water impoundment, sand ballasted flocculation, and deep-bed granular activated carbon filters was recommended. Residuals from the treatment process will be treated using a gravity thickener and either solar drying beds or a centrifuge.

This Preliminary Engineering Study provides MWD with information on the feasibility of constructing a WTP. The next steps entail finalizing the capacity of the WTP, finalizing the site selection, and developing a conceptual design for the facility. If the MWD Board decides to design and construct a WTP, it will take approximately 3.5 years from the notice to proceed until the WTP can deliver water.

1. Introduction

1.1 Maricopa Water District Background

Maricopa Water District (MWD) service area is located in the Phoenix metropolitan area, approximately 30 miles northwest of downtown Phoenix. The approximate boundaries of the district (shown in Figure 1-1) are Grand Avenue to the north, I-10 to the south, the Beardsley Canal (191st Avenue) to the west, and Reems Road (155th Avenue) to the east. MWD service area is approximately 65 square miles and has traditionally been an agricultural area.

MWD provides irrigation water for lands within the district boundaries. This area of the West Valley is undergoing a rapid population increase, and some of the land within the MWD boundaries is being converted from agricultural use to residential use. As such, there is a need to provide potable water (rather than irrigation water) to the customers within the district. In addition, the communities surrounding MWD are also facing increasing potable water demands. MWD recognizes the changing water market in the area and would like to adapt to serve the area in the best manner possible. As such, MWD has begun the initial planning stages for the construction of a new potable water treatment plant (WTP). The WTP will treat surface water from the Beardsley Canal, which contains Colorado River water delivered via the Central Arizona Project (CAP) Canal. MWD is interested in constructing the WTP for the following reasons:

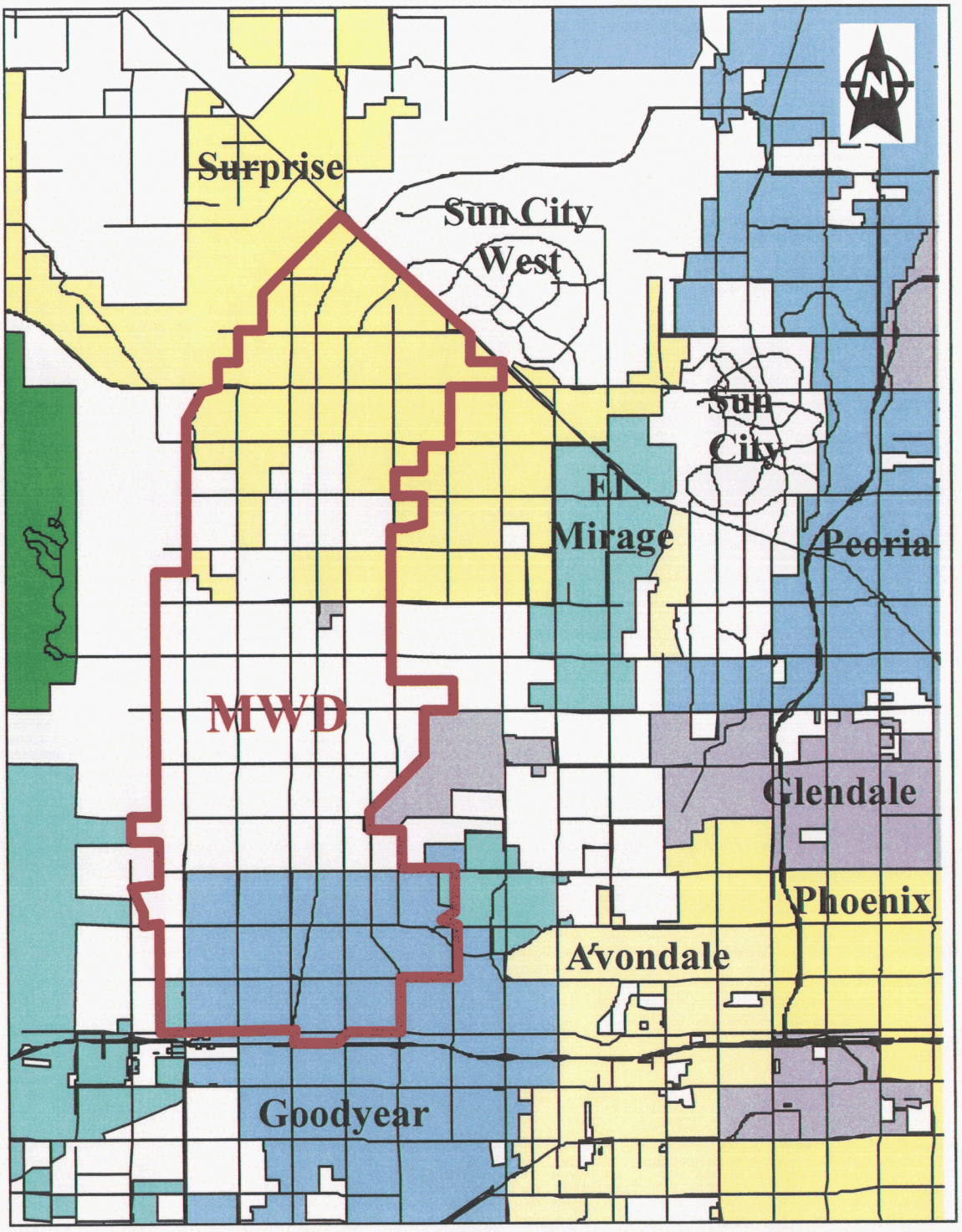
- There is a business opportunity for MWD to treat CAP water and sell to wholesale customers
- There are several potential customers in the communities surrounding MWD
- The customers have CAP allocations but no method of transporting, treating, or delivering the water
- MWD has a raw water conveyance system (the Beardsley Canal) and land available for construction
- MWD has renewable agreements in place with Hoover Power and the Colorado River Storage Project (CRSP) for power at a commercially attractive rate

MWD believes they can provide the surrounding communities with a cost-effective solution to mitigate shortage of potable water and an opportunity to cooperate with each other and participate in a regional water treatment project.

1.2 Study Objectives

In May 2006, MWD began a Preliminary Engineering Study to evaluate the potential construction of a WTP. The objectives of the Preliminary Engineering Study were as follows:

- Determine the potential capacity



0 2 4 Miles

Approximate Scale

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MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING
MARICOPA WATER DISTRICT LOCATION AND BOUNDARIES

August 2006

FIGURE 1-1

- Evaluate potential sites
- Screen potential treatment processes and estimate costs

This report documents the findings of the preliminary engineering study. In addition, the report also includes a timeline with information on the tasks needed to go from a green-field site to having a completed WTP delivering water.

2. Treatment Capacity Evaluation

The anticipated customers for the new WTP proposed by MWD are all wholesale customers. As such, traditional methods of forecasting demands (e.g., using land use maps, growth projections, and per capita demand factors) are not appropriate for determining the ultimate capacity of the WTP. Instead, it is more important to develop a list of customers in the surrounding areas that are potential partners for MWD. Using this list along with the available CAP allotment for each entity provides insight for the potential ultimate capacity of the facility. The WTP will be constructed in phases to support growth and demands of new bulk delivery customers in the area as they increase participation in the project. The maximum treatment capacity for the plant is not finalized at the present time; however, a preliminary analysis indicates that Phase I of the plant could be approximately 20 mgd of capacity. The ultimate capacity of the facility may be 80 mgd or greater. This section includes information on the potential customers, their CAP allocations, other water sources, and an initial discussion of the customers' interest level in this project.

2.1 Potential Customers

There are several potential wholesale customers in the area surrounding MWD. The preliminary evaluation focused on communities that are within 5 miles of the MWD border and water companies that serve these communities:

- City of Goodyear
- City of Avondale
- City of El Mirage
- City of Surprise
- Sun City (Arizona American Water)
- Sun City West (Arizona American Water)
- MWD (Arizona American Water)
- White Tanks (Arizona Water Company)
- Agua Fria (Arizona American Water)

Other neighboring communities were briefly considered, but because of limited surface water allocations or because they already have decided how to best user their surface water allocations, they were not considered further (e.g., Buckeye, Glendale, and Peoria).

2.2 CAP Allocations

The total available CAP allocation for the communities presented in Section 2.1 is 44.4 mgd (Table 2-1). The allocations shown are a compilation of the data available on the allocation section of the CAP website (www.cap-az.com) and information in the master plans for the communities. This table includes the currently known allocations obtained through leases with the Gila River Indian Community (GRIC). It should be mentioned that there could be additions to these allocations through further agreement with Indian Communities and/or CAP.

Table 2-1: CAP Water Allocations

Community	CAP Allocation	
	af/y	mgd
Goodyear [1]	17,742	15.9
Avondale	5,416	4.8
El Mirage [2]	508	0.5
Surprise [3]	7,303	6.6
White Tanks (AZ Water Company)	968	0.9
Agua Fria (Arizona-American)	11,093	9.9
Sun City (Arizona-American)	4,189	3.7
Sun City West (Arizona-American)	2,372	2.1
Total	**49,153**	**44.4**

[1] Includes 3,531 af/y (3.2 mgd) currently available and an additional 14,211 af/y (12.7 mgd) that will become available in 2009.
[2] Available from the AZ Water Settlement.
[3] Available in 2010.

2.3 Other Water Sources

In addition to the CAP allocations shown in Table 2-1, the MWD WTP may also be used to treat surface water from other sources or ground water. In particular, MWD currently has access to 16,000 af/y (14.3 mgd) of Agua Fria water that may not be needed for the District's direct use customers. This amount is an annual average, and the actual amount available in a given year depends on the available supply and will vary according to the weather and seasonal runoff from the watershed. MWD may also be able to use some of the wells within the district to provide a backup to the surface water supplies. However, at this time it is not possible to send groundwater from within the district to areas outside of the district, so the appropriate water rights and exchanges would need to be developed before this strategy could be implemented.

Including the additional Agua Fria surface water allocation, the capacity of the MWD WTP could be as high as 58.7 mgd.

2.4 Interest Level and Phasing

The communities listed in Table 2-1 have all expressed interest in treating their CAP allocations. At the present time, Arizona American has expressed interest in constructing their own WTP; however, it is unclear whether they will be able to secure the partnerships and funding needed for construction. The other communities have varying levels of interest in participating in the MWD WTP project:

- The **City of Goodyear** has expressed the most interest in the MWD WTP project. They have attended the workshops during the Preliminary Engineering Study and have participated in some of the initial decision making. The City of Goodyear would like to participate in the project provided that the rate structure is amenable. At a minimum in Phase I, Goodyear is interested in approximately 5 mgd of capacity by 2009 with phased increases in capacity to meet their growing demands.
- The **City of Avondale** is commissioning a study to determine how best to use their surface water allocations.
- The **City of Surprise** has long range plans for their own surface water treatment plant, but has expressed interest in the MWD project.
- The **City of El Mirage** has expressed interest in the MWD project as it would be prohibitively expensive for El Mirage to build their own facility for treating their CAP allocation.

2.5 Future Capacity Determination Work

During the next several months, MWD should continue discussions with the City of Goodyear regarding their participation in the MWD WTP. In addition, it may be beneficial to open discussions with the other surrounding communities to further gauge their interest level. Through the discussions with Goodyear and the other communities, MWD should work to develop signed partnership agreements for the design of the facility.

3. Site Selection

The proposed MWD WTP will be constructed on a new site within the district boundary. MWD owns over 2,500 acres of land that borders the Beardsley Canal. Although a preliminary land use plan has been developed for the land owned by MWD, almost all of the land is available as a potential site for the MWD WTP. At the initial project meeting, four potential areas for locating the WTP were identified and during the project, a fifth site was brought into consideration. This section includes the site selection criteria, descriptions of the candidate sites, a comparison of the potential sites, and a recommendation for moving forward and finalizing the site for the WTP.

3.1 Site Selection Criteria

There are several criteria to consider when selecting a site for a WTP. Some of the site characteristics are related to the engineering design of the WTP (e.g., size, topography, and elevation) while others address specific concerns of MWD (e.g., proximity to residential neighborhoods and land use master plan). This section includes a list of site characteristics and how each one affects the site selection for the MWD WTP. The following criteria should be considered when selecting a site:

- **Size** – The WTP site should be large enough to accommodate the master site plan for the treatment facility at ultimate capacity. A reasonable estimate for preliminary planning is approximately one acre per mgd of capacity; however using treatment processes with smaller footprints can allow for significant reductions in space requirements. Section 4 contains more information on the size of the proposed WTP.
- **Topography** – A site that allows for the use of gravity to flow water through the plant is preferable (i.e., the site should slope downwards away from the source water towards the delivery point for the treated water).
- **Elevation** – The elevation of the WTP site will determine whether treated water can flow by gravity to the customer or whether it will need to be pumped.
- **Proximity to the water source** – A site near the Beardsley Canal will minimize the cost needed to convey raw water from the canal to the WTP.
- **Proximity to the potential customers** – A site near the customers will reduce the cost of conveying treated water by pumping or gravity flow.
- **Zoning ordinances or land use restrictions** – Commercial or industrial zones are typically preferred to minimize the effect on neighboring properties and to facilitate obtaining permits.
- **Land use master plan** – The areas that are master planned for higher density housing can be sold for higher prices. As such, areas master planned for lower density housing are preferable because there is smaller loss of revenue from unsold land.

- **Canal conveyance capacity** – A capacity evaluation for the Beardsley Canal was completed in 1999 for the West Valley CAP Subcontractors (WESTCAPS). This evaluation noted that the canal capacity south of Cactus Road is 50 mgd and will need to be increased if the capacity of the WTP exceeds 50 mgd.

3.2 Site Descriptions

Taking the selection criteria presented in Section 3.1 into consideration, the project team identified four potential sites for the MWD WTP at the first project meeting (Sites 1, 2, 3, and 4 on Figure 3-1). In a subsequent meeting that also included representatives from *Land Solutions*, MWD's land use planning consultants, a fifth site was added (Site 2A on Figure 3-1). The topography of all sites is similar and slopes downward from northwest to southeast. As such, the sites to the north have a higher average elevation than the sites to the south. Descriptions of each site and elements relating to the selection criteria are presented in this section.

3.2.1 Site 1 - East of Perryville Road, South of Waddell Road

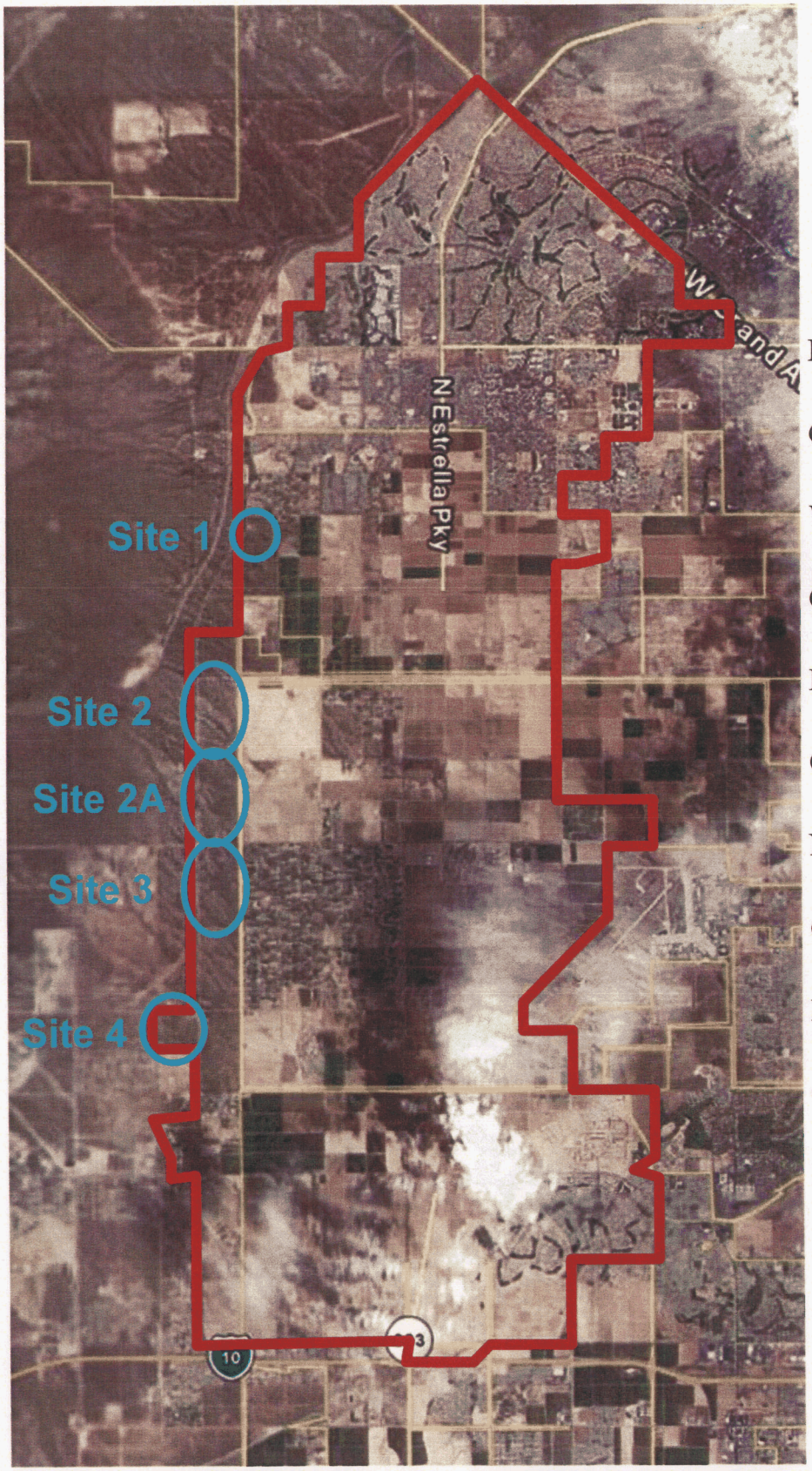
Site 1, shown in Figure 3-2, is an area of approximately 50 acres that is bisected by the Beardsley Canal. The site is slightly small for the ultimate capacity, but using processes with smaller footprints may make it feasible. The site is north of Cactus Road, so no canal improvements would be needed to convey the anticipated ultimate capacity of 80 mgd to the site. Site 1 has the highest average elevation of all the sites considered (approximately 1330 feet) and is the northern-most site evaluated. According to the Zanjero Trails land use plan, this area is master planned for a density of 2.0 to 2.5 dwelling units per acre (du/ac).

3.2.2 Site 2 - East of the Canal and Between Olive, Peoria Avenues

Site 2, shown in Figure 3-3, is an area of approximately 150 acres that is east of the Beardsley Canal and south of Peoria Avenue. This area is significantly larger than the anticipated size of the WTP site, but having a larger site increases flexibility to arrange the facilities in a manner to provide buffers with the surrounding areas. Because the site is south of Cactus Road, canal improvements are needed to convey more than 50 mgd to the site. Site 2 has an average elevation of approximately 1280 feet. According to the Zanjero Trails land use plan, this area is master planned for a density of 3.0 to 4.0 du/ac. The area directly east of Site 2 is a recently-developed residential community with rapid home sales. It is unknown how the new homeowners would react to having a WTP located nearby.

3.2.3 Site 3 - East of the Canal, Between Glendale and Northern Avenues

Site 3, shown in Figure 3-4, is an area of approximately 240 acres that is east of the Beardsley Canal, west of the proposed realignment of Perryville Road, and between Glendale and Northern Avenues. This site is also significantly larger than is needed for the WTP facilities, allowing for increased buffer areas. The site is south of Cactus Road, so canal improvements are needed to convey more than 50 mgd to the site. Site 3 has an average elevation of



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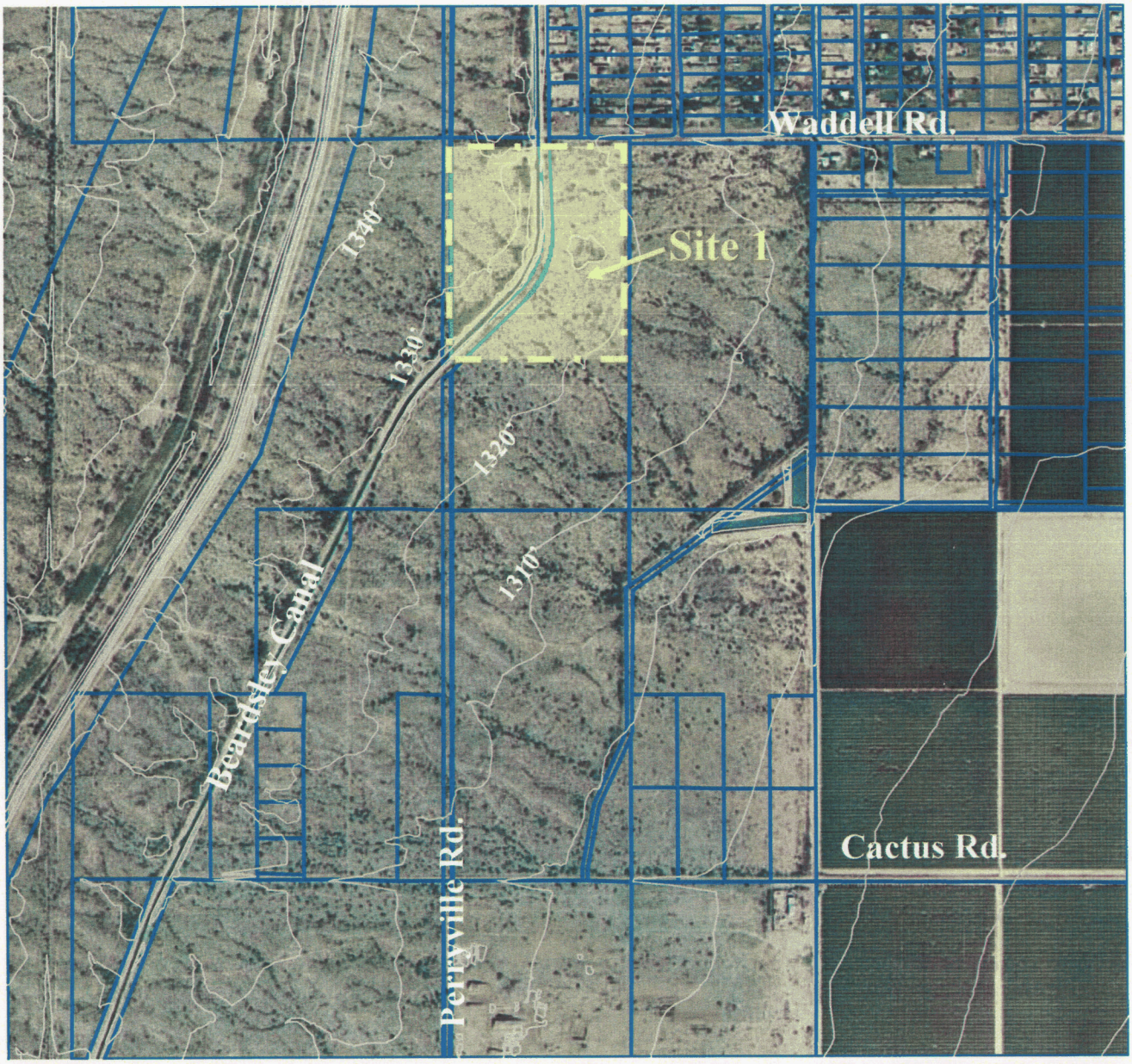
POTENTIAL WTP SITES

August 2006

FIGURE 3-1



0 0.25 0.5 Miles

Approximate Scale

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PRELIMINARY WATER TREATMENT PLANT PLANNING
SITE 1 AERIAL PHOTOGRAPH

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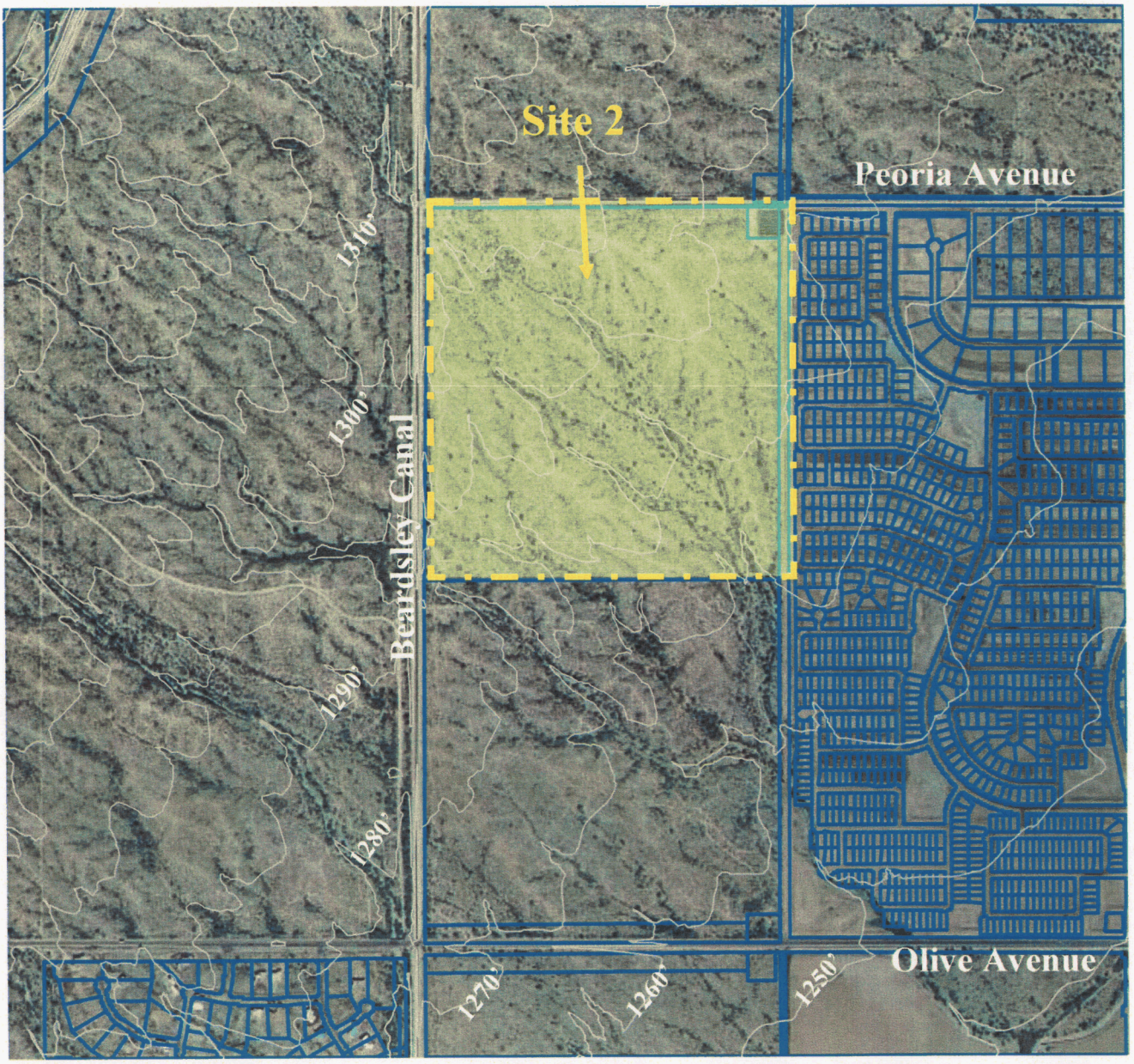
FIGURE 3-2



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Approximate Scale

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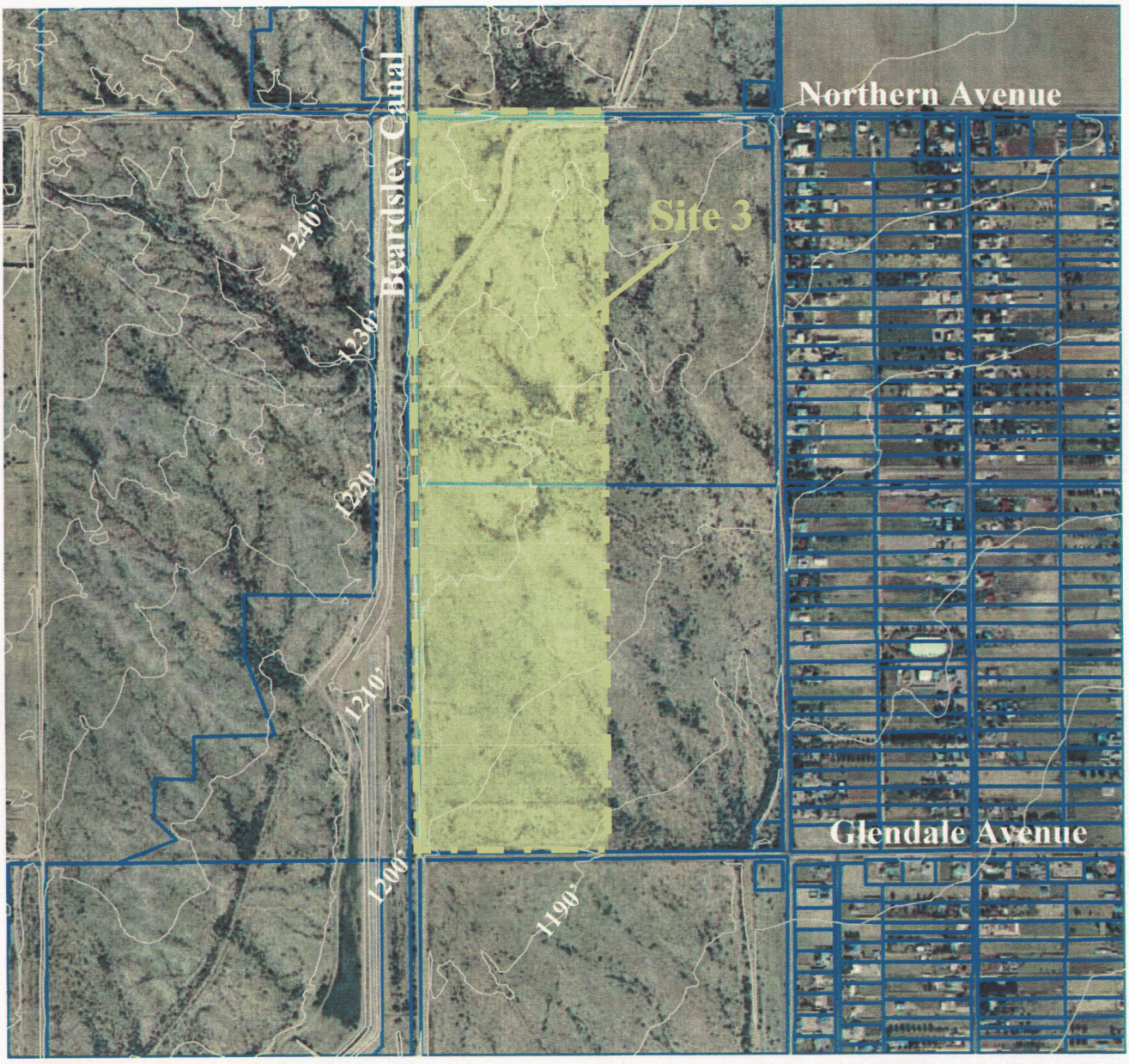
MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING
SITE 2 AERIAL PHOTOGRAPH

August 2006

FIGURE 3-3



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Approximate Scale

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PRELIMINARY WATER TREATMENT PLANT PLANNING
SITE 3 AERIAL PHOTOGRAPH

August 2006

FIGURE 3-4

approximately 1210 feet. According to the Zanjero Trails land use plan, this area is master planned for a density of 2.5 to 3.5 du/ac. Clearwater Farms, an established residential community, is located approximately ¼ mile east of the proposed site. The residents of Clearwater Farms were very involved during the preparation of the Zanjero Trails land use plan and negotiated a realignment of Perryville Road. As such, this is considered a potentially sensitive area, especially with respect to aesthetic concerns of lighting, noise, and odor.

3.2.4 Site 4 - West of the Canal, South of Bethany Home Road

Site 4, shown in Figure 3-5, is an area of approximately 170 acres that is west of the Beardsley Canal and south of Bethany Home Road. Similar to Sites 2 and 3, this site is larger than is needed for the WTP (allowing flexibility in arranging the treatment unit processes) and is south of Cactus Road, thereby necessitating canal improvements at the higher flow rates. Site 4 has the lowest average elevation of all sites considered (approximately 1180 feet) and slopes downward from west to east (toward the canal). The area is master planned for a density of 3.0 to 3.5 du/ac. The site is located in the spillway for the probably maximum flood (1 in 10000 years). Although it is unlikely that a flood of this magnitude would occur, this should be considered in the site evaluation. Site 4 is the southern-most site evaluated and is closest to the largest potential customer (City of Goodyear); however, it is further away from other potential customers that are north of the District.

3.2.5 Site 2A - East of the Canal, Between Northern and Olive Avenues

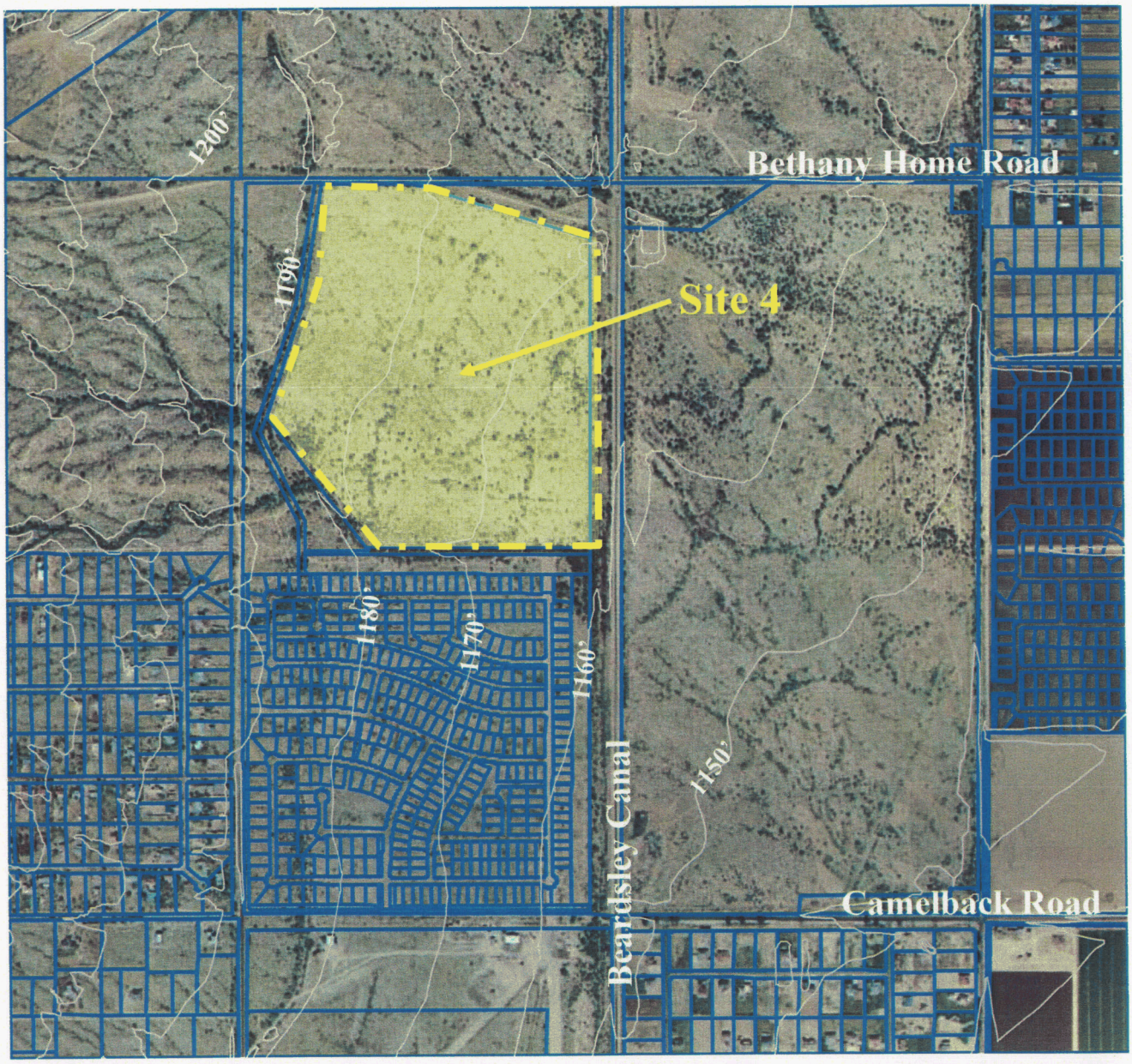
Site 2A, shown in Figure 3-6, was initially not considered as a potential site for the WTP because of the Flood Control Drainage Structure to be located directly east of the Beardsley Canal in the future. However, after further discussion it was determined that the structure will only occupy an area approximately 200 feet wide adjacent to the canal, leaving sufficient space for locating a WTP. Site 2A is an area of approximately 170 acres that is east of the Beardsley Canal and Flood Control Drainage Structure, west of the proposed Perryville Road realignment, and between Northern and Olive Avenues. The site is similar to Sites 2, 3, and 4 with respect to size considerations and necessary canal improvements. Site 2A has an average elevation of approximately 1250 feet and is master planned for a housing density of 2.0 to 2.5 du/ac.

3.3 Site Comparisons

Several characteristics of the sites described in Section 3.2 are similar to each other and are therefore not considered differentiators when selecting the potential WTP site:

- All sites are located along the canal and are therefore close to the water source.
- All sites are at an elevation sufficient to delver water by gravity to the customers located to the south.
- All sites are large enough to construct an 80 mgd facility.

As the site evaluation progressed, two characteristics that were initially thought of as differentiators were placed lower on the priority list: canal improvements and proximity to



0 0.25 0.5 Miles

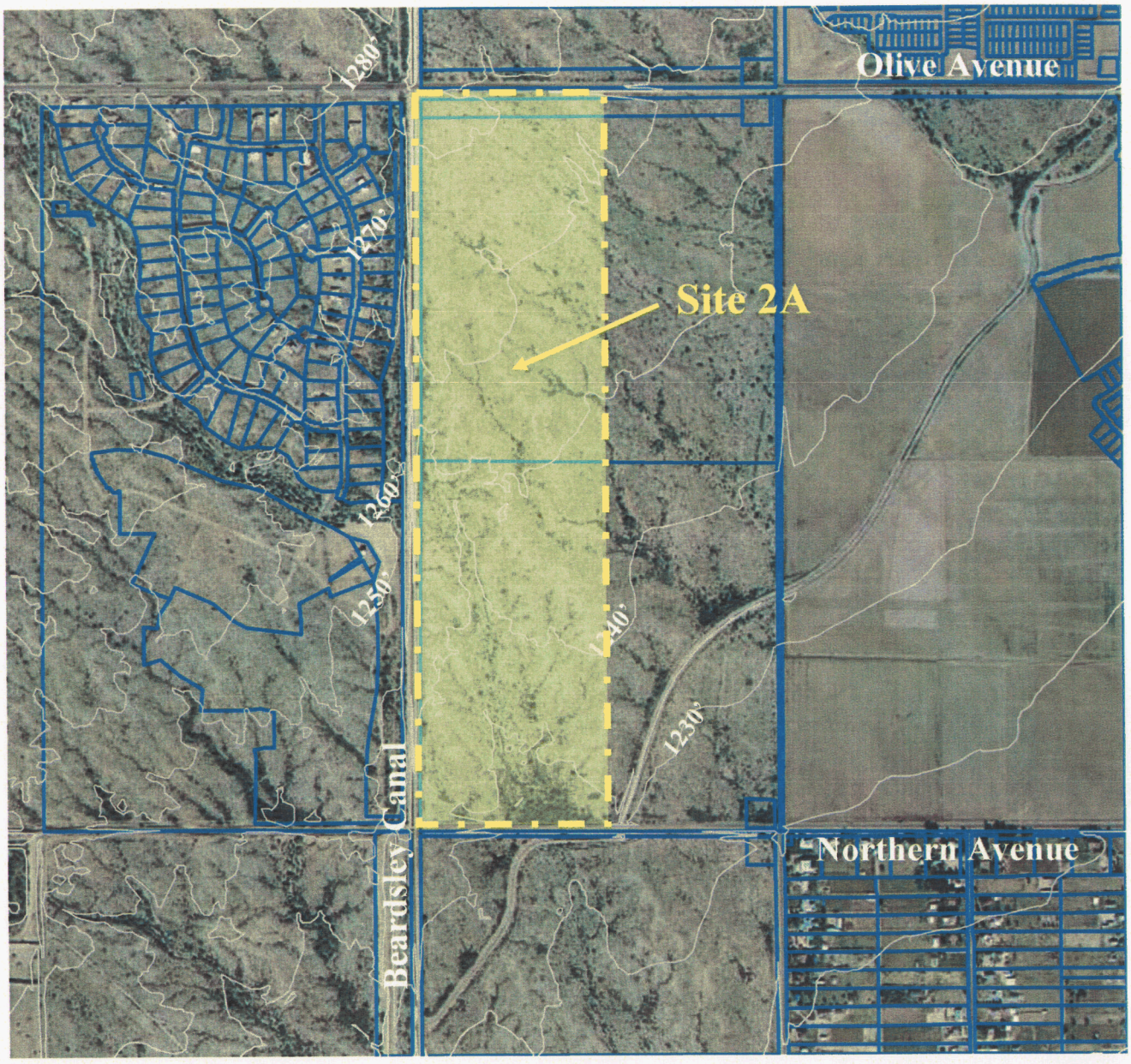
Approximate Scale

MALCOLM PIRNIE

MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING
SITE 4 AERIAL PHOTOGRAPH

August 2006

FIGURE 3-5



0 0.25 0.5 Miles

Approximate Scale

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MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING
SITE 2A AERIAL PHOTOGRAPH

August 2006

FIGURE 3-6

residential neighborhoods. MWD indicated that the canal improvements needed to convey more than 50 mgd south of Cactus Road will likely be implemented regardless of the site selected. With respect to potential neighborhood concerns, it is unknown whether a WTP would be considered an attractive or an unattractive neighbor for a residential neighborhood when compared to other potential land uses.

The remaining characteristics that provide some differentiation between the sites are as follows:

- Because of the topography (sloping downward from northwest to southeast), sites located east of the canal can more easily implement gravity flow through the WTP. As such Site 4 is considered less desirable.
- The further north the site is located, the shorter the pipelines will be to deliver water to the northern customers. Locating the WTP further south will shorten the pipelines to deliver water to the southern customers. Sites that are more centrally located are preferable (Sites 2, 2A, and 3).
- Because land with higher master planned land use density can likely be sold for a higher price, there will be less lost revenue if a site with a lower land use density is selected; as such, sites with lower planned land use density are preferable (Sites 1, 2A, and 3).
- Larger sites are preferable to smaller sites because of the increased flexibility to arrange the treatment plant elements with large buffer areas from the surrounding communities. As such, Site 1 is considered less desirable.
- Because Site 1 is bisected by the Canal, it may be more challenging to situate the treatment plant elements in manner that facilitates the hydraulic connection between unit processes. Pumping and crossing the canal may be needed.

3.4 Recommended Site Locations and Future Work

Based on the site selection criteria and the descriptions of the sites, two sites emerged as the preferred WTP site locations.

- **Site 2A** – East of the Canal, between Northern and Olive Avenues
- **Site 3** – East of the Canal, between Glendale and Northern Avenues

From a technical standpoint, both sites are sufficiently large, both slope downward away from the canal toward the delivery point (facilitating gravity flow through the WTP), and both are centrally located (facilitating delivery to the northern and southern customers). In addition, these sites have a lower proposed land use density so less revenue will be lost by not selling the land to developers. Before selecting a final site for the WTP, a public involvement program should be implemented so that concerns of the community can also be considered in the site selection. In addition, wildlife and vegetation evaluations, cultural and historical investigations, and geographic and topographic surveys should also be conducted before finalizing the site selection.

4. Treatment Process Selection

Several treatment process alternatives were considered for use at the proposed MWD WTP. After the kick-off meeting, two project workshops were conducted to facilitate selection of the preferred treatment process train. The following is a description of the project meetings:

- Kickoff Meeting (May 17, 2006) – The philosophy and regulations behind water treatment were discussed along with the goals of the project.
- First Project Workshop (June 8, 2006) – Information was presented on 4 pretreatment (pre-sedimentation, raw water impoundment, oxidation, recharge), 4 clarification (conventional flocculation and sedimentation, plate settlers, ballasted flocculation, dissolved air flotation), 4 filtration (dual-media granular, GAC filter-adsorbers, membranes, biofiltration), 4 disinfection (chlorine, chloramine, ozone, ultraviolet light), 2 advanced treatment (post-filter GAC, TDS removal), and 2 solids handling (drying beds, mechanical dewatering) processes. The infeasible alternatives were eliminated, and a list of 24 potential process trains was developed from the remaining 9 unit processes.
- Second Project Workshop (June 22, 2006) – Footprint and cost details were provided for the potential process trains and two trains were short-listed for further evaluation. Site layouts for the two treatment trains were presented for both 20 mgd and a possible future expansion to 80 mgd.

This section focuses on the information presented in the second project workshop after the infeasible treatment processes were eliminated, including descriptions of the unit processes, preliminary design criteria, conceptual costs, and selection of the recommended treatment process.

4.1 Treatment Process Goals

The goals for the treatment process are as follows:

- Meet all applicable regulations – This includes the recently promulgated Long Term 2 Enhanced Surface Water Treatment Rule for pathogen and particulate removal and the Stage 2 Disinfectants and Disinfection Byproduct Rule as it relates to consecutive systems.
- Achieve compatibility with disinfection strategy of surrounding customer base – Use free chlorine to satisfy the customers' needs.
- Achieve treatment goals for aesthetic parameters – The recommended treatment process will minimize customer taste and odor (T&O) complaints and will produce total dissolved solids (TDS) below 750 mg/L. The non-enforceable secondary standard for TDS is 500 mg/L but this may not be feasible using CAP water as the source.

4.2 Initial Process Alternatives

At the first project workshop, 16 unit process and 4 disinfection alternatives were presented, and several infeasible processes were eliminated. The remaining list of potential unit processes for the WTP constructed by MWD included two types of pre-sedimentation, three types of clarification, two types of filtration, and two types of solids handling. A discussion of the infeasible alternatives and brief descriptions of each process are included below.

4.2.1 Infeasible Processes

The infeasible alternatives included oxidation, recharge, plate settlers, dual-media granular filters, membranes, post-filter granular activated carbon (GAC), and TDS removal. Based on the desired water quality, oxidation and TDS removal are not required at this time and were eliminated. However, they may be desirable in the future. The recharge/recovery process was not chosen because of the uncertainty in water quality of recovered water. Plate settlers were removed from the treatment alternatives because they require extensive operator/maintenance attention. Both dual-media filters and membranes were eliminated because they do not provide adequate TOC removal and would require a separate TOC removal process, making them economically infeasible. Additionally, chlorine was selected as the disinfectant over chloramine, ozone, and ultraviolet light to produce water compatible with the water already in the distribution systems of the potential customers.

4.2.2 Pre-Sedimentation Processes

Like many water sources, the raw water emanating from the CAP Canal will be susceptible to variations in turbidity caused by the seasons and runoff into the canal system. Including a pre-sedimentation basin is important for solids removal during periods of high turbidity and to maintain a constant feed into the WTP. Two types of pre-sedimentation basins were considered for this project.

Conventional Pre-Sedimentation Basin

The concept for a "conventional" pre-sedimentation basin is to provide extra settling time to reduce solids loading and attenuate fluctuations in water quality to the downstream processes. In some cases, the pre-sedimentation basin can also be used as a contact basin for oxidants, powdered activated carbon, or other chemicals before the addition of a coagulant. The basin are constructed of concrete, and the hydraulic residence time is typically on the order of 30 to 60 minutes. As solids accumulate at the bottom of the basin, they are removed and sent to the solids handling facility for processing.

Raw Water Impoundment

The other concept for pre-sedimentation is a raw water impoundment (RWI), which is a large earthen basin lined with a plastic liner. The hydraulic residence time, approximately 20 to 30 times that of the conventional pre-sedimentation basin, is typically 12 to 24 hours. Although a RWI is significantly larger than a conventional pre-sedimentation basin and not ideal for

treatment plants where land is limited, its robust properties minimize the water quality fluctuations reaching the WTP and provide one day of raw water storage. Unlike the pre-sedimentation basin, a RWI will have to be drained to remove the settled solids (typically on the order of 5-10 years, depending on water quality).

4.2.3 Clarification Processes

The purpose of clarification is to reduce the solids loading reaching the filtration processes. By removing most solids in the clarification processes, filtration facilities can operate more efficiently. Three clarification processes that were considered for this WTP are summarized below.

Conventional Clarification

Conventional clarification using coagulation, flocculation, and sedimentation (shown schematically in Figure 4-1) is the most commonly used process for particulate removal.

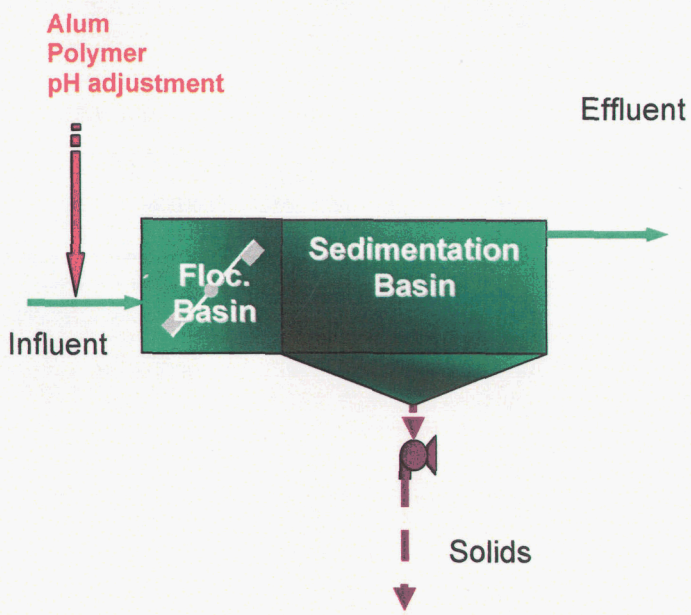


Figure 4-1: Conventional Flocculation/ Sedimentation Treatment Process Schematic

A coagulant (with or without a coagulant aid) is added to the water to destabilize particulates and to chemically react with natural organic matter (NOM). In the flocculation basin, the raw water and coagulants mix gently to promote agglomeration and particle collision. In the settling basin, the agglomerated particles settle due to gravity, and the supernatant is passed on to the filtration step. The sediment is collected at the bottom and removed from the basin.

Conventional clarification typically produces clarified water turbidity around 1 NTU or lower. Conventional treatment is not effective for the removal of taste and odor causing compounds and is often not used when there are space constraints because of its large footprint.

Sand Ballasted Flocculation

Sand ballasted flocculation (SBF), or ACTIFLO® (manufactured by Krüger), is a physical-chemical treatment process that uses continuously recycled micro-sand to enhance flocculation and sedimentation. As shown in Figure 4-2, the process operates as follows: In the coagulation chamber, a traditional metal coagulant (alum or ferric chloride) is added into a flash mixer. In the injection chamber, high molecular weight polymer and micro-sand are added to enhance floc formation. In the maturation chamber, the polymer, coagulant, and micro-sand are gently mixed to form a heavy floc that settles easily. The settling tank has inclined tube settlers to further aid in floc removal. The clarified water flows over launders. The residuals are removed from the bottom of the settling tank with scrapers and is sent through a hydrocyclone to separate the residuals from the micro-sand. The residuals are sent to a solids handling facility for further processing, and the micro-sand is recycled to the injection chamber.

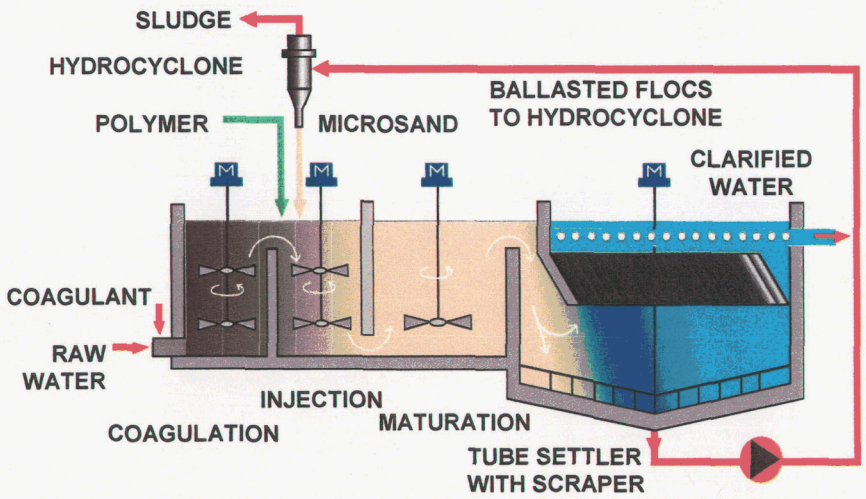


Figure 4-2: Sand Ballasted Flocculation Process Schematic

The primary advantage of sand ballasted flocculation is that it significantly reduces the process footprint needed for clarification (less than 10 percent of the area required for conventional clarification). Disadvantages are that the instrumentation and controls are more complex, therefore making the process more operator-dependent; the micro-sand and polymer added may pass through the system and affect downstream processes; and the use of hydrocyclone to separate the residuals from the sand breaks up the residuals into finer particulates, which can create an additional burden on the solids handling processes.

Dissolved Air Flotation

Dissolved air flotation (DAF), shown schematically in Figure 4-3, is a clarification method where flocculated particles attach to micro bubbles of air and "float" to the surface. A low density coagulant and raw water are gently mixed in a two or three stage flocculation process. The flocculation mixing promotes agglomeration; however, small flocs are preferred because it is easier to float those to the surface than larger, heavier flocs. Micro bubbles are then injected by an air saturator and attach to the flocs. The low density of the air bubbles brings the flocs to the top and forms a residual blanket, which is then removed by a hydraulic or a mechanical system.

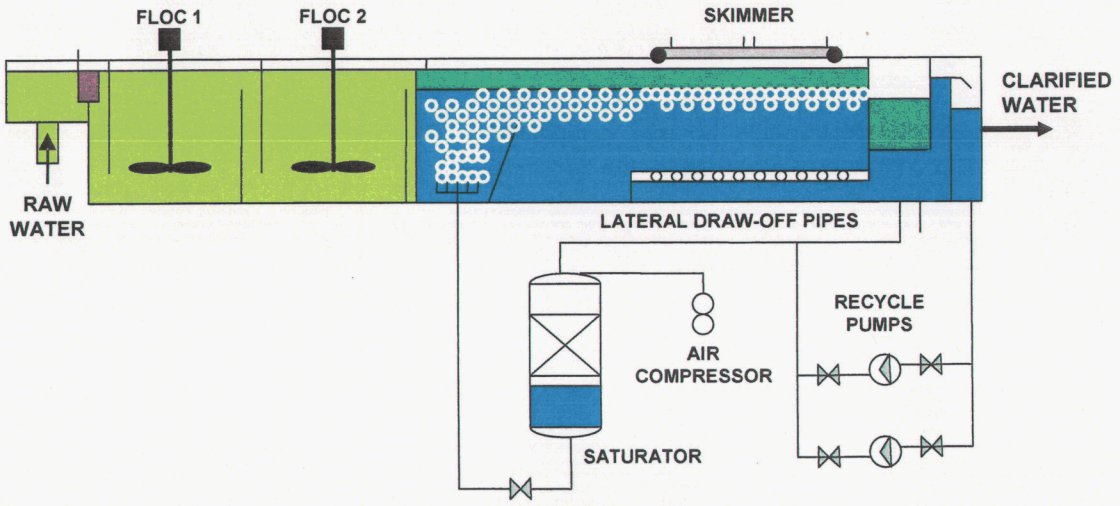


Figure 4-3: Dissolved Air Flotation Process Schematic

Turbidity, pathogen, total organic carbon (TOC), and disinfection byproduct (DBP) precursor removal by DAF has been reported to be similar to conventional clarification. In addition, algae removal of up to 90 percent has been reported.

4.2.4 Filtration Processes

The purpose of filtration is to remove suspended solids from the water that are not removed during the clarification process. Two potential filtration processes are summarized in this section. In addition to removing particulates, the proposed filtration processes provide the added benefit of reducing TOC and T&O.

Deep Bed Granular Activated Carbon Filters

Granular activated carbon filter adsorption is a variation of conventional granular dual media filters. In these filters, GAC is used as the filter media, which provides removal of particulate contaminants by filtration while also removing dissolved contaminants through adsorption and biodegradation. GAC filter adsorbers can be made with a single deep (assumed to be 96 inches

for this study) GAC layer (Figure 4-4). Clarified water is fed through the filter at rates generally between 2 gallons per minute per square foot (gpm/ft^2) and 12 gpm/ft^2. Particles are trapped in the filter as water passes through the filter. GAC filters are periodically backwashed; the length of the filter cycle is typically less than 48 hours, but it ultimately depends on the filtered water turbidity, headloss through the filter, and maximum filter run time. The backwash sequence may be challenging because it is difficult to control the backwash flow rates without losing GAC in the filter troughs, and particulates suspended in the filter media will pass though the GAC, potentially being adsorbed and shortening the life of the GAC.

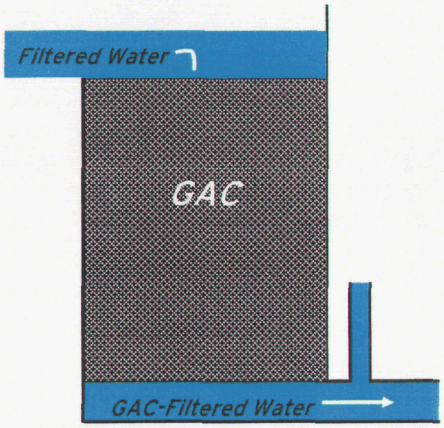


Figure 4-4: Typical Granular Activated Carbon Filter Cross-Section

The empty bed contact time (EBCT) for this type of filter is approximately 10 minutes. If the treatment process relies on removal of dissolved contaminants by adsorption, the GAC will need to be replaced and/or regenerated. The frequency of replacements depends on the extent of desired removal and the available EBCT. Alternatively, if the removal of dissolved contaminants is only achieved through biological degradation on the GAC surface, the media replacement occurs less frequently (or never).

Traditionally, GAC filter media is used to control taste and odor compounds, but it also is used to reduce organic compounds (e.g., TOC, NOM) and inorganic compounds (e.g., nitrogen, sulfides, and heavy metals). The primary disadvantage of this process is that particle removal and organics adsorption are combined in one process, making optimization challenging. In addition, the cost of replacing or regenerating the GAC can be significant.

Ozone-Biofiltration

Biofiltration also uses GAC beds as described previously; however, the EBCT is half that of the deep bed GAC filters. A typical EBCT for GAC biofilters is approximately 5 minutes, decreasing the bed depth to approximately 48 inches. As GAC filters age, bacteria begin to colonize, digesting the organics passing through the media, a process known as biodegradation. As long

as the filters are not backwashed with chlorinated water, the bacteria will continue to digest the organic matter, theoretically breaking it down into carbon dioxide and water. This process can be enhanced further with the use of ozone prior to filtration.

Ozone is one of the most powerful oxidants used in water treatment. Ozone can oxidize organic molecules into smaller chains and inorganics such as iron and manganese to their insoluble states for removal by sedimentation or filtration. The detention time in the ozone application chamber is approximately 2 to 3 minutes. The ozonated water then passes to an ozone dissipation chamber where the ozone reacts with organic compounds, breaking apart carbon chains thereby creating smaller organic molecules. Ozone does not significantly contribute to the formation of trihalomethanes or haloacetic acids. However, if bromide is present in the source water, bromate can form, which must be monitored because it is a regulated DBP.

The primary advantage of the ozone-biofiltration process shown in Figure 4-5 is its robust ability to destroy T&O causing compounds and to inactive bacteria and viruses. Disadvantages include the high capital cost and formation potential for bromate. Some of the initial capital cost, however, can be offset by the reduction in GAC media replacement frequency when compared to deep bed GAC filters.

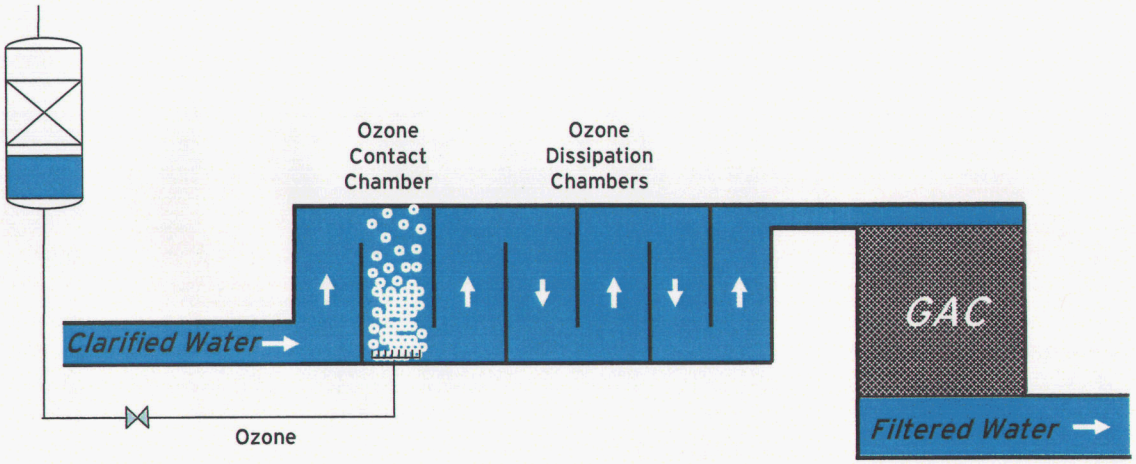


Figure 4-5: Typical Ozone-Biofiltration Cross Section

4.2.5 Solids Handling Processes

The purpose of solids handling is to concentrate solids produced from a WTP into a manageable form, minimizing disposal costs. A gravity thickener receives residuals from the treatment process and concentrates the solids through a settling process. The thickened residuals are then sent to a dewatering process. The gravity thickener and the two dewatering processes under consideration for this WTP are summarized in this section.

Gravity Thickeners

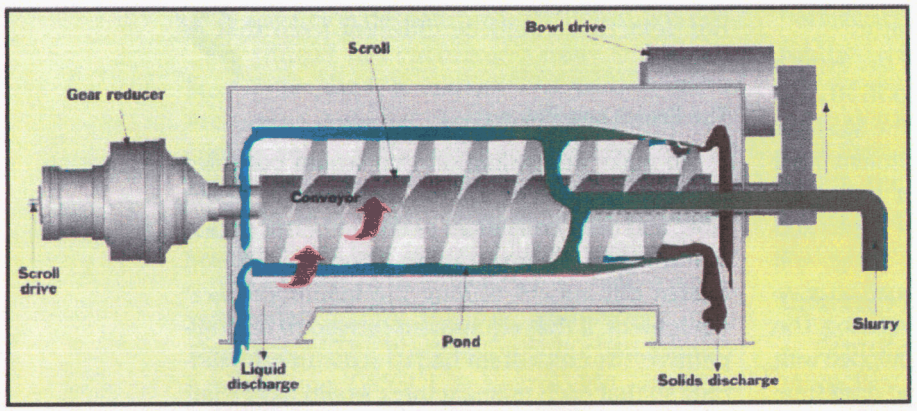
Gravity thickeners act as a sedimentation basin for residuals originating from the treatment plant. Pre-sedimentation solids, sedimentation solids, filter backwash, and plant runoff are sent to gravity thickeners, where solids are collected at the bottom by gravity and then sent to a dewatering process. The supernatant is transferred to the head of the plant where it joins the raw water feed. The size and efficiency of the gravity thickener will depend on the quality of the water it receives. Gravity thickeners work very well with conventional floc/sed processes because the large floc residuals are easily settled. The settling process may be more difficult following sand ballasted flocculation because the process tends to break up floc residuals, increasing the settling time. If a DAF process is used, gravity thickeners may not be needed, but this, along with the other scenarios, would need to be evaluated in the next phase of the project.

Solar Drying Beds

The use of solar drying beds is an alternative for dewatering because of Arizona's low humidity and warm climate. The residuals produced from the gravity thickener are pumped onto large concrete pads, where water and solids separate via evaporation, eventually leaving solids with a lower moisture content. The solids are then removed from the drying beds with a front-end loader and sent to a landfill. The advantages of solar drying beds are the low use of electricity and the low moisture content in the solid waste. The primary disadvantage is the large amount of space that each drying bed requires.

Centrifuge

A centrifuge, shown in Figure 4-6, applies a centrifugal force to a thickened residuals stream from the gravity thickener, forcing the liquid and solid fractions to separate. The liquid obtained is recycled through the plant, and the solids leaving the centrifuge are collected and hauled away to a disposal location. The advantages of a centrifuge are minimal odor production, continuous feed, and a small process footprint. The disadvantages of the process are the high electricity consumption and noise. In order to minimize the noise, the centrifuge should be placed in a building.



Source: Ireland and Balchunas, 1998.

Figure 4-6: Typical Centrifuge Cross Section

4.3 Process Design Criteria

Preliminary process design criteria were used to develop footprints and dimensions for each of the unit processes. The process footprints were used as building blocks for the site layouts. Even though the WTP has been designed at 20 mgd entering and leaving the plant, flowrates will vary from process to process depending on the recycle stream. The flow rate schematic shown in Figure 4-7 was used as the basis for design. 0.2 mgd entering and leaving the dewatering process will not be recycled if solar drying beds are chosen.

Additional facilities common to all treatment plant processes (backwash clarifier, gravity thickener, clearwell, chemical facility, intermediate pumping, admin building/lab/shop, disinfection facility, high service pump station, canal intake/bar screen) were also sized to develop more complete water treatment plant footprints. The criteria and footprint dimensions for each unit process alternative are shown in Table 4-1. Footprint dimensions for the additional facilities are shown in Table 4-2.

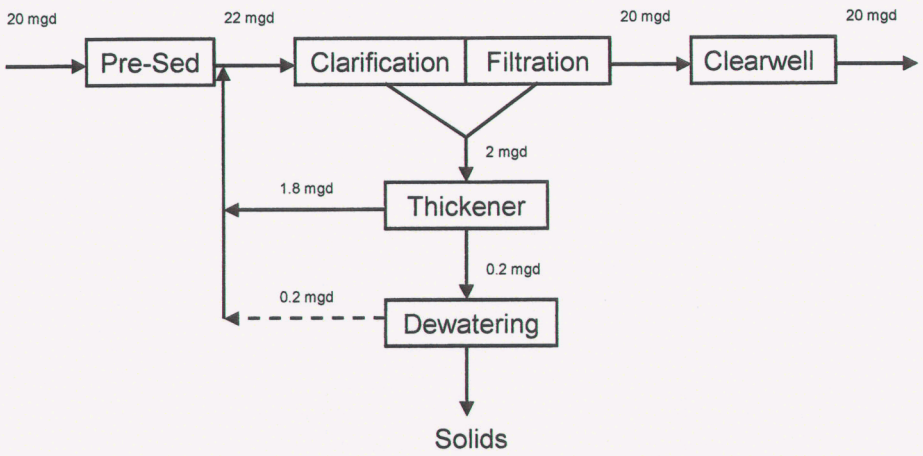


Figure 4-7: MWD WTP Flow Rate Diagram

Table 4-1: Process Alternatives Preliminary Design Criteria

Pre-Sedimentation	
No. of trains	2 (10 mgd each)
Total detention time	60 minutes
Individual dimensions	80 ft diameter x 12 ft
Raw Water Impoundment	
No. of trains	2 (10 mgd each)
Total detention time	24 hours
Individual dimensions	120 ft x 800 ft x 15 ft
Conventional Flocculation and Sedimentation	
No. of trains	3 (7.3 mgd each)
No. of flocculation stages	3
Hydraulic residence times	Flocculation: 30 min Sedimentation: 120 min
Flocculation basin dimensions	35 ft x 150 ft x 12 ft
Sedimentation basin overflow rate	1100 gpd/ft^2
Sedimentation basin dimensions	50 ft x 150 ft x 12 ft
Process dimensions	150 ft x 150 ft x 12 ft

Table 4-1: Process Alternatives Preliminary Design Criteria (con't)

Dissolved Air Flotation	
No. of trains	2 (11 mgd each)
Rise rate	8-10 gpm/ft^2
Hydraulic residence times	Flocculation: 5-10 min Flotation: 20-30 min
Process dimensions	60 ft x 80 ft x 13 ft
Sand Ballasted Flocculation	
No. of trains	2 (11 mgd each)
Rise rate	20-25 gpm/ft^2
Hydraulic residence times	Flocculation: 5-10 min Sedimentation: 7 min
Process dimensions	45 ft x 55 ft x 18 ft
Deep-Bed Mono-Media GAC Filters	
Filtration rate	6 gpm/ft^2 (constant rate)
No. of filters	9 (two out-of-service)
Empty bed contact time	10 min
Media depth	96 inches GAC
Combined filter dimensions	55 ft x 80 ft
Ozone-Biofiltration	
Filtration rate	6 gpm/ft^2 (constant rate)
No. of filters	9 (two out-of-service)
Empty bed contact time	5 min
Media depth	48 inches GAC
Combined filter dimensions	55 ft x 80 ft
Ozone contactor detention time	15 min
Ozone contactor dimensions	40 ft x 55 ft x 15 ft
Backwash Clarifier	
Backwash rate	17 gpm/ft^2
Backwash duration	15 min
Number of filters backwashed consecutively	2
Backwash clarifier dimensions	50 ft diameter x 12 ft

Table 4-1: Process Alternatives Preliminary Design Criteria (cont.)

Gravity Thickeners	
No. of Units	2
Flow received	2.0 mgd
Weir overflow rate	250 gpd/ft^2
Thickened solids concentration	2-4%
Individual thickener dimensions	80 ft diameter x 12 ft
Drying Beds	
Design flow rate	140 gpm
Number of Units	12
Dewatered solids concentration	20-30%
Dimensions	180 ft x 440 ft
Centrifuge	
Design Flow Rate	140 gpm
Number of Units	2 (one out-of-service)
Dewatered solids concentration	20-30%
Housing dimensions	80 ft x 80 ft

Table 4-2: Additional Facility Dimensions Needed for Costing and Layouts

Facility	Dimensions
Clearwell (2 MG)	130 ft diameter x 20 ft
Chemical Facility	70 ft x 140 ft
Intermediate Pumping	25 ft x 60 ft
Admin Building/Lab/Shop	100 ft x 100 ft
High Service Pump Station	25 ft x 60 ft
Disinfection Facility	50 ft x 70 ft
Canal Intake/Bar Screen	40 ft x 50 ft

4.4 Process Conceptual Costs

Using the preliminary design criteria and footprints presented in Tables 4-1 and 4-2, the capital cost, O&M cost, and total present value for each of the unit processes was determined using previous project designs for similar plants. The costs developed are Level 4 costs as defined by the Association for the Advancement of Cost Engineering (AACE). Level 4 costs are appropriate for a screening or feasibility analysis at an approximate project completion of 1 to 15 percent.

The basis for the costs is site layouts, process flow diagrams, and a preliminary list of engineered equipment. The accuracy range of a Level 4 estimate is minus 15 to plus 20 percent in the best case and minus 30 percent to plus 50 percent in the worst case.

Included in the capital cost shown in Table 4-3 are earthworks, concrete, equipment and installation, sitework, piping, electrical and instrumentation, engineering and construction administration, and a scope of project contingency of 30 percent. Operation and maintenance costs include electricity ($0.06/kWh), chemicals, and materials. Labor is not included in either the capital cost or the O&M cost, but stated as a separate line item. Land prices were not taken into account. The total present and annualized costs are based off a 6 percent interest rate for 20 years. For a breakdown of each unit process cost, refer to Appendix A.

Table 4-3: Capital, Annual O&M, and Present Value Costs of Unit Processes

Unit Process	Capital Cost	Annual O&M Cost	Total Present Value
Pre-Sedimentation	$3,500,000	$70,000	$4,300,000
Raw Water Impoundment	$2,500,000	$50,000	$3,100,000
Conventional Flocculation/Sedimentation	$9,900,000	$400,000	$15,000,000
Sand Ballasted Flocculation	$6,400,000	$380,000	$11,000,000
Dissolved Air Flotation	$6,700,000	$370,000	$11,000,000
Deep Bed GAC Filters	$7,900,000	$840,000	$17,000,000
Ozone-Biofiltration	$17,000,000	$450,000	$24,000,000
Drying Beds	$2,000,000	$40,000	$2,500,000
Centrifuge	$3,600,000	$80,000	$4,500,000
Gravity Thickener	$1,400,000	$50,000	$2,000,000
Backwash Clarifier	$1,200,000	$36,000	$1,600,000
Chemical Facility	$5,500,000	$130,000	$7,000,000
Intermediate Pumping	$1,500,000	$45,000	$2,000,000
Admin Building/Lab/Shop	$6,300,000	$150,000	$8,000,000
Disinfectant Facility	$2,500,000	$100,000	$3,700,000
High Service Pump Station	$4,500,000	$330,000	$8,300,000
Canal Intake/Bar Screen	$2,700,000	$57,000	$3,400,000
Clearwell	$1,100,000	$23,000	$1,400,000
Labor		$550,000	$6,300,000

4.5 Building Treatment Trains

Given the treatment processes described in Section 4.1, 24 treatment process trains are possible. Each unit processes was combined with others to form potential process trains shown in Table 4-4. The four alternatives highlighted in yellow have the lowest capital costs and total present values.

Table 4-4: Level 4 Preliminary Cost Estimates for Treatment Alternatives

No.	Pre Treatment	Clarification	Filtration	Solids	Common Elements	Total Capital (M$)	Unit Capital Cost ($/gal)	Total Annual O&M (M$/year)	Total Present Value (M$)	Total Present Value ($/gpd)
11	RWI	SBF (Actiflo)	Deep GAC	Thickener + Drying Beds	All	45.8	2.29	2.77	77.5	3.88
7	RWI	DAF	Deep GAC	Thickener + Drying Beds	All	46.0	2.30	2.76	77.7	3.88
23	Pre-Sed	SBF (Actiflo)	Deep GAC	Thickener + Drying Beds	All	46.8	2.34	2.79	78.8	3.94
19	Pre-Sed	DAF	Deep GAC	Thickener + Drying Beds	All	47.0	2.35	2.78	78.9	3.95
12	RWI	SBF (Actiflo)	Deep GAC	Thickener + Centrifuge	All	47.3	2.37	2.81	79.6	3.98
8	RWI	DAF	Deep GAC	Thickener + Centrifuge	All	47.6	2.38	2.80	79.7	3.99
24	Pre-Sed	SBF (Actiflo)	Deep GAC	Thickener + Centrifuge	All	48.3	2.42	2.83	80.8	4.04
20	Pre-Sed	DAF	Deep GAC	Thickener + Centrifuge	All	48.6	2.43	2.82	81.0	4.05
3	RWI	Floc/Sed	Deep GAC	Thickener + Drying Beds	All	49.2	2.46	2.79	81.3	4.06
9	RWI	SBF (Actiflo)	Biofiltration	Thickener + Drying Beds	All	55.3	2.76	2.55	84.5	4.23
15	Pre-Sed	Floc/Sed	Deep GAC	Thickener + Drying Beds	All	50.2	2.51	2.81	82.5	4.12
5	RWI	DAF	Biofiltration	Thickener + Drying Beds	All	55.5	2.78	2.54	84.7	4.23
4	RWI	Floc/Sed	Deep GAC	Thickener + Centrifuge	All	50.8	2.54	2.83	83.3	4.16
21	Pre-Sed	SBF (Actiflo)	Biofiltration	Thickener + Drying Beds	All	56.3	2.81	2.57	85.8	4.29
17	Pre-Sed	DAF	Biofiltration	Thickener + Drying Beds	All	56.5	2.83	2.56	85.9	4.30
10	RWI	SBF (Actiflo)	Biofiltration	Thickener + Centrifuge	All	56.8	2.84	2.59	86.6	4.33
16	Pre-Sed	Floc/Sed	Deep GAC	Thickener + Centrifuge	All	51.8	2.59	2.85	84.5	4.23
6	RWI	DAF	Biofiltration	Thickener + Centrifuge	All	57.1	2.86	2.58	86.7	4.34
22	Pre-Sed	SBF (Actiflo)	Biofiltration	Thickener + Centrifuge	All	57.8	2.89	2.61	87.8	4.39
18	Pre-Sed	DAF	Biofiltration	Thickener + Centrifuge	All	58.1	2.91	2.60	87.9	4.40
1	RWI	Floc/Sed	Biofiltration	Thickener + Drying Beds	All	58.8	2.94	2.57	88.2	4.41
13	Pre-Sed	Floc/Sed	Biofiltration	Thickener + Drying Beds	All	59.8	2.99	2.59	89.5	4.47
2	RWI	Floc/Sed	Biofiltration	Thickener + Centrifuge	All	60.3	3.02	2.61	90.3	4.51
14	Pre-Sed	Floc/Sed	Biofiltration	Thickener + Centrifuge	All	61.3	3.07	2.63	91.5	4.58

NOTES:

Yellow Rows Indicate Lowest Capital Cost and Lowest Total Cost

4.6 Selecting the Recommended Treatment Trains

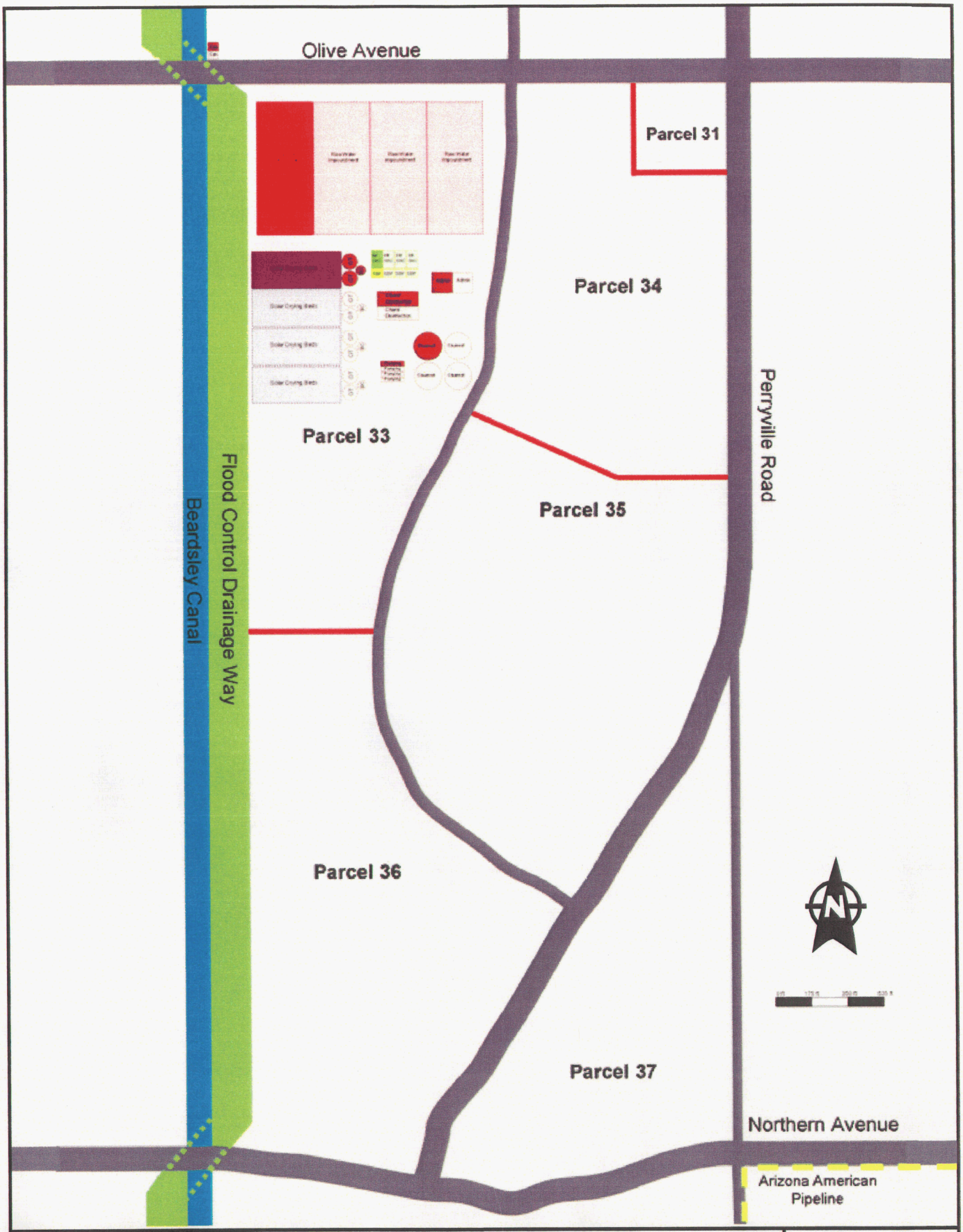
The main decision drivers for selecting the recommended treatment process trains were as follows:

- Do the treatment processes provide the desired water quality?
- Do the process footprints fit on the site layout?
- Which processes will provide the most economical solution to meet the above criteria?

Because all processes could achieve the desired water quality and land space was not a priority, the team selected the most economical solution: Alternative 11 consisting of raw water impoundment, sand ballasted flocculation, deep bed GAC and drying beds. The raw water impoundment facility will provide a buffer between the canal and water treatment plant that will not only minimize turbidity spikes reaching the plant but will also provide 24 hours of raw water should the canal experience downtime. Sand ballasted flocculation and deep bed GAC filters will provide excellent particulate and organic removal needed to achieve the Federal and State water quality regulations and MWD water quality goals. Drying beds are the lowest cost alternative for solids handling if space is not a priority. Because drying beds may present odor issues, Alternative 12, which is identical to Alternative 11 except for centrifuges in place of drying beds, is also a recommended alternative.

Additionally, Alternatives 7 and 8 (similar to 11 and 12 with DAF instead of SBF) may also considered in future evaluations. Although the cost evaluation performed in the Preliminary Engineering Study identifies these alternatives as nearly equal, because of the lower quantity of residuals produced by DAF, there may be a significant cost savings by reducing the size of the gravity thickener. Selection of a clarification technology should consider the overall package, including the clarification step and the residuals handling. The final decision between Alternatives 11, 12, 7, and 8 can be deferred until later in the design process after a more thorough investigation is conducted. Based on AACE Level 4 estimates of the four alternatives, the capital cost of each process is between $32 M and $71 M, worst case. The total present value for each process is between $54 M and $120 M at 6 percent for 20 years.

The layouts for Alternatives 11, 12, 7, and 8 in both selected sites (2A and 3) are shown in Figures 4-8 through 4-15. In the eight figures, the 20 mgd facilities are presented in bold colors, and the additional facilities needed for 80 mgd ultimate capacity are shown in lightened colors. Based on the figures, Alternatives 7 and 11 occupy approximately 45 to 50 acres and Alternatives 8 and 12 occupy 35 to 40 acres at 80 mgd. These anticipated areas are significantly smaller than the land available at either site. This allows flexibility when finalizing the site layouts to include sufficient buffer zones between the WTP and neighboring communities.



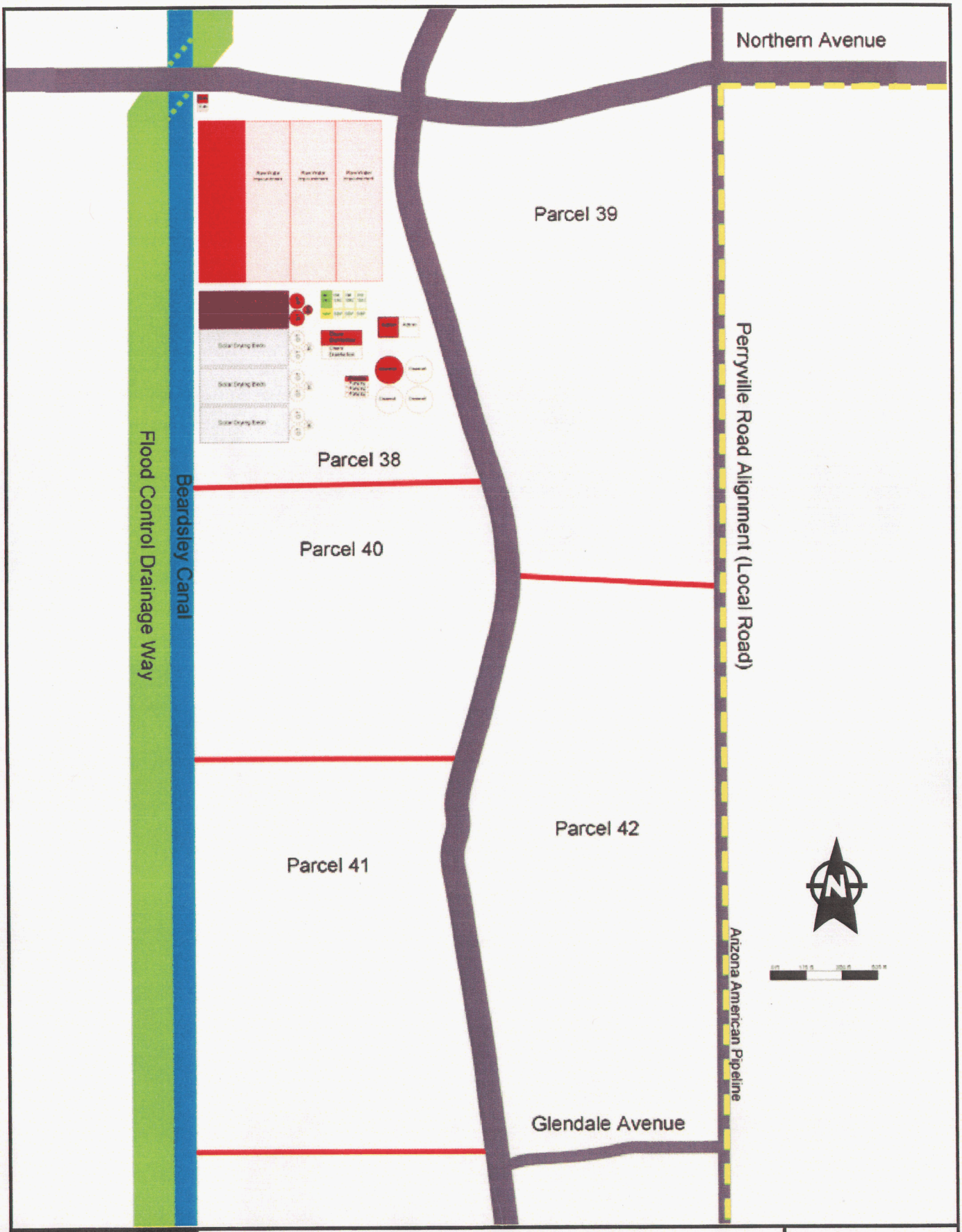
MALCOLM PIRNIE

MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING

ALTERNATIVE 11 AT SITE 2A (20 MGD/80 MGD)

August 2006

FIGURE 4-8



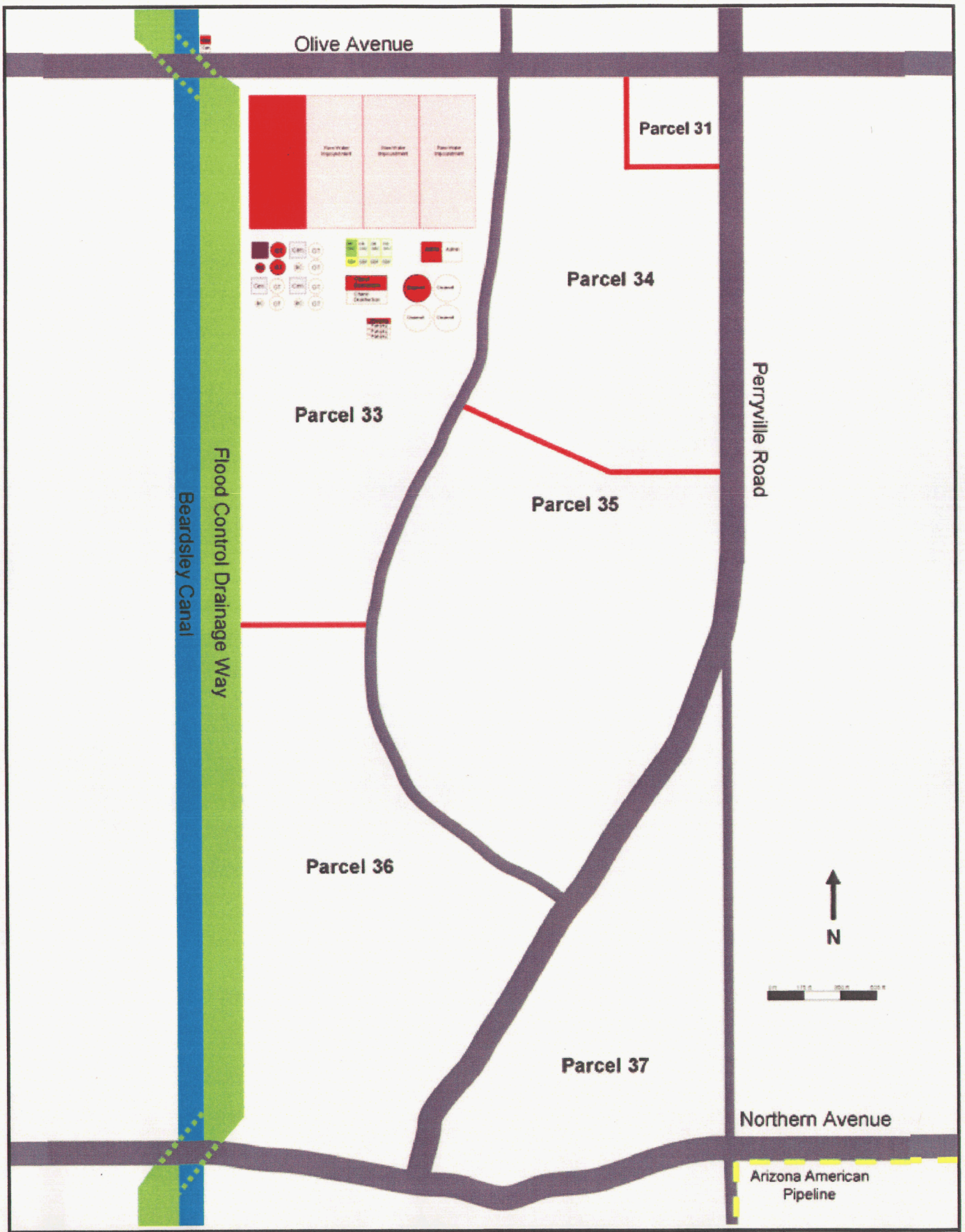
MALCOLM PIRNIE

MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING

ALTERNATIVE 11 AT SITE 3 (20 MGD/80 MGD)

August 2006

FIGURE 4-9



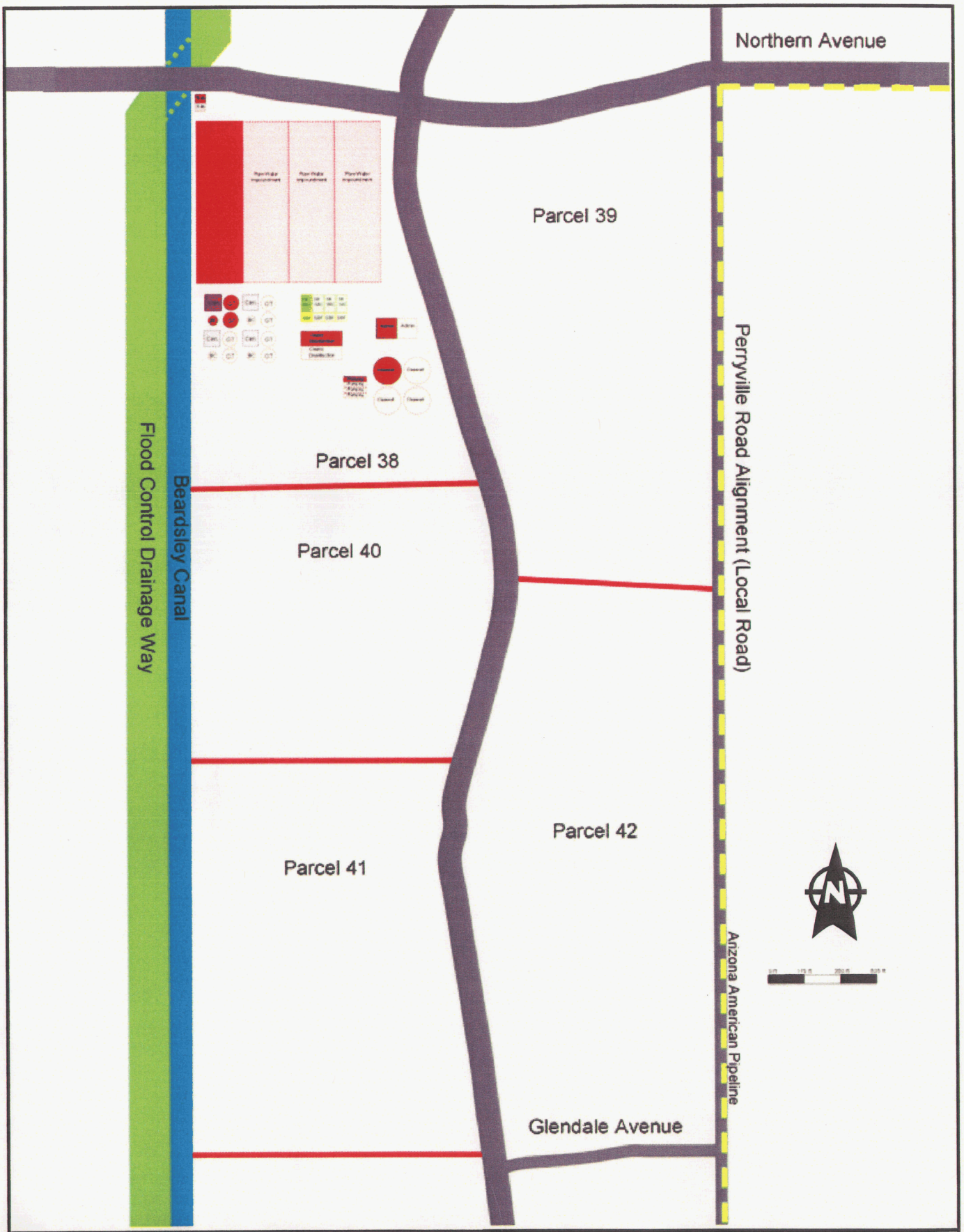
MALCOLM PIRNIE

MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING

ALTERNATIVE 12 AT SITE 2A (20 MGD/80 MGD)

August 2006

FIGURE 4-10



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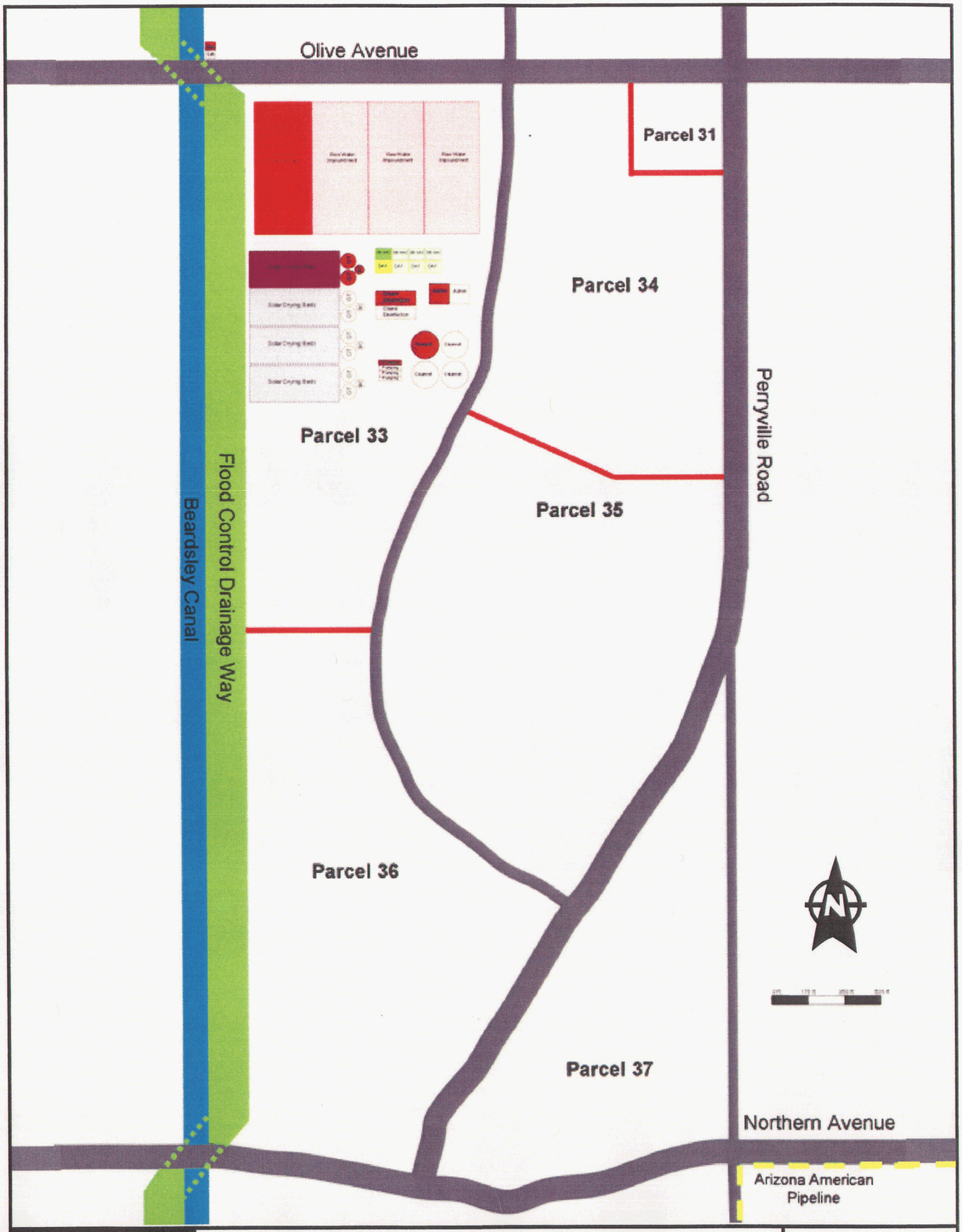
MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING

ALTERNATIVE 12 AT SITE 3 (20 MGD/80 MGD)

August 2006

FIGURE 4-11



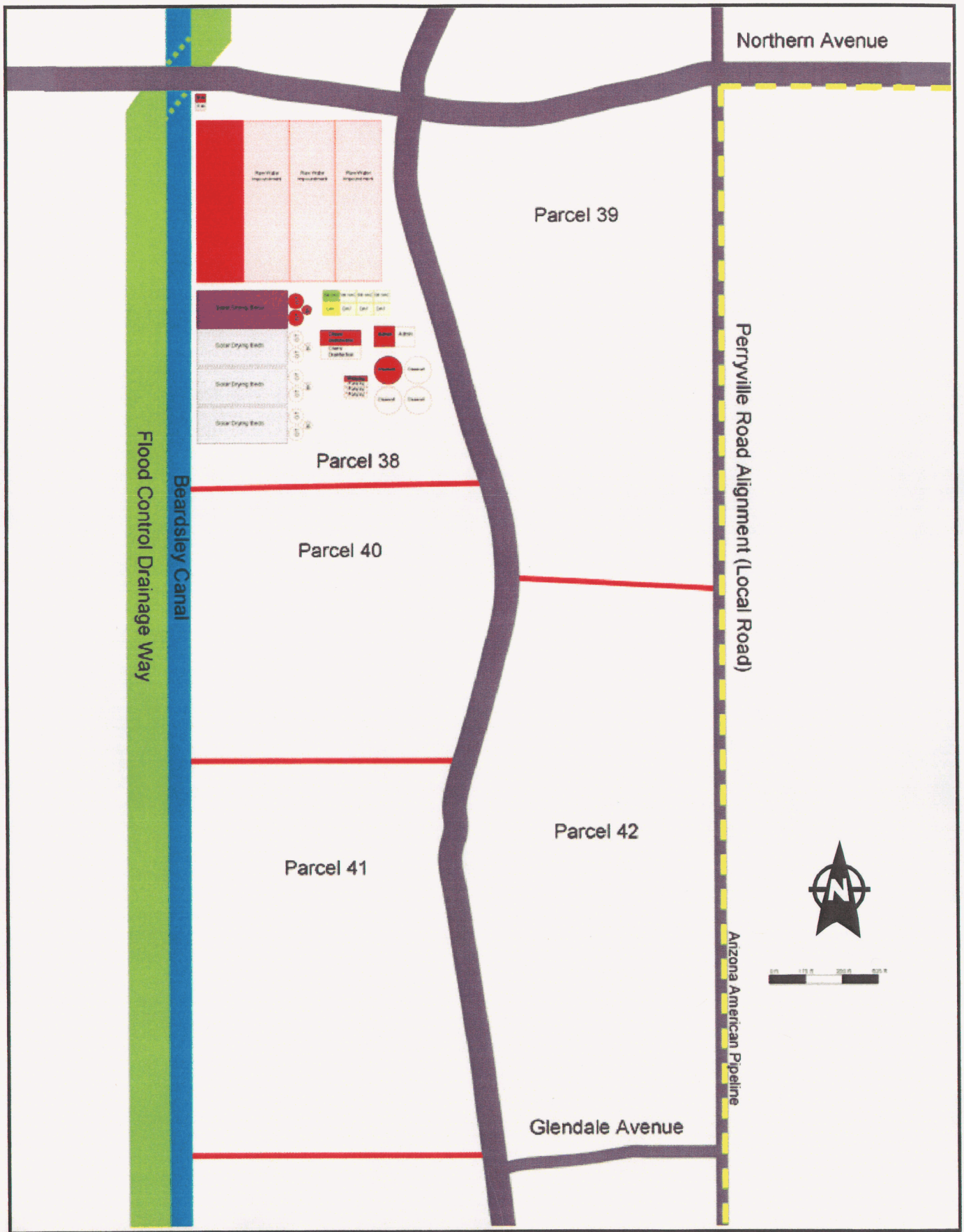
MALCOLM PIRNIE

MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING

ALTERNATIVE 7 AT SITE 2A (20 MGD/80 MGD)

August 2006

FIGURE 4-12



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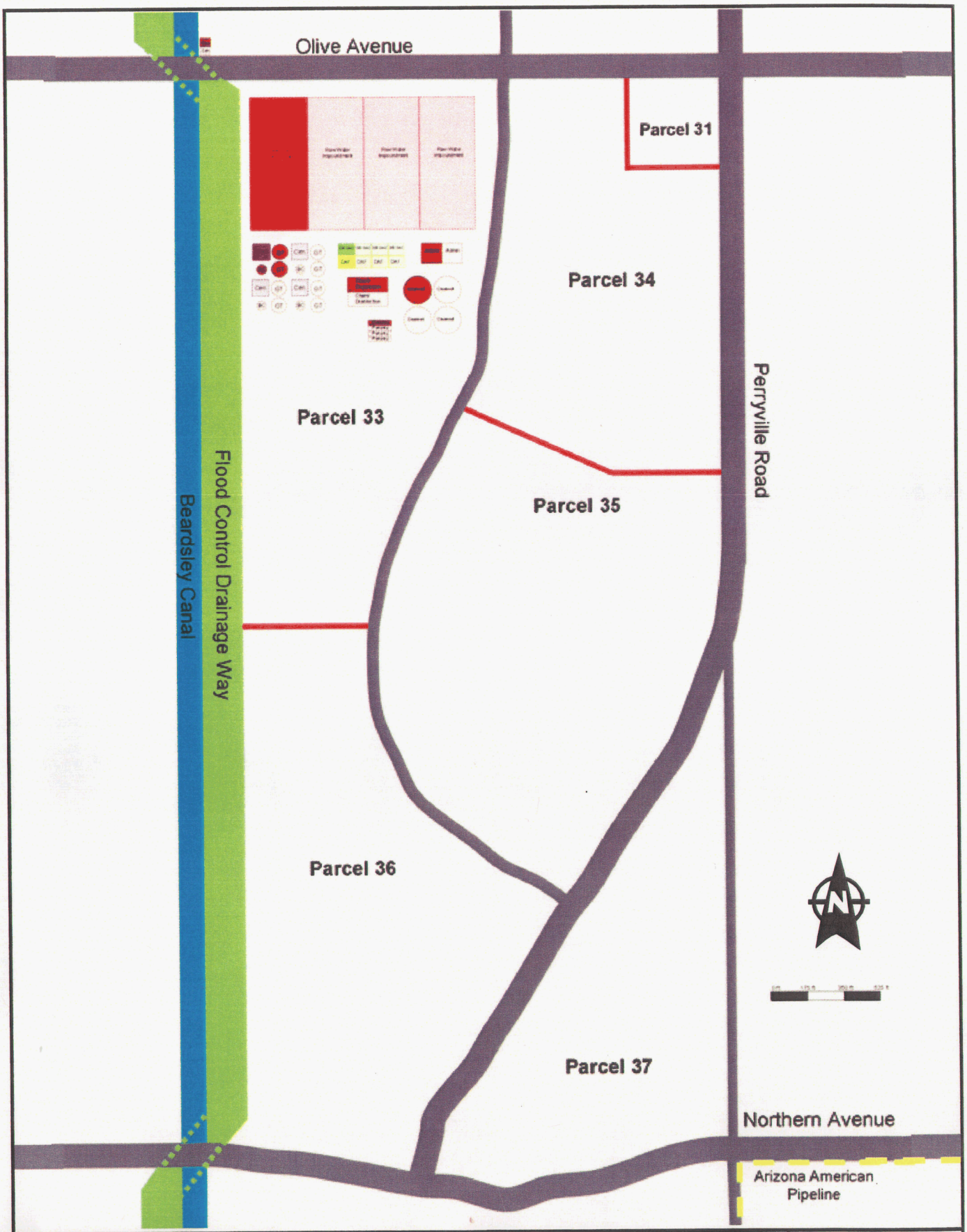
MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING

ALTERNATIVE 7 AT SITE 3 (20 MGD/80 MGD)

August 2006

FIGURE 4-13



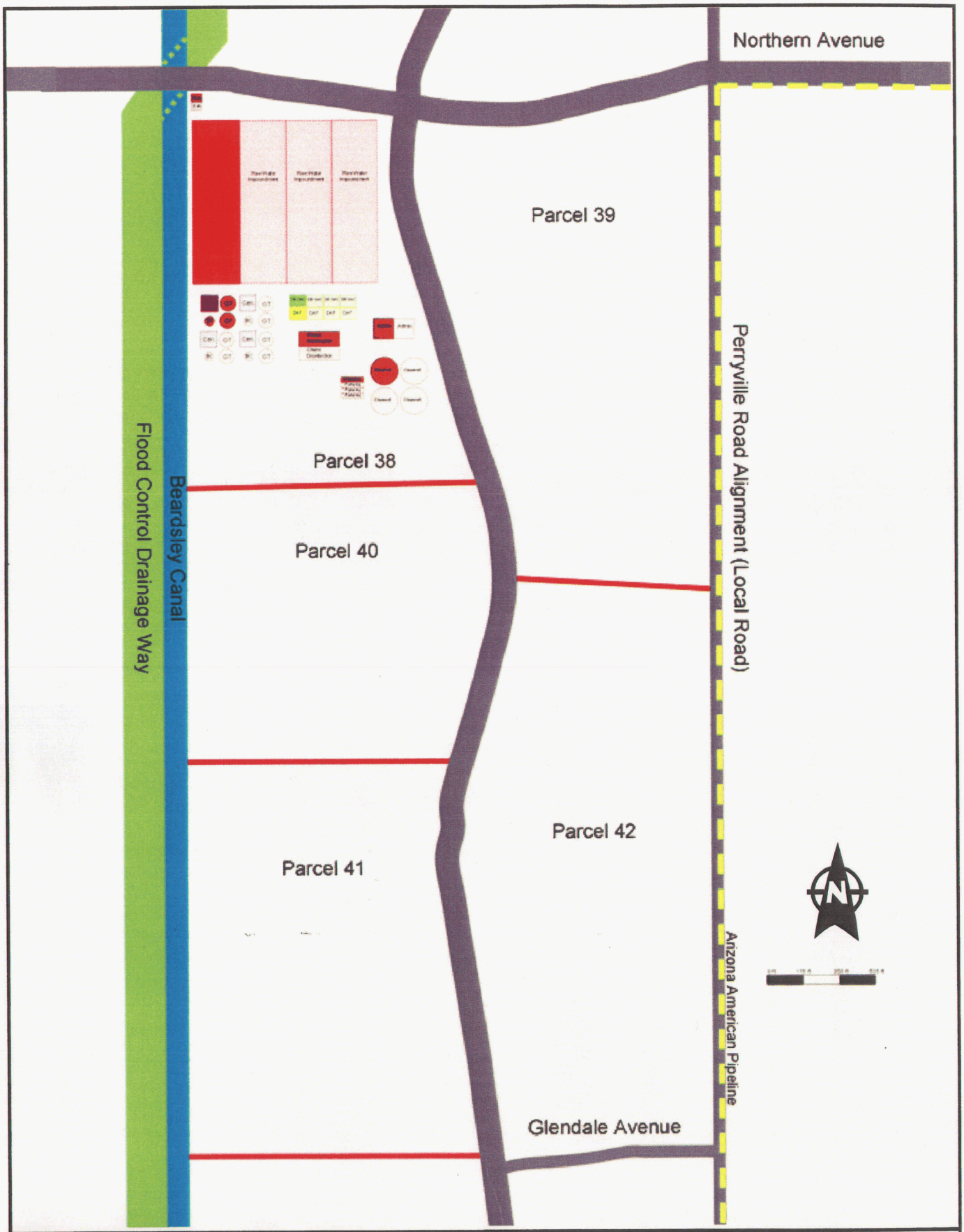
MALCOLM PIRNIE

MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING

ALTERNATIVE 8 AT SITE 2A (20 MGD/80 MGD)

August 2006

FIGURE 4-14



MALCOLM PIRNIE

MARICOPA WATER DISTRICT
PRELIMINARY WATER TREATMENT PLANT PLANNING

ALTERNATIVE 8 AT SITE 3 (20 MGD/80 MGD)

August 2006

FIGURE 4-15

5. Conclusions and Recommendations

This Preliminary Engineering Study provides MWD with information on the feasibility of constructing a WTP, particularly with respect to the treatment capacity, WTP site, and treatment process selection. This section summarizes the results of the Preliminary Engineering Study and provides information on the next steps needed to move toward construction of a WTP.

5.1 Treatment Capacity Evaluation

This project identified several potential customers within five miles of MWD boundaries. The known surface water allocations (CAP and Agua Fria) total 58.7 mgd. The available water could increase through leasing agreements with Indian Communities and/or reallocations from CAP. To date, the community that has expressed the most interest in partnering with MWD for the WTP is the City of Goodyear. Provided the rate structure is amenable, Goodyear is interested in approximately 5 mgd of capacity by 2009 with phased increases in capacity to meet their growing demands. During the next several months, MWD should continue discussions with the City of Goodyear and open discussions with the other surrounding communities to further gauge their interest level. The capacity of Phase I, which could be as much as 20 mgd, should be finalized by continued discussions and negotiations with the potential partners for the facility.

5.2 Site Selection

Five sites along the Beardsley Canal on land already owned by MWD were investigated as potential locations for the WTP. Based on the technical feasibility of locating a WTP at each site and land use planning information from MWD, two sites emerged as the preferred WTP site locations:

- **Site 2A** – East of the Canal, between Northern and Olive Avenues
- **Site 3** – East of the Canal, between Glendale and Northern Avenues

Before selecting a final site for the WTP, a public involvement program should be implemented so that concerns of the community can also be considered in the site selection. In addition, wildlife and vegetation evaluations, cultural and historical investigations, and geographic and topographic surveys should also be conducted before finalizing the site selection.

5.3 Treatment Process Selection

Several possible unit process alternatives were evaluated for implementation at the proposed WTP. Using the WTP treatment goals along with order of magnitude capital and operating costs for the proposed treatment trains, the top two recommended process trains include the

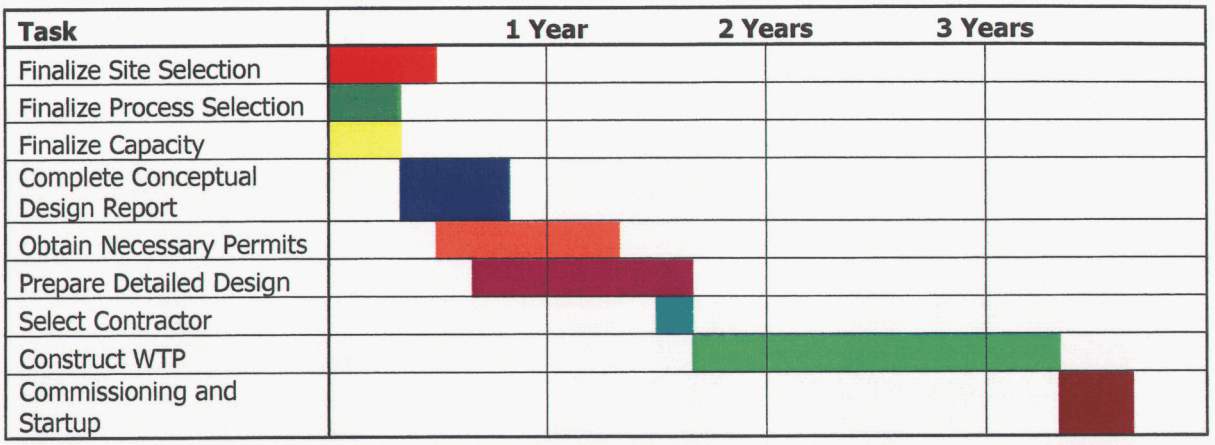
following treatment processes: raw water impoundment, high-rate clarification, and deep-bed GAC filters. Residuals from the treatment process will be treated using a gravity thickener and either solar drying beds or a centrifuge. The high-rate clarification will either be sand ballasted flocculation or dissolved air flotation (DAF). Although the cost evaluation performed in the Preliminary Engineering Study identifies these alternatives as nearly equal, because of the lower quantity of residuals produced by DAF, there may be a significant cost savings by reducing the size of the gravity thickener. Selection of a clarification technology should consider the overall package, including the clarification step and the and residuals handling. The final decision can be deferred until later in the design process after a more thorough investigation is conducted.

5.4 Project Timeline and Next Steps

The next steps entail finalizing the capacity, site selection, and process selection for the WTP and developing a conceptual design for the facility. If the MWD Board decides to design and construct a WTP, it will take approximately 3.5 years from the notice to proceed until the WTP can deliver water.

The tasks necessary to complete the project are described in this section and are accompanied by a timeline (Figure 5-1). Following this report, a survey should be conducted to finalize the site selection. Finalizing site selection will take approximately 6 months and entails conducting wildlife and vegetation evaluations; cultural, historical, and archeological investigations; and geographic and topographic surveys. During this time, the treatment process should also be finalized and MWD should obtain partner agreements to determine the capacity. To finalize the treatment process selection, a more thorough evaluation of clarification technologies and how they related to the residuals handling processes is recommended. In addition, it is recommended that MWD visit WTPs using drying beds and centrifuges to help determine the most appropriate residuals handling process. Once the process and capacity have been determined, the conceptual design of the WTP can begin and necessary permits can be obtained. Following, detailed design drawings and specifications can be developed and a construction contractor can be secured. Project construction, commissioning, and startup will last approximately 24 months.

Figure 5-1: Estimated Project Timeline



Appendix A. Unit Process Costs

Table A-1: Unit Process Conceptual Level Capital Costs, O&M Costs, and Total Present Values

	Raw Water Impoundment	Pre-Sedimentation Basin	Conventional Floc/Sed	Sand Ballasted Flocculation	Dissolved Air Flotation	Deep Bed GAC Filters[3]	Ozone[2]	GAC Filters[3]	Gravity Thickener	Drying Beds[1]	Centrifuge[3]
Earthworks	$890,000	$330,000	$340,000	$370,000	$460,000	$180,000	$800,000	$180,000	$82,000	$70,000	$590,000
Concrete	$0	$950,000	$3,300,000	$2,600,000	$2,600,000	$1,300,000	$970,000	$1,300,000	$120,000	$950,000	$160,000
Equipment and Installation (25% equipment)	$250,000	$310,000	$910,000	$150,000	$150,000	$2,000,000	$2,400,000	$1,600,000	$440,000	$22,000	$850,000
Sitework (5%)	$57,000	$80,000	$230,000	$450,000	$460,000	$170,000	$210,000	$150,000	$32,000	$52,000	$80,000
Piping (15%)	$170,000	$240,000	$680,000	$590,000	$610,000	$700,000	$630,000	$620,000	$96,000	$160,000	$320,000
Electrical & Instrumentation - E&I (20%)	$230,000	$320,000	$910,000	$1,200,000	$1,300,000	$700,000	$1,700,000	$620,000	$130,000	$52,000	$700,000
Scope of Project Contingency (30% capital)	$500,000	$700,000	$1,900,000	$1,070,000	$1,120,000	$1,500,000	$2,000,000	$1,300,000	$300,000	$480,000	$600,000
Engineering and Construction Administration (20%)	$420,000	$590,000	$1,650,000			$1,310,000	$1,740,000	$1,150,000	$240,000	$340,000	
Land											
Capital Cost	**$2,517,000**	**$3,520,000**	**$9,920,000**	**$6,430,000**	**$6,700,000**	**$7,860,000**	**$10,450,000**	**$6,920,000**	**$1,440,000**	**$2,046,000**	**$3,620,000**
CAPITAL COST RANGE	**$2.1 M - $3.3 M**	**$3.0 M - $4.6 M**	**$8.4 M - $13 M**	**$5.5 M - $8.4 M**	**$5.7 M - $8.7 M**	**$6.7 M - $10 M**	**$8.9 M - $14 M**	**$5.9 M - $9.0 M**	**$1.2 M - $1.9 M**	**$1.7 M - $2.7 M**	**$3.1 M - $4.7 M**
Electricity ($0.06/kWh)	$0	$0	$4,000	$16,000	$40,000	$0	$9,000	$0	$25,000	$2,000	$10,000
Chemicals	$0	$0	$200,000	$230,000	$200,000	$680,000	$230,000	$25,000	$0	$0	$0
Labor											
Materials (2% capital)	$50,000	$70,000	$200,000	$130,000	$130,000	$160,000	$210,000	$140,000	$29,000	$41,000	$72,000
O&M Cost	**$50,000**	**$70,000**	**$400,000**	**$380,000**	**$370,000**	**$840,000**	**$450,000**	**$170,000**	**$50,000**	**$40,000**	**$80,000**
O&M COST RANGE	**$43,000 - $65,000**	**$60,000 - $91,000**	**$340,000 - $520,000**	**$320,000 - $480,000**	**$310,000 - $480,000**	**$0.7 M - $1.1 M**	**$380,000 - $590,000**	**$140,000 - $220,000**	**$43,000 - $65,000**	**$34,000 - $52,000**	**$68,000 - $100,000**
Total Present Cost (6%, 20 years)	**$3,090,000**	**$4,323,000**	**$14,508,000**	**$10,789,000**	**$10,944,000**	**$17,495,000**	**$15,611,000**	**$8,870,000**	**$2,013,000**	**$2,505,000**	**$4,538,000**
TOTAL PRESENT COST RANGE	**$2.6 M - $4.0 M**	**$3.7 M - $5.6 M**	**$12 M - $19 M**	**$9.2 M - $14 M**	**$9.3 - $14 M**	**$15 M - $23 M**	**$13 M - $20 M**	**$7.2 M - $12 M**	**$1.7 M - $2.6 M**	**$2.1 M - $3.3 M**	**$3.9 M - $5.9 M**
Total Annualized Cost (6%, 20 years)	**$269,000**	**$377,000**	**$1,265,000**	**$941,000**	**$954,000**	**$1,525,000**	**$1,361,000**	**$773,000**	**$176,000**	**$218,000**	**$396,000**
TOTAL ANNUALIZED COST	**$230,000 - $350,000**	**$320,000 - $490,000**	**$1.1 M - $1.6 M**	**$0.8 M - $1.2 M**	**$0.8 M - $1.2 M**	**$1.3 M - $2.0 M**	**$1.2 M - $1.8 M**	**$0.7 M - $1.0 M**	**$150,000 - $230,000**	**$190,000 - $280,000**	**$340,000 - $510,000**

	Backwash Clarifier	Chemical Facility	Intermediate Pumping	Admin Building/ Lab/Shop4	Disinfectant Facility	High Service Pump Station	Canal Intake/Bar Screen5	Clearwell
Earthworks	$110,000	$2,100,000	$12,000	$2,800,000	$550,000	$130,000	$0	$290,000
Concrete	$240,000		$470,000		$68,000	$1,200,000	$270,000	$310,000
Equipment and Installation (25% equipment)	$230,000	$400,000	$210,000	$0	$540,000	$710,000	$1,400,000	$0
Sitework (5%)	$29,000	$130,000	$35,000	$280,000	$58,000	$100,000	$84,000	$30,000
Piping (15%)	$87,000	$380,000	$100,000	$420,000	$170,000	$310,000	$0	$90,000
Electrical & Instrumentation - E&I (20%)	$120,000	$500,000	$140,000	$560,000	$230,000	$410,000	$0	$30,000
Scope of Project Contingency (30% capital)	$200,000	$1,100,000	$300,000	$1,200,000	$500,000	$900,000	$500,000	$200,000
Engineering and Construction Administration (20%)	$200,000	$920,000	$250,000	$1,050,000	$420,000	$750,000	$450,000	$190,000
Land								
Capital Cost	**$1,216,000**	**$5,530,000**	**$1,517,000**	**$6,310,000**	**$2,536,000**	**$4,510,000**	**$2,704,000**	**$1,140,000**
CAPITAL COST RANGE	**$1.0 M - $1.6 M**	**$4.7 M - $7.2 M**	**$1.3 M - $2.0 M**	**$5.4 M - $8.2 M**	**$2.2 M - $3.3 M**	**$3.8 M - $5.9 M**	**$2.3 M - $3.5 M**	**$1.0 M - $1.5 M**
Electricity ($0.06/kWh)	$12,000	$13,000	$15,000	$16,000	$22,000	$240,000	$3,000	$0
Chemicals	$0	$0	$0	$0	$27,000	$0	$0	$0
Labor								
Materials (2% capital)	$24,000	$111,000	$30,000	$130,000	$51,000	$90,000	$54,000	$23,000
O&M Cost	**$36,000**	**$124,000**	**$45,000**	**$146,000**	**$100,000**	**$330,000**	**$57,000**	**$23,000**
O&M COST RANGE	**$30,000 - $47,000**	**$110,000 - $160,000**	**$38,000 - $59,000**	**$120,000 - $190,000**	**$85,000 - $130,000**	**$280,000 - $430,000**	**$48,000 - $74,000**	**$20,000 - $30,000**
Total Present Cost (6%, 20 years)	**$1,629,000**	**$6,952,000**	**$2,033,000**	**$7,985,000**	**$3,683,000**	**$8,295,000**	**$3,358,000**	**$1,404,000**
TOTAL PRESENT COST RANGE	**$1.4 M - $2.1 M**	**$5.9 M - $9.0 M**	**$1.7 M - $2.6 M**	**$6.8 M - $10 M**	**$3.1 M - $4.8 M**	**$7.1 M - $11 M**	**$2.9 M - $4.4 M**	**$1.2 M - $1.8 M**
Total Annualized Cost (6%, 20 years)	**$142,000**	**$606,000**	**$177,000**	**$696,000**	**$321,000**	**$723,000**	**$293,000**	**$122,000**
TOTAL ANNUALIZED COST	**$120,000 - $180,000**	**$520,000 - $790,000**	**$150,000 - $230,000**	**$590,000 - $900,000**	**$270,000 - $420,000**	**$610,000 - $940,000**	**$250,000 - $380,000**	**$100,000 - $160,000**

NOTES:

(1) Electrical & Installation - E&I (5%)
(2) Electrical & Installation - E&I (40%)
(3) Piping (20%)
(4) Sitework (10%)
(5) Piping included in Equipment and Installation