

# **Acceptability of Market-based Approaches to Water Management: An Analysis of the Deschutes Groundwater Mitigation Program**



## **Final Report**

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## **Abstract**

Growing urbanization, shifting water uses and a focus on ecosystem health in the Deschutes River Basin in Central Oregon led to experimentation with new voluntary market-based approaches to water management in the last decade. To meet groundwater demands while maintaining instream flows and upholding prior water allocations, the Oregon Water Resources Department developed the Groundwater Mitigation Program (GMP) in 2002. While evaluative reports on the effectiveness of the GMP that include consultation of basin water users are due to the Water Resources Commission in 2008 and 2009, no research of the program participants' perceptions of the GMP has been carried out. As the effectiveness of the program depends in part on how it is accepted, this research focuses on how acceptable the GMP is to its participants. The research uses the Institutional Analysis and Development framework (Ostrom et al, 1994) as a basis for analysis. Using two hypothetical alternative scenarios to compare the GMP, acceptability is determined by the following criteria: usability, accountability, enforcement, equity, information dissemination, cost-effectiveness and utility. The research incorporates a mixed-method approach: Primary data was collected through interviews and postal surveys that included open- and closed-ended questions. Results indicate that although the GMP is more acceptable than the proposed alternatives, a lengthy groundwater permitting process, passive enforcement and a lack of information make the program less acceptable to its participants. Lack of information proves to be of particular concern to participants and, if improved, could increase acceptance of the GMP and create a more effective program.



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## 1. Introduction

*“We can’t create water or increase the supply. We can only hold back and redistribute what there is” (Stegner 1987).*

Surface water in the Deschutes River Basin in Central Oregon has been fully appropriated since the start of the Twentieth Century. Towards the end of the latter century new demands for water increased with rapid population growth, a changing economy and shifting values. With all surface water rights already fully allocated primarily for agricultural uses, groundwater began being used to meet the new demands. Despite the extensive groundwater system in the Deschutes Basin, state and federal regulations on groundwater pumping, hydraulic connectivity between surface and groundwater as well as increased requirements of instream flows<sup>1</sup> have greatly impacted the ability to supply water to the rising needs in the basin. In order to meet the growing demands through groundwater supplies while offsetting the effects on instream flows, the state implemented the Groundwater Mitigation Program (GMP) in 2002.

The Oregon Water Resources Department (OWRD) created a stakeholder group process to develop what would become the GMP. However, the collaborative approach never reached consensus and the final rules for the GMP were implemented by OWRD. Some stakeholders involved with the initial process were unsatisfied with the outcome because key issues under debate remained unresolved (e.g. the timing of mitigation). Hence they filed a lawsuit that led to a ruling against the GMP. However, ensuing legislation reinstated the program with the conditions that its effectiveness must be evaluated by the Water Resources Commission every five years (the first in 2008 and 2009) and that the program may sunset in 2014.

In order to meet the evaluation criteria, it must be shown that the GMP achieves its objectives effectively and that it is viable for the Deschutes Basin. Since a primary objective of the GMP is to “sustain existing water uses and accommodate growth through new groundwater development” (OWRD 2003), an important aspect of maintaining the GMP is its ability to meet the needs of the water users in the basin (i.e. program participants and potential participants).<sup>2</sup> Meeting the participants’ needs may be evaluated by assessing how acceptable the GMP is to them. However, research regarding the GMP participants’ acceptance of the program is lacking.

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<sup>1</sup> An instream flow requirement specifies a volume of streamflow required to sustain a certain instream use or multiple uses (National Research Council 1992).

<sup>2</sup> Program participants are defined as groundwater permit applicants with pending applications, permit holders, as well as withdrawn and denied applicants.

The objective of this paper is not to evaluate the effectiveness or the viability of the program as a whole. The focus is to use acceptability as one indicator of the program's effectiveness and viability; based on the logic that if a program is acceptable to its participants then it is more effective and viable.<sup>3</sup> Hence the main research question asks: How acceptable is the GMP to its participants? Based on the research question, the following hypothesis is tested: The GMP is more acceptable to its participants than the alternative management/regulatory options discussed in this research.

## **2. Framework and Methods**

The Institutional Analysis and Development (IAD) framework (Ostrom E. 1994) is employed as a basis for analysis.<sup>4</sup> Central to the IAD framework is the "action arena" characterized by the physical context, the institutional arrangements, and the social-cultural context (Ostrom E. 1994). These three attributes contextualize the action arena where the underlying factors affecting the development of the GMP are addressed. Within the context of the action arena, the GMP is compared against two hypothetical institutional arrangements that bound the current program on either side: 1) a moratorium on all new groundwater pumping beyond the exempt use;<sup>5</sup> and 2) a return to the pre-1995 institutional arrangement where there are no rules limiting further groundwater appropriations. Seven criteria are then used to evaluate acceptability of the GMP in comparison to the two hypothetical alternatives. Acceptability is determined by participants' perception of the following criteria: usability; accountability; enforcement; equity; information dissemination; cost-effectiveness; and utility of the GMP.

The IAD framework allows for a mixed-method approach. Primarily qualitative data is collected through interviews and is supplemented by quantitative data obtained through interviews and surveys. In the first phase of research a purposive sampling method was used to conduct interviews (face-to-face or via telephone) with 22 key experts.<sup>6</sup> These interviews were used to provide background information to depict the action arena. During the second phase, a census of all GMP participants (n=159) were contacted, or attempts were made to contact them, and 47 were interviewed either face-to-face or via telephone. All interviews were conducted with a structured

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<sup>3</sup> It must be taken into account that the objective of the program is not only to meet the needs of water users (i.e. the participants) in the basin; the GMP serves a larger role of protecting the water resources of the basin while allowing for development through new water uses: offsetting the effects of groundwater pumping in order to meet statutory requirements and restore instream flows (OWRD 2003).

<sup>4</sup> This framework draws from classic political economy, institutional economics, public choice theory, neoclassical microeconomic theory, transaction-cost economics and non-cooperative game theory (Ostrom E. 1994).

<sup>5</sup> Exempt well use permits the use of up 15,000 gallons per day or up to one-half an acre for irrigation or domestic uses.

<sup>6</sup> Key experts are defined as people closely linked to the GMP's development and/or implementation (consisting mostly policy makers, administrators, lawyers and hydrologists).

interview questionnaire with closed- and open-ended questions arranged in six themes aligned with the seven criteria: 1) water use; 2) application process; 3) economic cost/benefit; 4) awareness; 5) suggestions, scenarios, overall rating; and 6) socio-economic parameters. Phase three involved a postal survey to all remaining contactable participants (n=73). A modified form of the interview questionnaire was used for the surveys. The response rate from the survey was 42%.<sup>7</sup> In total, data was collected from 100 respondents; 78 from program participants.<sup>8</sup> The qualitative data from both the interviews and surveys was coded with *a priori* codes (based on the criteria) and analyzed in word documents. The quantitative data (also from both the interviews and surveys) was analyzed in excel. Pivot charts and tables were created to provide descriptive statistics that complement the qualitative data.

### 3. The Action Arena

#### 3.1 Physical Context



Encompassing 10,484 square miles, the Deschutes River Basin is the second largest in Oregon and a main sub-basin of the Columbia River Basin (Bastasch 2006). The majority of the upper basin, which is the focus of this research, lies within Central Oregon. Draining approximately 4,500 square miles of north-central Oregon, the upper basin is located above the junction of the Deschutes, Metolius and Crooked Rivers; including the Deschutes, Jefferson and Crook counties (see figure 1).

Most pertinent to the action arena of the GMP is that due to the hydrogeology

**Figure 1. Map of the Deschutes River Basin (Source: Deschutes River Conservancy)**

<sup>7</sup> This is lower than the 50% response rate called for experts (Dillman 2000). However, all efforts were made to increase response following Robson’s (2002) method, three mailings were sent and one round of phone calls was conducted (Robson 2002).

<sup>8</sup> Of the 159 participants of the GMP, 73 did not contribute input to the research. The inability to obtain data from these participants was due to: 1) refusal to respond; 2) no listed or disconnected/faulty phone numbers; 3) never returned messages; 4) never picked up the phone (and do not have an answering machine).

in the basin, *groundwater* discharge from the upper basin supplies over three-quarters of the streamflow for the Lower Deschutes River (Gannett 2001). In 2001, a USGS study confirmed a hydraulic connection between groundwater and surface water (Gannett et al. 2001), which implies that nearly all groundwater not consumptively<sup>9</sup> used in the upper basin contributes to the flow of the Lower Deschutes River. Therefore, groundwater pumping in the upper basin either needs to be stopped or offset in order to maintain flows in the lower basin.

### 3.2 Institutional Context

The major institutional factor that contributed to the development of the GMP is the amendment to the Scenic Waterway Act that incorporated groundwater regulation. In 1995, the Scenic Waterway Act was amended to specify that OWRD must assess the potential impacts of new groundwater uses on scenic waterways. The statute included the “measurably reduce” clause that if an impact of 1% or 1 cubic foot per second (whichever was less) was triggered in instream flow then a groundwater permit would be denied (Ground Water Uses Within Scenic Waterways 1995). Since the lower Deschutes is a scenic waterway and the hydraulic connection was established in 2001, it meant that either OWRD would have to place a moratorium on all new groundwater pumping or find a solution that would mitigate impacts, such as the GMP.

Using a combination of regulatory and market-driven mechanisms, the GMP caps new groundwater pumping<sup>10</sup> and enables an existing water right to be changed to instream flow as groundwater mitigation. Mitigation credits can either be obtained through mitigation banks or private parties.<sup>11</sup> Two state-chartered mitigation banks exist in the basin: the Deschutes Water Exchange Mitigation Bank (run by the Deschutes River Conservancy<sup>12</sup>); and the Deschutes Irrigation Mitigation Bank (operated by John Short). There are two types of mitigation credits under the GMP: temporary and permanent. Temporary credits are created from instream leases and must be purchased annually (only obtainable through the DRC’s bank). Permanent credits are a one time purchase and apply for the life of the permit or certificate (with a large, one-time cost; obtainable from private parties and the DRC’s bank).

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<sup>9</sup> Consumptive use meaning that water is used in a way that causes an overall reduction of streamflow; often associated with evaporation or transpiration.

<sup>10</sup> Under the GMP rules, there is a cumulative total of 200 cfs maximum rate that serves as the cap for approving new groundwater permits in the upper Deschutes Basin (which is otherwise under a groundwater moratorium).

<sup>11</sup> Private parties are individuals who can create mitigation permanent mitigation credits by permanently transferring water instream.

<sup>12</sup> The DRC is a non-profit in the basin that works on restoring streamflow. It also operates the state-chartered Groundwater Mitigation Bank, providing temporary and permanent mitigation credits.

### 3.3 Social-cultural context

The main social-cultural aspects that pertain to the existence of the GMP are the rapidly growing population in the upper Deschutes Basin and the changing values. Deschutes County, which lies within a large portion of the upper basin, has been the fastest growing county in the state since 1989 (Yake 2003).<sup>13</sup> It was found that the majority of new residents in the upper basin come from out-of-state, are often retired and over thirty years-old (BOR 1997). While historically, irrigated agriculture was the central use and value for water in the Deschutes Basin (BOR 1997), with the influx of new residents, values in the basin are shifting from agricultural water uses to recreational and hobby-farming uses (Aylward 2006; Yake 2003). Analysis of irrigation district water right holdings in Central Oregon, particularly in Deschutes County, reveal that large farms are limited in number and the majority of water use occurs on properties of 10 acres or less (Aylward 2006). As the rising population demands more water and surface water is over-appropriated, the new water users turn to groundwater and the GMP.

## 4. Results

### 4.1 Demographics and Water Use

The majority of participants can be characterized as irrigators who predominantly use groundwater for grazing and pastures (63 of 78 participants)<sup>14</sup> and non-commercial purposes (42 of 66 participants); consume less than 10 acre-feet<sup>15</sup> (51 of 78 participants); to support a lifestyle rather than a livelihood choice (33 of 53 participants say the GMP is not vital for their livelihood); above age 50 (median age); attended college (53 of 71 participants); have lived on their property for less than ten years (38 of 63 participants); frequently hire consultants<sup>16</sup> to assist them in the process (40 of 74 participants); and with a median annual income of approximately \$100,000 (based on 51 responses). Of the 159 participants in the GMP since its inception in 2002, 23 have withdrawn from the program.

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<sup>13</sup> Between 2000 and 2006, the percent change in population growth in Deschutes County was 29.3% in comparison to 8.2% in Oregon (U.S. Census Bureau 2008).

<sup>14</sup> Survey and interview results are combined. Unless specified, both interview and survey results are presented. The sample size for each question varies depending on the number of participants who responded to each question.

<sup>15</sup> One acre-foot covers one acre in a foot of water. Consumptive use means that water is used in a way that causes an overall reduction of streamflow; often associated with evaporation or transpiration.

<sup>16</sup> Consultants are used as an umbrella term for anyone who was hired to assist with the GMP process. This includes engineers, lawyers, developers etc.

## 4.2 Acceptability

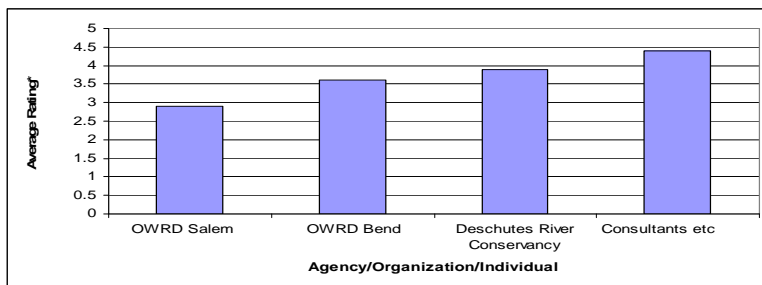
In order to assess the acceptability of the program to its participants, results are presented by the seven criteria: usability, accountability, enforcement, equity, information dissemination, cost-effectiveness and utility.

### 4.2.1 Usability

Many participants comment that the GMP is not user-friendly; it is seen as being overly complex. Several participants admit that when they realized how extensive the process would be, they thought about quitting. Some participants say that their neighbors do not bother with the GMP because they see it as too bureaucratic and time intensive. A primary frustration among most participants is the length of the application process (until a permit is issued). An elderly survey participant comments that she is waiting until “OWRD gets around to acting on my application – if I’m alive by then.” On average, it takes three years for a new groundwater permit to be issued (median=2.5; standard deviation=1.7). While many do not understand why the process is so extensive, some participants acknowledge that it is a new program and that everyone is learning. An interview participant involved in the early days of the program notes that the process is getting easier; data shows that the length of the permitting process is decreasing.

### 4.2.2 Accountability

In general, participants say that OWRD Salem (head office) and Bend (field office) are unresponsive. Figure 2 shows that OWRD Salem is rated the lowest (just below good - 2.9) in terms



of its assistance. While the figure shows the DRC’s rating as being close to that of OWRD Bend, interview participants involved with the DRC’s bank provide a primarily positive

**Figure 2. Average rating of agencies, organizations and individuals**  
\* 1=Poor. 2=Fair. 3=Good. 4=Very Good. 5=Excellent.

review. Yet several other participants are not aware of the DRC. Consultants are rated as providing the highest level of assistance. Many participants feel that hiring a consultant is almost a prerequisite to partaking in the GMP because the process is so challenging and extensive.

### 4.2.3 Enforcement

Numerous participants express concern regarding the lack of enforcement by OWRD. A participant notes that “just because there’s this process, illegal use has not stopped, maybe it made it



worse.” Some participants who have not been issued a permit have begun pumping; 15 of 40 unpermitted interview participants reported such activities. However, under the hypothetical moratorium scenario, many participants think that illegal uses would increase; the potential to over use their exempt use would be raised. Currently, most participants do not report their annual water use (20 of 31 permitted participants are not reporting). Furthermore, despite the fact that a water meter is a permit *requirement*, 10 out of 29 permitted participants lack a water meter.

#### *4.2.4 Equity*

Beyond reducing the credibility of the program, the enforcement problems also lead to equity concerns. Many participants say that enforcement is not uniform. Several view the GMP as unfair because those who abide by the law have to pay for their pumping yet those not following the law face no consequences. Participants also find it unjust that they need to provide mitigation before they are allowed to pump; some participants are paying for credits without being able to pump. Another equity concern relates to the perception that “big water users are not paying and the small ones are.” Several participants raise the issue that some golf-courses and resorts are allowed to use a great amount of groundwater without having to pay. However, a few participants also note that those golf-courses and resorts that are paying for mitigation credits drive up the prices. Some participants dislike the idea of a water market as they find it inequitable; they say that water belongs to the public and the price should not be determined by resorts. Furthermore, it is difficult for the small water user to accept being restricted from pumping when golf-courses and resorts use water at a greater rate than he ever will. Many participants criticize OWRD for allowing what they see as wasteful water use by golf-courses while the small users are made to wait three years to irrigate an acre: “when you see so much waste of water, but a draconian [approach] to my permit...it is difficult to take the OWRD Deschutes Mitigation process seriously.”

#### *4.2.5 Information Dissemination*

While information dissemination about the purpose and functioning of the GMP was noted as occurring at the onset of the program, many participants feel uninformed and this leads to false expectations and frustration. Many participants expected their groundwater application to go through quickly; 41 of 67 participants said that they felt uninformed about the length of the process. While participants say that professional consultants are adequately informed about the GMP, the typical water user is not. One aspect is a lack of information and another is that the information that is available is difficult for many to understand. Several participants state that they were not aware of the fact that they even needed a groundwater permit in order to pump. Furthermore, a general lack of

information regarding the GMP means that many potential participants are not aware of the ability to obtain a permit for a dry property. Many participants also feel uninformed as to why they have to mitigate: A general sentiment holds that “if we don’t need to mitigate then it’s a total waste to have the GMP.”

#### *4.2.6 Cost-Effectiveness*

For some participants, the monetary cost that the program incurs is a major impediment as these costs are significant to them (53 of 66 participants say costs are significant). Some say that only the rich can afford this program. Others note that the costs are large relative to the outcome; the GMP is a big investment without tangible outcomes. Yet others believe that while upfront the costs seem huge, their property value will increase (although this didn’t occur for some). While several participants complain that mitigation credit costs are increasing exponentially, for others the cost of credits is reasonable (but the pumping costs may be high, i.e. for resorts). Several participants express satisfaction with temporary credits because they are cheaper and provide more flexibility than permanent credits. However, prices for temporary credits are increasing, which is of concern to small water users who are losing money through the GMP: “a lot of us who don’t make money off of the land don’t need these credits. But it seemed like the sensible thing to do. Increasing the cost of credits will decrease the willingness to buy them.” This participant says that he could probably get away without a permit (just slightly over-use the exempt use). Despite the costs and limited availability of permanent credits, most participants see the benefits of permanent credits because they can retire their mitigation obligation; 56 of 61 participants are considering purchasing permanent credits.

#### *4.2.7 Utility*

Despite frustrations with the process and the rising costs, most participants say that the program is meeting their needs for groundwater (48 of 62 participants). Many also see the GMP as promoting economic growth and development in Central Oregon (32 out of 45 participants). While a representative from a resort notes that without the GMP no economic growth in Central Oregon would be possible, others say that the GMP hinders economic growth because of the lengthy process. For many participants the idea that the GMP promotes development does not make the program more acceptable; the GMP is “good for economic growth, but on the flipside, it’s not necessarily good to have development in the long-run.” While some participants are motivated to purchase credits because they believe it benefits the environment and gives them “peace of mind,” most participants feel uncertain about the GMP’s utility for instream flows. Some rationalize that if

the money (from mitigation) goes towards restoring flows, then there must be some benefit but others say the hassle of the program is not worth it. A few participants see no utility in the GMP; they describe it as a “joke,” a “game,” a means for the state and/or consultants to make money. While certain participants are unhappy with any regulation of water on *their* land, others note that water resources are limited, that they are living in the desert and think it’s important to control water use: “it’s our own benefit to be able to green-up our properties” and “the program sounds like a socially responsible way to proceed.”

## **5. Discussion & Conclusion**

In comparing the GMP with the two hypothetical arrangements – a moratorium on all new groundwater pumping or no rules for limiting groundwater appropriations - it must be recognized that both alternatives are extreme cases that impose large costs on some although not all participants. With the moratorium there would be no process and no incurred monetary costs, except for those who use groundwater for commercial purposes. Thus in a sense, a moratorium may be less frustrating (from a usability perspective) for water users. Furthermore, since a moratorium would place a restraint on everyone (including developers) it could be viewed as more equitable to many participants. However, accountability, enforcement and information would remain major issues. Since many participants perceive the latter criteria as already lacking and believe that illegal uses would increase under a moratorium, this alternative may be less acceptable than the GMP. In addition, since participants would be restricted from fulfilling their personal needs for groundwater, the utility of a moratorium would be less than with the GMP.<sup>17</sup>

Under the alternative scenario of the pre-1995 institutional arrangement, participants could simply pump as much as they wanted. Again, there would be neither a process nor incurred costs (besides pumping costs), which would make this option less frustrating than the GMP. Accountability and enforcement would be less of an issue under this alternative as it would be legal to pump regardless of the situation. However, equity may become a major concern as the wealthy, who can afford to pump more (in terms of pumping costs) may use more groundwater; less may be available to others due to aquifer drawdown. Furthermore, this may lead to rapid development by golf-courses and resorts, which would be met with disapproval by many participants as they express a strong sentiment against the plethora of golf-courses and resorts in the basin. However, while the utility may be high for participants initially, as their needs for groundwater would be met, the

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<sup>17</sup> While surface water transfers would still be possible, participants would be restricted from pumping more than the exempt well use.

resource could be depleted under this free-for-all and groundwater availability would be decreased. Since many participants note the need for conservation as well as express equity concerns, the pre-1995 alternative may be less acceptable to most participants than the GMP.

With regards to the results and the discussion of the two alternatives, it can be concluded that (despite frustrations incurred by the program) the GMP is more acceptable than the alternatives to most participants because it enables them to meet their groundwater needs in a way that offsets depleting instream flows while allowing for economic growth in a manner that may restrict development more than the pre-1995 alternative. Hence, this research supports the hypothesis that the GMP is more acceptable to its participants than the alternative management/regulatory options discussed in this paper.

Given the “action arena” in the Deschutes Basin, with its unique hydrogeology, conjunctive water laws and shifting values from agricultural to hobby-farming, the GMP is functioning to meet the diverging needs. The simple fact that people are participating in and staying with the GMP is an indicator of its acceptability. Yet there are many ways in which the program could be improved that may raise the acceptability. Participants’ most frequent recommendations include: more information (in plain English), with a time-line to help set expectations; clarify and simplify the application process; provide updates on the activities of the GMP; and increase public awareness. The general lack of clear information for participants seems to be a major concern. This issue is not new in the Deschutes Basin; a Bureau of Reclamation study in 1997 found that “new residents...need information in a usable form. An education program responsive to local needs would help reach new residents” (BOR 1997: 33-34).

Providing more and understandable information may assist in alleviating other frustrations of the program. The program may become more user-friendly as participants are more knowledgeable about the GMP; participants could gain more understanding about OWRD and its enforcement system; and knowing why mitigation is required may make the program seem more equitable, increase the utility as well as making it more cost-effective (i.e. seen as more worthwhile). By becoming more acceptable to participants through increased information dissemination, the GMP would also become more effective and viable as compliance may increase and water would be pumped in a legal manner. As noted by Wallace Stegner (Stegner 1987), in order to manage water resources in an over-allocated basin, redistribution is central; without the acceptance and compliance of the water users, redistribution becomes an even greater challenge.

## References Cited:

- Aylward, B. 2006. *Growth, Land Use and Irrigated Agriculture in Central Oregon, Deschutes Water Alliance Issues Paper*. Bend: Deschutes River Conservancy.
- Bastasch, Rick. 2006. *The Oregon Water Handbook: a guide to water and water management*. 2nd ed. Corvallis: Oregon State University Press.
- BOR, Bureau of Reclamation, and Oregon Water Resources Department. 1997. Upper Deschutes River Basin Water Conservation Study: US Department of the Interior.
- Dillman, D.A. 2000. *Mail and Internet Surveys: The Tailored Design Method*. New York: John Wiley and Sons, Inc.
- Gannet, M. W., Lite, K., Morgan D. S. and Collins, C.A. 2001. Ground-Water Hydrology of the Upper Deschutes Basin, Oregon  
Series Title: Water-Resources Investigations Report. Portland: U.S. Department of the Interior, U.S. Geological Survey.
- Senate Bill. 1995. *Ground Water Uses Within Scenic Waterways*. 1033.
- National Research Council. 1992. *Water Transfers in the West: Efficiency, Equity and the Environment, Committee on Western Water Management, Water Science and Technology Board, Commission on Engineering and Technical Systems*. Washington, D.C.: National Academy Press.
- Ostrom E., Gardner R., and Walker, J. 1994. *Rules, Games and Common-Pool Resources*. Michigan: The University of Michigan Press.
- OWRD. 2003. Deschutes Mitigation Program Annual Implementation and Evaluation Report In *Water Resources Commission Work Group Item IV*.
- Robson, Colin. 2002. *Real World Research: A Resource for Social Scientists and Practitioner-Researchers*. 2nd ed. Malden, MA: Blackwell Publishing.
- Stegner, Wallace. 1987. *The American West as Living Space*. Ann Arbor: University of Michigan Press.
- U.S. Census Bureau. 2008. State & County QuickFacts: Deschutes County Oregon.
- Yake, Kolleen. 2003. Upper Deschutes Subbasin Assessment. Bend: Upper Deschutes Watershed Council.