DISCUSSION PAPER

October 2015 ■ RFF DP 15-46

Expected versus Actual Outcomes of Environmental Policies

The Clean Water State Revolving Fund

Winston Harrington and Anna Malinovskaya

This paper is one in a series of retrospective analyses from RFF's Regulatory Performance Initiative. www.rff.org/regulatoryperformance.

1616 P St. NW
Washington, DC 20036
202-328-5000 www.rff.org

RESOURCES FOR THE FUTURE

Expected versus Actual Outcomes of Environmental Policies: The Clean Water State Revolving Fund

Winston Harrington and Anna Malinovskaya

Abstract

This paper examines the performance of the Clean Water State Revolving Fund (CWSRF), a federally funded program to provide loans to local publically owned treatment works (POTWs) in four states: Iowa, Indiana, Maryland and Texas. We find that between 2007 and 2014, the typical plant receiving a loan in these states substantially improved the quality of effluent discharges of biochemical oxygen demand (BOD) and organic nitrogen (N) in all four states, compared to a sample of plants in the same states that did not receive loans. We also found, however, that plants receiving loans tended to better the performance of plants that did not receive loans in 2007, before the funds were distributed. Thus, while loans were effective in improving water quality, it appeared that the plants receiving loans were not the plants most in need of improvement, but were already among the best. Thus, state authorities responsible for choosing plants receiving loans favored plants with a record of prior success rather than a record of current need.

Key Words: water quality, publicly owned treatment works (POTWs), federal loans for local POTWs, Clean Water State Revolving Fund

Contents

Introduction **1**

Background **2**

Brief Overview of the CWSRF Process **6**

Needs and Loans 6

Data **8**

Clean Watersheds Needs Survey (CWNS) 9

Clean Water Benefits Reporting System (CBR) 9

Monitoring and Enforcement Data 9

Annual Reports 10

Assembling Treatment and Control Groups **10**

Methods and Expected Outcomes **11**

Implied Treatment Group Selection Criteria 12

Absolute and Relative Improvement of Treatment and Control Groups, 2007–2014 13

Results **13**

Changes in Average Discharge Rates 14

Changes in Discharge Rates at Plants with the Highest Discharge Rates 15

Conclusion **17**

References **18**

Appendix: A Comparison of Subsidies **19**

Tables **21**

Expected versus Actual Outcomes of Environmental Policies: The Clean Water State Revolving Fund

Winston Harrington and Anna Malinovskaya*

Introduction

The Clean Water State Revolving Fund (CWSRF) is a federal program that has capitalized loan funds in each state and Puerto Rico for a wide variety of water quality improvements. In 2014, the total of new federal capitalization grants and matching state funds was over $1.6 billion for new loans,[1] which is not much, perhaps, when set against the vastness of the entire federal budget, but nonetheless it amounted to more than 20% of the total US Environmental Protection Agency (EPA) budget of that year.[2] In this paper we take a look back at the results achieved by the CWSRF, concentrating on the period between 2007 and 2014 in four states: Iowa, Indiana, Maryland, and Texas. We were interested in the following questions:

- By comparing plants receiving and not receiving loans, could we make any inferences about the selection criteria?
- Over the period for which we had data (2007–14), did publicly owned treatment works (POTWs) receiving loans on average reduce their pollutant discharges, and if so, by how much?
- Over the same period, how did plants that did not receive loans perform on the same metric?
- How did the performance of plants in the two groups compare? For example, even if both groups improved on average, did one group do better than the other?
- Could we say anything about the "worst" plants, the ones with the highest discharge levels? Did they tend to receive loans, and did they tend to catch up with the others?

* Harrington: senior fellow, Resources for the Future (RFF), harrington@rff.org; Malinovskaya: research assistant, RFF.

[1] EPA, Clean Water State Revolving Fund: Fiscal Year 2014, http://www2.epa.gov/sites/production/files/2015-04/documents/cwsrf_2014_financial_statements.pdf.

[2] EPA, EPA's Budget and Spending, http://www2.epa.gov/planandbudget/budget.

We call the POTWs receiving loans and those not receiving loans the "treatment group" and the "control group," respectively.

Overall, we find that the program does seem to have reduced effluent discharges of the plants with the highest pollutant discharge rates in 2007. For the average plant, we also generally find improvement, albeit modest, in the treatment group, but not in the control group. In both, nonetheless, it was not uncommon for effluent mass loadings and concentrations to increase. Table 1 offers a preview of our results: the median change in pollutant discharge concentrations for biochemical oxygen demand (BOD5), total suspended solids (TSS), and organic nitrogen in each state and group.[3] For the 11 state/pollutant combinations for which we had data, plants in the treatment group improved in every one, both in absolute terms and relative to the control group. Median change in the control group was about what we would expect, with five combinations showing improvement and five showing deterioration.[4] The treatment-group improvements were not particularly large except for organic nitrogen. A well-functioning POTW with conventional treatment should reduce concentrations of BOD5 and TSS by about 85%, but our treatment-group results fall well short of that standard. Part of the reason seems to be that considerable pollutant reductions had already been achieved by CWSRF investments in wastewater treatment prior to 2007, the beginning of our observation period.

Background

In most US communities, transport and disposal of sanitary wastewater are handled by publicly owned water and sewer authorities. These authorities have historically answered to state

[3] BOD5 measures the effect of the pollutant on the level of dissolved oxygen in a water body. Typically, the concentration of dissolved oxygen in freshwater is less than 20 milligrams per liter (mg/l) and declines with temperature. The dissolved oxygen level is an important measure of the health of a water body, and if driven too low, can deprive fish and other aquatic organisms of the oxygen essential for life. Wastewater high in BOD5 concentration tends to oxidize when discharged into receiving waters, and if strong enough, it can adversely affect aquatic life. BOD5 can be measured by introducing a sample of wastewater into a fixed amount of water under standard conditions and observing the change in dissolved oxygen concentration in five days. TSS is the mass of suspended material in a sample of wastewater that cannot pass through a filter of an appropriate pore dimension, after subtracting off the mass of material in particles too large to remain suspended. High TSS levels are hazardous to water bodies mainly because of turbidity: they limit the penetration of light into streams, impeding photosynthesis and interrupting the food chain. Organic nitrogen (N) can deplete oxygen as well and also is a nutrient that can overenrich water bodies, leading to algal blooms harmful to stream biota.

[4] Rates of improvement were highly variable in each state, and we judged that the median gave the best indicator of the typical rate of change. Later in the paper, we present additional measures of central tendency.

regulators in terms of the volume and quality of wastewater discharged into receiving waters. Since 1972, the concentrations of pollutants in wastewater have also faced generally more stringent federal standards, and to help them meet these new obligations, states and localities have received financial assistance from the federal government. In that year, the Federal Water Pollution Control Act Amendments (P.L. 92-500) imposed national standards on the quality of effluent from POTWs. The act also initiated the Construction Grants Program, initially provided funds to finance 75% of the capital cost of wastewater treatment facilities, later reduced to 65%. While the locals were responsible for operating costs, the heavy capital costs of these facilities meant that, overall, local authorities paid only about 45% of total costs.

By the 1980s, the Construction Grants Program had come under criticism for its high cost and lack of flexibility—it had been learned that there were other, possibly more effective and less costly approaches to improving water quality besides investing in large, capital-intensive wastewater treatment projects—and for providing local authorities with perverse incentives to design overcapitalized projects. A new approach to federal assistance, the Clean Water State Revolving Fund (CWSRF), emerged in the Clean Water Act (CWA) of 1987 (P.L. 100-4), relying not on federal grants to local water and sewer authorities for wastewater treatment, but on loans. The CWA authorized the initial capitalization of 51 state revolving funds (including Puerto Rico), their purpose being to provide loans at below-market rates to local water and sewer authorities for the construction and expansion of municipal wastewater treatment systems or for other purposes to improve local water quality. To obtain the federal contribution to the loan funds, each state was also required to provide a 20% match. Anticipating passage of the CWA, Congress also authorized the appropriation of funds to create and capitalize the state revolving funds beginning in FY1986 and continuing to the present, at a level ranging from $625 million to $4.7 billion per year (the latter figure thanks to a onetime injection of $4 billion by the American Reinvestment and Recovery Act of 2009).

Thus the expectations implicit in the 1987 CWA were that the federal government would eventually remove itself from the business of funding wastewater treatment projects. The Construction Grants Program would be phased out and replaced by the CWSRF, with the last grant to be made during FY1990. In addition, it was expected that federal capitalization of the individual state CWSRFs would eventually be phased out as well. Eventually, the federal grants, together with the state and local repayments of previous "revolving" loans—so called because the repayments would remain in the state funds to be available for other loans at a later time—would allow the fund to be self-sustaining. That is, it was thought that after a period of years, the annual federal grants plus the loan repayments would build up the state revolving funds to the point where the federal contribution would no longer be necessary.

In reality, neither of these expectations has yet been borne out. Even in 1987, the CWA contained other provisions that authorized construction grants to be made to a small number of local sewer authorities named in particular sections of the act. These included Section 510, which provided grants for a Mexican Border Initiative to provide wastewater treatment to communities on both sides of the border, at first specifying Tijuana and San Diego, but in subsequent years including cities in the other border states; Sections 512 and 515, which authorized funds for relocating natural gas transport facilities near a treatment plant in the Red Hook area of Brooklyn and for constructing a new wastewater treatment plant in Des Moines, respectively; and Section 513, which authorized funds for "needy cities," including remote villages in Alaska that had no preexisting wastewater treatment. This "needy cities" section also seemed to be the rationale for relatively large grants for wastewater treatment in and around Boston (Copeland 2012). These same four cities—Boston, Brooklyn, Des Moines, and San Diego—continued to receive grants for years afterward; by the late 1990s, nearly a billion dollars in wastewater infrastructure grants were appropriated for the Boston area, for example.

From the early 1990s to the present, construction grants for named facilities or for new projects continued to appear in EPA appropriations statutes, even though the main source of funds for wastewater infrastructure had shifted to the CWSRF. The grants were not limited to the four areas mentioned above, as more and more members of Congress were able to secure grants for their own constituents. After all, the grants were popular with local constituencies; in contrast to CWSRF loans, they did not have to be repaid. To be sure, the local sewer authorities did have to pay operating and maintenance costs and a share of the capital cost, but in total they were paying only about 45% of the total cost of the wastewater infrastructure, a figure that varied in specific cases depending on the terms written into the authorization or appropriation. Over time, however, it appeared that the 45% local cost share evolved. Initially an incidental outcome of the 75%, or later 65%, federal share of capital costs and the local ratios of capital and operating costs, the 45% figure became a target that was referred to explicitly in the appropriation bills. From the perspective of the local authorities, having to cover only about 45% of the total capital and operating costs of wastewater treatment was a much better deal than the CWSRF (the costs of which we estimate in the appendix to be about 87.5%), even with low-cost loans and easy terms. Thus plenty of sentiment remained among states and local authorities—and often their senators and representatives in Congress—to retain the Construction Grants Program.

From 1994 to 2012, over $6 billion in State Categorical Sec. 106 Wastewater Treatment Grants was expended,[5] authorized not by the CWA but by language in annual EPA appropriations acts. At first these funds were exclusively for wastewater treatment and went primarily to the named entities mentioned in CWA Sections 510, 512, 513, and 515. As time went by, however, more and more local sewer authorities were able to gain access to what were called Special Purpose Grants, or less formally but more frequently, "earmarks." Their scope was also expanded to include other water-related purposes. But while the number of grants increased, the total funds available did not. By 2005, $400 million in awards were disbursed to 669 projects ranging in size from $29 thousand to $49.6 million (Copeland 2008) (see Table 2). At that point, legislators were beginning to perceive problems with a funding procedure that, though instituted for large-scale capital-intensive projects, was in fact distributing ever smaller grants to ever larger numbers of recipients. EPA officials and state environmental administrators were also beginning to object, because more funds for special project awards meant less funds to build up the state revolving funds. By 2010, the total number of grants had fallen to 319, and we have not yet been able to find the number of projects supported after that year. It seems likely that the use of earmarks in this context had fallen out of fashion, at least for the time being. It was only after 2005 that the grants program appeared to slow down, but a quarter of a billion dollars in grant money for localities remains in the FY2016 budget.

Meanwhile, federal funding of the state revolving funds was also extended. One reason for this was an expansion of eligible uses of the funds into projects not anticipated in 1987, including an expansion to include funding for nonpoint-source projects in 1993. Nonetheless, the lion's share of funds still went for infrastructure projects. Altogether, federal funding for water infrastructure exceeded $2 billion every year from 1995 through 2007, including the newly established Drinking Water State Revolving Fund (DWSRF) and the construction grants discussed above (Table 2). And except for 2007, CWSRF funding between 1994 and 2004 exceeded $1.2 billion per year.

In 2008, when total water infrastructure funding sank to $1.7 billion, a level it had not reached in over a decade, the United States entered the economic slowdown now called the Great Recession. In response, Congress enacted the American Reinvestment and Recovery Act (ARRA), which had the twin goals of replacing and refurbishing public infrastructure and

---

[5] EPA, FY 2016 EPA Budget in Brief, http://www2.epa.gov/sites/production/files/2015-02/documents/fy_2016_bib_combined_v5.pdf.

injecting a much-needed stimulus into the economy. Water infrastructure funding soared to $7.7 billion in 2009, with $4.7 billion for the CWSRF. Annual funding for both the CWSRF and DWSRF, though well below the 2009 level, was still far above historic averages through 2012.

An interesting question involving the ARRA is whether pushing so much money into the CWSRF pipeline so quickly led to the funding of less-worthy projects. Unfortunately, however, this question is not easy to analyze. In our study, the units of analysis are the local sewer facilities, whereas in the ARRA, the unit is the loan. ARRA loans may be shared by several facilities, and many facilities received funds from several loans—both ARRA and non-ARRA—during the study period. Sorting out these revenue flows is possible, and likely of great interest, but it is beyond the scope of our analysis.

Brief Overview of the CWSRF Process

The methods used here to evaluate the CWSRF have been more or less dictated by the funding process for the program, which takes place in overlapping four-year cycles coterminous with presidential election years. The funding cycle begins with the assembly and publication of the *Clean Watersheds Needs Survey* (CWNS; EPA 2008), a compendium of desired investments by all eligible facilities in every state for at least the next 20 years. It is a bottom-up process, with individual facilities deciding on their needs over the planning horizon, then submitting them to state authorities, who assemble the data and make decisions on which projects will be passed on to EPA for potential funding. Meanwhile, Congress finalizes the overall budget and projective state shares for the upcoming two years. Unsurprisingly, the sum of proposed investments substantially exceeds the total funds that Congress has allocated for the federal portion of the loans. States select the loans to go forward and an amount they are willing to fund (which can be either less or greater than the amount requested), together with a schedule indicating when during the next four years that the loan will be made. Total funding by the state need not conform to the state share of the yearly appropriation, as the revolving fund provides some flexibility, enabling the total loans to be more or less than what was appropriated. In any event, the state publishes an Intended Use Plan, which lays out the recipients and amounts of loans, together with a funding schedule that has to be consistent.

Needs and Loans

Table 3 provides some indications of the relative size of the CWSRF in the four states. The first section of the table shows the number of loans, number of recipients, and total loan amounts by state to the plants reporting needs in the CWNS. The difference between the number of plants and loans indicates that some POTWs in each state received more than one loan during the study period. As shown, Iowa, the most rural of these four states, had the smallest total loan but the largest number of individual loans. In general, loan amounts seemed to be influenced by population, but by no means exactly.

Moving to the second section of the table, we were surprised to find that quite a few plants received loans without reporting needs at all. This is contrary to the way we understand the process is supposed to work, but we also notice that in each state, the average size of these loans and the total loan amount are considerably smaller than the loans for those plants reporting needs, especially in Maryland. We are not sure why plants were able to obtain loans in this way; perhaps it is a manifestation of the flexibility of the process that every state seems to count on and value. In any case, we left these plants out of the analysis, although we may revisit this class of plants in the future.

In the third section of Table 3, we define our control group: the plants that reported needs but did not receive loans. In this table, the outlier is Texas. In the other three states, the number of control-group plants is about twice the size of treatment group. Thus if the state authorities were to try to spread the wealth, a typical plant would receive a loan about every third cycle, or every 12 years or so. In Texas, however, the size of the control group is about 10 times the size of the treatment group, implying a loan for each plant every 11 cycles, or once every 44 years. Part of the explanation for the difference might be that Texas, unlike the other states, made much more use of “decentralized” wastewater treatment. Decentralized plants are smaller, serve fewer households, process less wastewater, are more easily automated, and can be placed closer to high-population areas. In addition, the smaller size makes it possible to use simpler treatment processes that allow wastewater to be disposed of on land or lagoons isolated from the natural network of rivers and lakes, rather than natural water bodies. Texas has over 200 decentralized plants, compared to 2 or 3 in each of the other states.

As noted above, it was common for local sewer authorities to receive loans that were smaller than their reported needs. We were again surprised to find that the reverse was also true, with many loans exceeding the amount requested, as shown in Table 4, which divides the successful loan requests between cases when needs exceeded loans and cases when loans exceeded needs. In three of the four states, in fact, loans exceeded needs in the majority of cases. Only in Maryland did we find what we expected to be the normal pattern, with needs exceeding loans. In most cases, the average excess, or the absolute difference between needs and loans, was small; the exception was Maryland, where instances of needs exceeding loans averaging over $100 million. We also noted that in all four states, the total absolute excess of needs exceeding loans is much higher when needs exceed loans. Our interpretation is that it was common for needs to exceed loans among the large systems, and the reverse was true among the small rural plants. Possibly the large urban plants were more likely to have professional engineers making the decisions, people who had a much better idea of what was needed to achieve water quality objectives, while in rural areas these decisions may be made by nonprofessionals. Even within states, this pattern seemed to hold. In Iowa, for example, the largest loans and the largest positive disparity between needs and loans occurred in the largest cities, including Des Moines and Cedar Rapids. This pattern of loans relative to needs indicates that state authorities, for whatever reason, routinely shift resources from large to small plants.

Data

We collected data from several EPA and state-level sources and assembled them into a database that combines the investment needs reported by each plant at the beginning of the study period (2007), data on the CWSRF loans received during the period, technical data about each plant, and a comparison of effluent quality achieved by the plant in 2007 and 2014.

We need to begin with a word about the variable quality of the data available. As near as we could tell, the CWSRF datasets describing the plants and loans were reasonably complete, although some of them evidently were not intended for the kinds of numerical analysis we had in mind and required data entry by hand, which was slow and tedious. For example, data about ARRA loans was not explicitly presented; ARRA was only mentioned in prose descriptions of the projects in the *Clean Watersheds Needs Survey*. Because these data were difficult to collect, we had suspicions about the data completeness and ended up not using this variable.

Most of our data problems concerned the discharge monitoring reports (DMR), and in particular, the completeness and accuracy of the monitoring results reported to EPA by state authorities. We collected data on three of the most commonly monitored pollutants: five-day biochemical oxygen demand (BOD5), total suspended solids (TSS), and organic nitrogen (N).

In three of the four states we examined, we had data issues that compromised the analysis. In Iowa, about half the records had missing flow data, which meant that we did not have pollutant concentration data either. For Maryland, the problem was that no BOD5 data were collected, leaving us with only the pollutants TSS and N. In Texas, the data were reasonably complete, but there were several instances of negative values for effluent flow, raising questions about data reliability. In the end, we simply assumed that the minus signs were typos and ignored them. Of the four states examined, therefore, we felt fully confident only about the Indiana data.

In the remainder of this section, we describe data sources, including the CWNS database and several EPA databases. The next section discusses the data assembly process.

Clean Watersheds Needs Survey (CWNS)

For the anticipated outcomes, we use the CWNS database for 2008, which contains project descriptions and cost estimates for all facilities with "needs" anticipated for the next 20 years. A need is defined as the unfunded capital cost of a project to address a water quality or public health concern identified before January 1 of the year of the survey. It should be noted that throughout this paper, "cost" refers to capital cost. We are not aware of any data source that contains information, prospective or actual, on operating costs. Fortunately, these water treatment projects tend to be very capital-intensive.

The CWNS database is also the primary source of ex ante data for the analysis. In addition to the project description and cost, the CWNS database includes present and projected population served by the facility, unit processes employed and changes anticipated, water flow, effluent quantity and quality, and discharge equipment characteristics. Locational data include latitude and longitude, state and county, a tribal indicator, and the US Geological Survey (USGS) eight-digit hydrological unit code. The CWNS database evidently includes all projects that will receive funding over the four-year planning horizon plus many projects that will not. Facilities and projects are also subcategorized extensively, assisting us in the comparison of like with like in the analysis. For realized outcomes, datasets are not quite so neatly packaged.

Clean Water Benefits Reporting System (CBR)

The Clean Water Benefits Reporting System (CBR), an EPA dataset, is the source of information on which plants in the four states were to receive loans during the four-year cycle, including an initial estimate of the loan amount. CBR also contains a wealth of other project-specific information, including costs and anticipated environmental benefits for CWSRF projects. The system was instituted in 2005 but was not made mandatory until April 2010; however, numerous states submitted voluntary project-level data prior to that date, including the four states we examine. The CBR database is not fully available to the public; it is primarily intended for use by state programs, as a source of information and as a way of entering data.

Monitoring and Enforcement Data

We also rely on EPA's Pollutant Loading Tool, which calculates pollutant discharges from data collected in EPA's Integrated Compliance Information System for the National

Pollutant Discharge Elimination System (ICIS-NPDES). DMR data are available for the years 2007–11, but if necessary, we can refer to the data in the older ICIS-NPDES system. As the name indicates, the DMR system also has enforcement/compliance outcomes by source. We rely on the DMR for data on changes in flow and in effluent discharges at facilities benefiting from program investments.

Annual Reports

In addition, state websites contain information on real project implementation, but the website contents vary dramatically from state to state. Some states, notably Texas and California, make available detailed annual reports that contain every project under way during the year in question, so it is possible to track actual expenditures on individual projects over multiple years. While all states no doubt maintain this information, for many it is not readily available on their websites.

Assembling Treatment and Control Groups

Now we describe the assembly of our state datasets, using Texas as an example. We begin by merging CWNS and CBR data.

Although the CWNS 2008 database contains about 1,400 records of wastewater treatment plants in Texas, only about 1,000 of them reported any needs. We keep only those plants that reported needs, and we further focus on plants that reported needs in at least one of the following three needs categories: secondary treatment, advanced treatment, and infiltration correction. In the CWNS database, plants can report needs as official needs, unofficial cost estimates, or needs not submitted for review. We consider these three ways of reporting needs as all being legitimate for our analysis. We also exclude plants to be built and keep only existing plants and new plants that are going to replace existing facilities, so that we can compare plant performance before and after treatment. This gives us about 550 plant records in CWNS. We next need to distinguish the treatment group, plants that received at least one loan according to the CBR data, from the control group, plants that received no loans with records in the CBR database.

We can now start merging CWNS records at the plant level with CBR records at the level of individual loans. A major difficulty, however, is that there is no numerical variable that we can use as a match variable to match loans from the CBR database with the CWNS records of the plants that received those loans. The CBR variables include borrower name, location, project description, and some other qualitative information, but the amount of this information available varies by loan. In the CWNS database, each plant is identified by an authority name, a CWNS number, and a permit number, plus some qualitative information.

We first create all pairwise combinations of plants in CWNS and loans in CBR at the authority/borrower level. The result is 168 plant/loan combinations. Then, in order to distinguish true plant/loan combinations, we examine qualitative information associated with each pair and provided by CBR and CWNS, supplementing this qualitative information with permit number/loan number information from annual reports where possible. Fortunately, Texas is one of the few states that provide permit numbers of loan recipient plants in annual reports for most years.

Finally, we merge CWNS/CBR data with DMR and compliance history data. After merging our data with the DMR data, our treatment-group size decreases to 30 to 40 plants, and the control group size decreases to about 90 to 100 plants. After merging CWNS/CBR data with compliance history ratings data, the treatment group contains 20 to 30 plants, and the control group contains about 100 plants.

Methods and Expected Outcomes

The funding process allows us to employ an approach that bears a passing resemblance to a clinical research project in medicine. A number of POTWs have stated that they have needs for funding to remedy some problem in maintaining or achieving water quality. Some portion of that group, the treatment group, receives loans; the remainder, the control group, does not. The funds are disbursed and the improvements made; then time passes, and at some future time, the researcher will be able to observe and compare outcomes. This analogy is not perfect; for one thing, in clinical research, the assignment to treatment and control groups is customarily randomized, but the CWSRF funding selections are unlikely to be random. Indeed, we would probably expect the selection of funded plants to be decidedly nonrandom, with the funding presumably going to the plants with the most urgent needs. (Below, other possible decision criteria are mentioned.)

Regardless, we adopt the terminology of treatment and control groups, selecting four states—Iowa, Indiana, Maryland, and Texas—for more detailed analysis. We also do not choose randomly; instead, we choose states that seem to have the most informative annual reports and give promise of having the most complete or accessible data, at least in our initial inquiries. Given the quality of the data available, it is no surprise that these states ranked among the “least corrupt” of the 50 states according to the investigation of Liu and Mikesell (2014), with Iowa in the first quintile and Indiana, Maryland, and Texas in the second quintile of states. As will be evident below, this selection of states, though not random, at least offered us a wide range of observable outcomes. Our dataset consists of all the loans made during the period from 2008 and 2012, the period consistent with the *Clean Watersheds Needs Survey* (CWNS) published in 2008. Thus the treatment group in each state consists of all POTWs in those states that reported needs and received loans, and the control group consists of those plants that also reported needs but did not receive loans. For each plant, we construct measures of performance based on the quality of effluent reported by the plant in 2007, just before the period began, and in 2014, two years after the period ended. This setup provides us with several interesting comparisons.

Implied Treatment Group Selection Criteria

Using the 2007 data, we can compare the performance of the two groups in 2007, before the first loans of the new cycle are distributed, to look for insight into the implicit rules governing the selection of loan recipients. Several hypotheses come to mind. We can group the outcomes into three categories.

First, state authorities may favor the largest plants, especially where the average flow from the treatment plant can approach or even exceed the natural flow of the receiving water body. Even if they comply with effluent discharge regulations, such plants can cause serious damage to receiving waters and may have to be subject to considerably more stringent discharge limitations to maintain instream water quality.[6] However, examination of the average size of plants in the treatment and control groups of each state suggests that plant size is not always a determining factor. In Table 5, we see that the size of the average treatment-group plants substantially exceeds that of the control group only in Iowa.

Another possible criterion for treatment-group selection is the recent history of plant performance, with state authorities selecting loan recipients among the plants having the greatest difficulty in maintaining compliance with the regulations. In particular, we might observe the treatment-group performance in 2007, in terms of effluent quality, to be consistently worse than performance of the plants in the control group. This outcome would be consistent with a tendency to direct the funds to the laggards, the plants most in need of improved performance. This outcome would presumably achieve the largest environmental gain for the funds available.

---

[6] Such plants are often called “water-quality-limited” plants, in contrast to the more common “effluent-limited” plants subject to uniform and less stringent discharge regulations.

On the other hand, we might observe just the opposite, with most of the funds going to plants having the greatest success in improving water quality. While this might seem perverse, it is also consistent with rewarding efficiency and providing incentives for improved performance over time.

Yet a third possible outcome is apparent randomness. As noted above, these awards are not truly random events; they are the product of political give and take involving important players within the state, no doubt with a certain amount of kibitzing from EPA, with the net effect of these not easily observed forces being more or less indistinguishable from randomness. Then, too, some loans have no effect on a plant's effectiveness in reducing pollutants, as they may achieve other goals, such as increasing capacity or improving the wastewater collection system.

Absolute and Relative Improvement of Treatment and Control Groups, 2007–2014

The next comparison is the contrast between the 2007 POTW performance in the two groups and the performance of the same plants in 2014, two years after the last loan in the current cycle has been awarded. In this case, we would expect substantial improvement among the plants in the treatment group overall, even if some of the loans have little to do with improving the efficiency of wastewater treatment. It is not so clear what to expect from the plants in the control group. Many will have received loans in preceding cycles; if such plants have not yet fully achieved the expected improvement, they may now show some additional improvement. On average, however, we would expect more improvement in the treatment group. In addition, we consider the 2014 performance of plants in both groups that did not perform well in 2007. There are not many plants in this subcategory, but in any case, we would expect to see plants in both groups performing better in 2014. In the control group, this would simply be regression to the mean; in the treatment group, it might reflect the targeting of a plant with problems for assistance.

Results

We use two metrics to compare performance of the plants in the treatment and control groups: (i) the percentage change in estimated pollutant load in kilograms per year (kg/y) between 2007 and 2014; and (ii) the change in pollutant concentration for pollutants of interest. The pollutants of greatest interest and most complete data are BOD5, TSS, and ammonia nitrogen. Two performance comparisons of treatment and control groups are paramount:

focusing on the average changes in pollutant discharges in each group and on the plants with the largest pollutant discharges in 2007, before the loans were made.

Changes in Average Discharge Rates

For average plant performance, we display results in measures of BOD5 among plants in Indiana, the CWSRF program with the best and most comprehensive data among these four states. The comparison is constructed in the following way. First, we divide the 2014 flows and BOD5 discharges by the 2007 flows and discharges, respectively, to get the percentage changes between the two years. We then take the means of these ratios, over the entire set of the 44 plants in the treatment group, where computable, plus several submeans conditional on the kinds of initial needs reported in the CWNS. The dispersion of these ratios was pretty high, so we also display both mean and median measures of central tendency. By comparing these treatment-group ratios, we can see immediately how the absolute performance of the TG plants changed over the eight-year period from 2007 to 2014. Because we divide treatment-group changes by control-group changes, ratios less than unity indicate improvements in effluent quality.

We then repeat the process for the 84 plants in the control group, comparing measures of performance between 2007 and 2014 to get a set of measures of performance among the plants that had needs but did not get loans. The final step is to divide the average change in each treatment-group measure by the corresponding control-group measure. Ratios that are less than one indicate greater improvement in the treatment group between 2007 and 2014. These ratios are converted to percentage improvement and shown in Table 6.

As shown, in the control group the average wastewater flow in 2014 was about 28% greater than in 2007, and the increase in BOD5 was about 50% greater. In the treatment group, the growth in flow was double that of the control group (56.6%), yet the increase in BOD5 was about half the control group. Plants reporting secondary or advanced treatment needs did much better than this, with mean BOD growth by only 15% in the control group and a more than 15% decline in the treatment group. Moreover, the median results echoed the conditional mean results: a 20% decline in the treatment group versus a 15% increase in the control group. To put this in perspective, we observe that secondary treatment is expected to reduce the concentration of BOD5 in untreated waste by 80–90%. Here, the reduction is about a third, which would be consistent with what might be found in a plant that already had some level of treatment. Looking beyond Indiana to the other states, it turns out that experiences in Texas are similar, with the treatment group showing rather modest reductions in BOD in 2014 relative to their 2007 discharge rates, and the plants of the control group experiencing small increases. Results in

Maryland and Iowa are less clear-cut, largely because of the data difficulties discussed above (lack of BOD5 data for Maryland and concentration data for Iowa).

We can also divide the ratios of changes in the treatment group by those in the control group to see the *relative* rates of change, which we show in Tables 7 through 10 for each of the four states. Here, an entry of 1 indicates that the average rate of change of the pollutant is the same in both groups. The preponderance of entries between 0 and 1 in these tables indicates that the improvement in effluent quality in the control group plants trailed the corresponding rate of change in the treatment group, and conversely. Only six of the values in these tables exceed unity, with four in Table 7 (Iowa), and three of those are attributable to an obvious outlier, affecting the mean outcomes for TSS. Focusing on the median outcomes, we see that the ratios favor BOD5 and TSS by 10–30%, and for nitrogen the relative treatment-group improvement is 40–80%, which is pretty substantial.

Changes in Discharge Rates at Plants with the Highest Discharge Rates

Tables 11 through 15 trace the change in performance of the plants in each state that have the highest effluent discharge rates in 2007. There are five tables for the four states because Texas has two types of POTWs that we treat separately: 300 conventional plants and 220 decentralized plants.

To select the plants with the highest discharge rates in 2007, we use a set of "cutpoints"; if a plant's reported discharge rates are higher than the cutpoints, that plant is included in one of the tables. These cutpoints were not set primarily with water quality in mind; rather, they were set to provide separation, to generate a large enough sample of "problem" plants. Initially, we set cutpoints at 15 mg/l for BOD5 and TSS and 5 mg/l for ammonia nitrogen, but at this level, fewer than 10% of plants in each state-pollutant combination were affected. For this reason, we also used an alternate and more stringent set of cutpoints set at 5 mg/l for BOD and TSS and 1 mg/l for ammonia nitrogen. At these levels, the 2007 discharges of many plants exceed cutpoints, up to a third or so for BOD5 and nitrogen and nearly 50% for TSS.

With this setup, we are now able to reconsider the question of the initial selection of the plants to receive loans in 2008–12. Remarkably, using the more stringent alternate cutpoints, we see a good deal of consistency in the relationship between selection into the treatment group and the incidence of excursions above the cutpoints in 2007.

- In Iowa (Table 11), the control group was more than three times as likely as the treatment group to have BOD5 excursions in 2007, based on the alternate cutpoint. Oddly, it appears that in the control group, a great number of plants were clustered between the two cutpoints of 5 and 15 mg/l, while the treatment group had no such plants. Results for TSS were even; for ammonia nitrogen, there were too few observations to say.

- The Indiana experience (Table 12) was similar to Iowa's. The percentage of BOD5 excursions in the control group exceeded those in the treatment group by three to one, and again many control-group plants had results that clustered between the cutpoints. The TSS and N percentages were very close across the groups at both cutpoints, with a slight edge to the treatment group.
- Maryland (Table 13) had no BOD5 data. For TSS and N, the 2007 performance was about the same in the two groups at both cutpoints.
- Splitting Texas into two groups meant that there were small treatment groups in both. Still, in the conventional group (Table 14), Texas stands out from the other states in the very low percentage of BOD5 excursions in the treatment group at either cutpoint. Here again, the control group had a large number of plants with results between the cutpoints. For TSS, the rate of excursions was greater in the control group at both cutpoints by about 50%, but for N, the rate of excursions was about the same in both groups.
- In the Texas decentralized treatment (Table 15), the results approximately replicated the Texas conventional treatment results.

In the five cases with BOD data, the treatment group contains the better performers, especially using the alternate cutpoints, even *before* the loans were distributed and the plant improvements made. Thus, in these states at least, it seems quite unlikely that the loans are targeted toward plants having difficulties; instead, the loans awards are consistent with a strategy of rewarding better performance.

Turning to the comparison in 2007 and 2014, the results from Tables 11–15 are more difficult to characterize, and each state has a slightly different story.

- In Iowa, there is little difference between the treatment and control groups. BOD5 reductions appear to be a little greater in the treatment group, but sample size is small. For TSS, improvement in the treatment group is a bit better than in the control group at both cutpoints. Nitrogen also shows greater improvement, but again the sample size is small.
- In Indiana, we see a big improvement in the treatment group for BOD5 and N, but little change for TSS.

- In Maryland, we see a substantial improvement in TSS in the treatment group (using alternate cutpoints) and a modest improvement in N, but there is no substantial change in either in the control group.
- Texas conventional performance is so good in 2007 that there is hardly any room for improvement. TSS is basically unchanged in both groups, but for N, the improvement in the treatment group is much better than that in the control group (using alternate cutpoints).
- As with Texas conventional, Texas decentralized results are a bit better in the treatment group for N, but not so much for BOD5 or TSS.

Conclusion

Our investigation of the effect on the quality of effluent discharges in four states from loans made from the Clean Water State Revolving Fund between 2008 and 2012 has yielded three interesting conclusions. First, we find consistent improvement in average effluent quality between 2007 and 2014 in plants receiving loans, compared with the plants that did not receive loans during the period. By examining ratios of treatment-group changes in effluent to control-group changes, we see that in each state, average pollutant concentrations improved from 10% to 60%, depending on state and definition of central tendency. However, when we look at the “worst” plants in each state, those with the greatest likelihood to have effluent discharges that are high relative to the mean effluent quality, we find that those plants were disproportionately located in the control group, which did not receive loans. As our naïve expectation at the beginning of the project was that the loans would be more likely to go to the plants with problems, this was quite a surprise. We believe a consequence of this distribution of resources was that the plants receiving the loans were the ones with the least scope for improving effluent quality. Based on these results, it seems as though state regulators should think about revising the criteria for distributing CWSRF funds. Nonetheless, we recognize that many other factors can affect loan distributions and may need to remain in consideration.

References

Copeland, Claudia. 2008. Water Infrastructure Projects Designated in EPA Appropriations: Trends and Policy Implications. Washington, DC: Congressional Research Service.

———. 2012. Water Infrastructure Financing: History of EPA Appropriations. Washington, DC: Congressional Research Service.

EPA. 2008. Clean Watersheds Needs Survey: Report to Congress. http://www.epa.gov/cwns.

———. 2012. Technical Users Background Document for the Discharge Monitoring Report (DMR) Pollutant Loading Tool, Version 1.0. Washington, DC: EPA.

Esworthy, Robert, David M. Bearden, Mary Tiemann, Claudia Copeland, James E. McCarthy, and Jane A. Leggett. 2012. Environmental Protection Agency (EPA): Appropriations for FY2013. Washington, DC: Congressional Research Service.

Liu, Cheol, and John L. Mikesell. 2014. The Impact of Public Officials' Corruption on the Size and Allocation of U.S. State Spending. Public Administration Review 74 (3): 346–58.

Appendix: A Comparison of Subsidies

As noted above, the Construction Grants Program made large subsidies available to local water and sewer authorities. But the CWSRF also contained a subsidy program, inasmuch as those entities receiving loans could borrow the money at low interest rates over periods of 20 years or more. In this section, we consider how the subsidies implicit in the below-market loan rates compare with the subsidies in the Construction Grants Program.

To begin with, the subsidized loan programs are operated by the states, and one finds a great deal of variety among them, at least in the methods used to calculate the rate. *Florida* has a rate formula based on the current market interest rate, an affordability index based on community income, and community population. For example, in 2014, when the risk-free market rate was 4.23%, the average rate across communities was 2.53% for DWSRF loans and 1.82% for CWSRF. *Indiana's* rate starts at 90% of the 20-year AAA-rated municipal bond rate and is adjusted for median household income in the community and average usage rates. *Massachusetts* kept the rate for SRF loans at 0% until 2006, and afterward raised the rate to 2%. *Maryland* has a standard rate of 1.9% plus an administrative fee, as well as a separate rate for disadvantaged communities of 0.9%. *Texas* sets its base rate at 1.55% below the market rate and forgives 30–70% in disadvantaged communities (designation is based on median income and household cost of service).

Now we use a simple model to compare the level of the subsidies in the two programs, who pays and how much, and whether the apparent perverse incentive for local governments to overcapitalize is remedied by the SRF. We use the following notation:

K Capital cost, $ for a wastewater treatment plant

A Annualized capital cost, $/year

M O&M cost, $/year

r Municipal market interest rate

T Loan duration, years

For a given loan, we can express the cost shares for the federal government and the local community as follows:

Federal share: $0.75\ K$ (in dollars)or $0.75\ A$ (in dollars/year)

Local share:$0.25\ K + M$ (in dollars) or $0.25\ A + M$ (in dollars/year)

Recall also that $K = A\frac{(1-e^{-rT})}{r}$

We also have one stylized fact about the typical federal and local shares—namely, that the local share is 45% of the total, so that

$$0.75\,A = 0.55(A + M)$$

i.e., $A = 2.75\,M$. Annually, the local and federal shares are therefore $0.614\,A$ and $0.75\,A$, and the total annualized cost is $1.364\,A$.

Now we compute the cost shares for the same project made under the SRF. We assume a market interest rate r of 4% and a below-market interest rate r' for SRF loans of 2%, values that are within the range for the five state loan policies described above.

We have three players: the feds, the state government, and the local sewer authority. Again, let us say that the total annualized investment cost over the life of the loan is A, and the total O&M cost is M. We denote their annualized cost shares of the federal, state, and local governments by $A_F, A_S,$ and A_L respectively. Because the locals are responsible for O&M, the corresponding annualized cost shares are A_F, A_S, and $A_L + M$. We also know that $A_S = 0.2A_F$, because of the 20% match required of the states. Therefore, the federal plus state contributions are the total annualized costs less the local annualized cost, which is amortized at the below-market interest rate. Thus,

$$A_F + A_S = A - A_L = \frac{rK}{1-e^{-rT}} - \frac{r'K}{1-e^{-r'T}} = 0.0126\,K = 0.173\,A.$$

With the state cost share set at 20% of the federal share, we find the state cost share to be 0.028 A and the federal share to be 0.144 A, expressed as a fraction of the annualized capital cost. Since total cost is 1.364 A, we obtain the state, federal, and local shares to be 2%, 10.5%, and 87.5%, respectively. Compared with the local share of approximately 45% under the Construction Grants Program, it is easy to understand the scramble for federal earmarks in the years between 2000 and 2010.

Tables

Table 1. Median Change in Pollutant Concentrations, 2007–2014 (percent)

		Treatment group	Control group
Iowa	**BOD5**	–16	0
	TSS	–12	5
	Organic N	–63	–33
Indiana	**BOD5**	–2	17
	TSS	–14	16
	Organic N	–37	7
Maryland	**BOD5**	no data	no data
	TSS	–44	–9
	Organic N	20	52
Texas	**BOD5**	–13	–3
	TSS	–5	–3
	Organic N	–52	–9

**Table 2. Water Infrastructure
Annual Loans and Grants
(in millions of dollars except where indicated otherwise)**

Year	CWSRF (loans)	DWSRF (loans)	Special Purpose Grants		CWSRF portion
			Total $	Number	
1994	1,218	599	160	9	61.6%
1995	1,235	700	1,231	46	39.0%
1996	1,349	725	307	20	56.7%
1997	625	1,275	301	21	28.4%
1998	1,350	725	393	42	54.7%
1999	1,350	775	382	82	53.8%
2000	1,350	820	412	143	52.3%
2001	1,350	825	446	244	51.5%
2002	1,350	850	449	339	51.0%
2003	1,340	844	413	491	51.6%
2004	1,340	845	425	520	51.3%
2005	1,090	843	402	669	46.7%
2006	900	850	285	259	44.2%
2007	1,084	837	84	2	54.1%
2008	689	829	177	282	40.6%
2009	4,689	2,829	184		60.9%
2010	2,100	1,500	187	319	58.0%
2011	1,522	963	20		60.8%
2012	1,466	918	15		61.1%

Sources: Copeland 2008, 2012; various House and Senate reports

Table 3. CWSRF Loan Statistics in Four States: 2008–2012

	Iowa	Indiana	Maryland	Texas
Treatment group A: POTWs that reported needs and received loans				
Number of plants	77	45	39	33
Number of loans	97	50	61	58
Total loans (million $)	$399.1	$486.2	$463.3	$1,053.7
Treatment group B: POTWs that received loans without reporting needs				
Number of plants	35	12	2	19
Number of loans	39	14	2	23
Total loans (million $)	$68.8	$43.7	0.6	$222.0
Control group: POTWs that reported needs but did not receive loans				
Number of plants	153	85	72	476
Number of plants with usable data	115	84	69	439

Table 4. Needs and Loans for POTWs Reporting Needs

		Iowa	Indiana	Maryland	Texas
Number of loans		98	47	39	52
Total loan amount ($ millions)		$385.15	$463.83	$337.02	$1,053.4
Needs exceed loans	**Number**	37	16	31	25
	Total excess	$1,196.44	$101.51	$3,999.43	$1,525.07
	Avg. excess	$32.34	$6.34	$129.01	$61.00
Loans exceed needs	**Number**	61	31	8	26
	Total excess	$144.88	$275.79	$17.47	$170.63
	Avg. excess	$2.38	$8.90	$2.18	$6.56

Table 5. Average Plant Flow (mg/d)

	Treatment	Control
Iowa	20.6	1.1
Indiana	4.3	2.9
Maryland	4.8	5.0
Texas	3.7	3.5

Table 6. Indiana Pct. Change in Flow and BOD5 Variables: 2014 vs. 2007

	Flow	Pollutant		N
		Mass	Concentration	
Treatment Group				
Overall arithmetic mean	+56.6%	+20.3%	+27.3%	44
Plants with secondary treatment needs	+38.3%	−14.3%	−17.0%	19
Plants with advanced treatment needs	+13.7%	−10.1	−18.0%	6
Median	+0.2%	−11.7%	−20.0%	44
Control Group				
Overall arithmetic mean	+28.1%	+43.8%	+59.7%	84
Plants with secondary treatment needs	+54.8%	+39.6%	+15.9%	17
Plants with advanced treatment needs	+235%	+159%	+15.3%	4
Median	+0.1%	+12.6%	+17.5%	84

Table 7. Ratio Comparisons of Treatment and Control Groups: Iowa

Ratio type	BOD5	TSS	N
Overall arithmetic mean	0.764	3.231	0.256
Plants with secondary treatment needs	1.189	5.426	0.609
Plants with advanced treatment needs	0.734	0.886	0.226
Median	0.633	0.733	0.270
Flow-weighted means	0.902	2.188	0.558

Table 8. Ratio Comparisons of Treatment and Control Groups: Indiana

Ratio type	BOD5	TSS	N
Overall arithmetic mean	0.837	0.941	1.182
Plants with secondary treatment needs	0.614	0.592	3.512
Plants with advanced treatment needs	0.347	0.195	0.224
Median	0.785	0.806	0.613
Flow-weighted means	0.687	0.917	0.605

Table 9. Ratio Comparisons of Treatment and Control Groups: Maryland

Ratio type	BOD5	TSS	N
Overall arithmetic mean	no data	0.492	0.705
Plants with secondary treatment needs	no data	0.798	0.741
Plants with advanced treatment needs	no data	0.417	0.607
Median	no data	0.787	0.742
Flow-weighted means	no data	0.655	0.620

Table 10. Ratio Comparisons of Treatment and Control Groups: Texas

Ratio type	BOD5	TSS	N
Overall arithmetic mean	0.779	0.746	0.470
Plants with secondary treatment needs	0.743	0.792	0.463
Plants with advanced treatment needs	0.703	0.750	0.439
Median	0.900	0.989	0.555
Flow-weighted means	0.950	0.839	0.763

Table 11. Comparison of Iowa Effluent Excursions, Treatment Group vs. Control Group
Initial cutpoints

		BOD5 (80082)		TSS (530)		Nitrogen (610)	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size		64	113	63	115	14	36
Cutpoints		15	15	15	15	5	5
Excursions in 2007	**n**	8	10	22	35	1	1
	%	12.5%	8.8%	34.9%	30.4%	7.1%	2.8%
Excursions in 2014	**n**	6	13	15	32	0	0
	%	9.4%%	11.5%	23.8%	27.8%	0.0%	0.0%
Alternate cutpoints							
		BOD5 (80082)		**TSS (530)**		**Nitrogen (610)**	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size		64	113	63	115	14	36
Cutpoints		5	5	5	5	1	1
Excursions in 2007	**n**	8	47	29	56	2	3
	%	12.5%	41.6%	46.0%	48.7%	14.3%	8.3%
Excursions in 2014	**n**	6	45	21	52	0	2
	%	9.4%	39.8%	33.3%	45.2%	0.0%	5.6%

Table 12. Comparison of Indiana Effluent Excursions,
Treatment Group vs. Control Group
Initial cutpoints

		BOD5 (80082)		TSS (530)		Nitrogen (610)	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size		44	84	44	84	42	83
Cutpoints		15	15	15	15	5	5
Excursions in 2007	**n**	4	5	8	14	3	8
	%	9.1%	6.0%	18.2%	16.7%	7.1%	9.6%
Excursions in 2014	**n**	1	8	5	20	0	4
	%	2.3%	9.5%	11.4%	23.8%	0.0%	4.8%
Alternate cutpoints							
		BOD5 (80082)		**TSS (530)**		**Nitrogen (610)**	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size		44	84	44	84	42	83
Cutpoints		5	5	5	5	1	1
Excursions in 2007	**n**	4	24	33	65	11	23
	%	9.1%	28.6%	75.0%	77.4%	26.2%	27.7%
New excursions in 2014	**n**	1	28	28	66	4	24
	%	2.3%	33.3%	63.7%	78.8%	9.5%	28.9%

Table 13. Comparison of Maryland Effluent Excursions, Treatment Group vs. Control Group
Initial cutpoints

		BOD5 (80082)		TSS (530)		Nitrogen (610)	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size				38	69	31	47
Cutpoints				15	15	5	5
Excursions in 2007	**n**			7	13	4	7
	%			18.4%	18.8%	12.9%	14.9%
Excursions in 2014	**n**			8	11	6	11
	%			21.0%	15.9%	19.3%	23.4%

Alternate cutpoints

		BOD5 (80082)		TSS (530)		Nitrogen (610)	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size				38	69	31	47
Cutpoints				5	5	1	1
Excursions in 2007	**n**			19	40	12	19
	%			50.0%	58.0%	38.7%	40.4%
Excursions in 2014	**n**			11	38	11	22
	%			29.0%	55.1%	35.3%	46.8%

Table 14. Comparison of Texas Effluent Excursions, Treatment Group vs. Control Group, Conventional
Initial cutpoints

		BOD5 (80082)		TSS (530)		Nitrogen (610)	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size		15	170	17	257	15	178
Cutpoints		15	15	15	15	5	5
Excursions in 2007	**n**	0	3	0	36	2	5
	%	0.0%	1.8%	0.0%	14.0%	13.3%	2.8%
Excursions in 2014	**n**	1	3	1	34	0	6
	%	6.7%	1.8%	5.9%	13.2%	0.0%	3.4%
Alternate cutpoints							
		BOD5 (80082)		TSS (530)		Nitrogen (610)	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size		15	170	17	257	15	178
Cutpoints		5	5	5	5	1	1
Excursions in 2007	**n**	0	19	6	135	5	54
	%	0.0%	11.2%	35.3%	52.5%	33.3%	30.3%
Excursions in 2014	**n**	1	25	6	129	1	41
	%	6.7%	14.7%	35.3%	50.2%	6.7%	23.0%

Table 15. Comparison of Texas Effluent Excursions, Treatment Group vs. Control Group, Decentralized Initial cutpoints

		BOD5 (80082)		TSS (530)		Nitrogen (610)	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size		18	102	19	182	18	106
Cutpoints		15	15	15	15	5	5
Excursions in 2007	**n**	1	7	2	52	1	6
	%	5.6%	6.9%	10.5%	28.6%	5.6%	5.7%
Excursions in 2014	**n**	0	5	0	42	0	7
	%	0.0%	4.9%	0.0%	23.1%	0.0%	6.6%
Alternate cutpoints							
		BOD5 (80082)		**TSS (530)**		**Nitrogen (610)**	
		trmt	ctrl	trmt	ctrl	trmt	ctrl
Sample size		18	102	19	182	18	106
Cutpoints		5	5	5	5	1	1
Excursions in 2007	**n**	1	23	9	115	5	28
	%	5.6%	22.5%	47.4%	63.2%	27.8%	26.4%
New excursions in 2014	**n**	0	24	8	98	3	33
	%	0.0%	23.5%	42.1%	53.8%	16.7%	31.1%