Appendix A

ORGANIZATIONS REPRESENTED AT THE PAWN FINAL BRIEFING

The following organizations, agencies, and industries were represented at the PAWN final briefing:

The drinking-water companies of Amsterdam, Rotterdam, the Hague, Groningen, Friesland, Overijssel, East Gelderland, North Holland, East Brabant, Southwest Netherlands, Limburg, and the Brabantse Biesbosch.

All the provinciale Waterstaatsdiensten (water control agencies).

The waterboards of Rijnland, Delfland, Uitwaterende Sluizen in Kennermerland en West Friesland, Salland, West-Brabant, de Aa, de Dommel, Bangerbeek bezuiden de Vecht, Walcheren, West Friesland, and Waterland Nederweert.

The Union of Waterboards (Unie van Waterschappen).

The Union of Drinking-Water Companies in the Netherlands (Vereniging van Exploitanten van Waterleidingbedrijven in Nederland).

The Department of Public Works of the Municipality of Amsterdam.

The Government Service for Planology (Rijksplanologische Dienst).

Various Directorates and Services of the Rijkswaterstaat (government department for water control and public works).

The Ministries of Public Health and Environment; Culture, Recreation, and Social Work; Defense; Finance; and Economic Affairs.

The Universities of Delft, Wageningen, and Twenthe.

Various branches of the Ministry of Agriculture and Fisheries (Ministerie van Landbouw en Visserij), including the Institute for Cultivation and Water Management (Instituut voor Cultuurtechniek en Waterhuishouding), Department of Forestry (Staatsbosbeheer), Agricultural Economics Institute (Landbouw Economisch Instituut), and the various experimental stations (Proefstations).

Delft Hydraulics Laboratory.

The International Institute for Applied Systems Analysis

The Netherlands Economic Bureau for Road and Water Transport (Economisch Bureau voor het Weg- en Watervervoer).

The Netherlands Institute of Transport (Nederlands Vervoerswetenschappelijk Instituut).

Some industries: Foundation Europoort/Botlek, Akzo, Enka, DSM.

The Foundation for Nature and the Environment (Stichting Natuur en Milieu).

The Groundwater Survey Service of the Netherlands Organization for Applied Physical Research.

The Cooperative of Electric Power Producers (NV Samenwerkende Elektriciteits-Produktiebedrijven).

The Research Institute for the Electric Power Industry (NV Tot Keuring Van Elektrotechnische Materialen).

The Committee on Hydrological Investigation of the Netherlands Organization for Applied Physical Research.

The Rhine Committee for Drinking-Water Companies.

The Purification Waterboards of East Gelderland and Veluwe.

The State Institute for Nature Management (Rijksinstituut voor Natuurbeheer).

The State Institute for Drinking-Water Supply (Rijksinstituut voor Drinkwatervoorziening).

The Government Service for IJssel Lakes Polders (Rijksdienst voor de Ijsselmeer Polders).

Appendix B

ORGANIZATIONS INTERVIEWED BY PAWN

During problem formulation and analysis, PAWN interviewed representatives of the following organizations:

The Union of Environmental Defense (Vereniging voor Milieu Defensie).

The Union of Dutch Business Concerns (Vereniging van Nederlandse Ondernemingen).

The Shippers Bourse.

The Institute for Cultivation and Water Management (Instituut voor Cultuurtechniek en Waterhuishouding).

The Central Bureau of Statistics (Centraal Bureau voor de Statistiek).

The Central Planning Bureau (Centraal Plan Bureau).

The State Institute for Drinking Water Supply (Rijksinstituut voor Drinkwatervoorziening).

The State Institute for Nature Management (Rijksinstituut voor Natuurbeheer).

The Agricultural Economics Institute (Landbouw Economisch Instituut).

The Institute for Testing of Water Supply Appliances (Keuringsinstituut v. Waterleiding artikelen, KIWA).

Various drinking-water companies.

The Union of Drinking-Water Companies in the Netherlands (Vereniging van Exploitanten van Waterleidingbedrijven in Nederland).

The Directorate for Transport (Directoraat-Generaal voor Verkeer).

Experimental stations for cattle, horticulture, agriculture, flowers, potplants, and trees.

Industries: the Netherlands Blast Furnace Company (Hoogovens) and Akzo.

The Committee on Groundwater Withdrawals of Drinking-Water Companies (Commissie Grondwateronttrekkingen Waterleidingbedrijven).

The Union of Waterboards (Unie van Waterschappen).

Various waterboards.

The Foundation for Nature and the Environment (Stichting Natuur en Milieu).

The Research Institute for the Electric Power Industry (NV Tot Keuring Van Elektrotechnische Materialen).

The Cooperative of Electric Power Producers (NV Samenwerkende Elektriciteits-Produktiebedrijven).

In addition to the above organizations, we interviewed many members of the various parts of the Rijkswaterstaat. Through interactions with the ICWA working group on water management, we also received considerable exposure to the concerns of various government ministries and agencies affected by water management. We also obtained advice and assistance from the hundreds of documents we read, many of which were published by organizations we did not interview.

Appendix C

TACTICS AFFECTING THE NATIONAL AND REGIONAL DISTRIBUTION SYSTEMS

The tables in this appendix list, for each region, all of the non-waterboard plan tactics examined in the screening of technical and managerial tactics, together with the capacities that we considered and the annualized fixed cost of the tactic for these capacities. All costs are given in 1976 guilders and are exclusive of the value-added tax. Detailed descriptions of the tactics are given in Vol. II. The derivation of their costs is documented in Vol. XVI.

Table C.1

NORTH

Description	Capacity (m^3/s)	Annual Fixed Cost (Dflm)
Expand throughput capacity of Van Starkenborghkanaal	25.0	0.60
Drainage pipeline from Noordoost-polder to Flevoland	15.0	4.20

Table C.2

NORTHEAST HIGHLANDS

Description	Increase in Capacity (m^3/s)	Annual Fixed Cost (Dflm)
Route 1: Twenthekanaal	10.0	1.46
	15.0	2.05
Route 2: Hoogeveensche Vaart	10.0	3.17
	15.0	4.36
Route 3: Van Starkenborghkanaal	10.0	3.57
	15.0	5.06
Route 4: Drentsche Hoofdvaart	10.0	4.74
	15.0	6.53
Route 5: Overijsselsche Vecht	10.0	4.66
	15.0	6.73

Table C.3

NORTH HOLLAND

Description	Capacity (m^3/s)	Annual Fixed Cost (Dflm)
Redirect Wieringermeerpolder discharges	(a)	1.38

(a) Not applicable.

Table C.4

MIDWEST AND UTRECHT

Description	Capacity (m^3/s)	Annual Fixed Cost (Dflm)
Lopikerwaardkanaal	20.0(a)	2.29
Lopikerwaardkanaal plus Leidsche Rijn	30.0(a)	3.93
Krimpenerwaardkanaal	40.0(a)	5.68
Maarssen-Bodegravenkanaal	40.0(a)	12.79
Close Spui: dam & ship lock (permanent)	(b)	2.03
Close Oude Maas: caissons (temporary)	(b)	19.60
Close Nieuwe Maas: caissons (temporary)	(b)	26.30
Groin in Nieuwe Waterweg	(b)	0.70
Bubble screen in Nieuwe Waterweg	(b)	1.24
Pipeline from Maas to Delfland (3 pipes)	8.0	37.90(c)
Pipeline from Maas to Delfland (1 pipe)	8.0	29.50(c)
Leidschendam: pumping	20.0	0.72
Waddinxveen-Voorburgkanaal	15.0	12.75

(a) Throughput capacity to Rijnland.
(b) Not applicable.
(c) Includes expected annual pumping cost.

Table C.5

WEST BRABANT AND SOUTHERN DELTA

Description	Capacity (m^3/s)	Annual Fixed Cost (Dflm)
Create fresh Grevelingen	(a)	0.69(b)
St. Andries: bypass	17.0	0.66

(a) Not applicable.
(b) Includes 0.30 Dflm for implementation of a waterboard plan to permit fresh water in Grevelingen to be used by farmers.

Table C.6

SOUTHEAST HIGHLANDS

Description	Shipping Improvement Scenario	Increase in Capacity (m^3/s)	Annual Fixed Cost (Dflm)
Tactics to Expand the Supply Capacity to the Region			
Dominated tactics(a)			
Expand Zuid-Willemsvaart (DenBosch-Helmond)	min	5.0	9.48
	max	5.0	4.99
Pipeline from Maasbracht to Panheel		4.2	2.50
Pump Waal water from St. Andries to Panheel		10.0	6.81
Tactic 1	min	5.0	0.24
	max	5.0	0.22
Expand Zuid-Willemsvaart (Lozen-Nederweert)			
Expand syphon to Noordervaart			
Tactic 2	min	5.0	4.09
	max	5.0	3.56
Pump Roer water to Panheel			
Increase throughput at Panheel			
Build pumping station at Noordervaart			
Tactic 3	min	5.0	2.96
	max	5.0	2.43
Increase throughput at Panheel			
Build pumping station at Noordervaart			
Tactic 4	min	15.0	2.25
	max	15.0	1.57
Expand Zuid-Willemsvaart (Lozen-Nederweert)			
Expand syphon to Noordervaart			
Increase throughput at Panheel			
Tactic 5	min	15.0	7.30
	max	15.0	5.42
Expand Zuid-Willemsvaart (Lozen-Nederweert)			
Expand syphon to Noordervaart			
Increase throughput at Panheel			
Install pumping on Wilhelminakanaal			

Table C.6 (continued)

Description	Shipping Improvement Scenario	Increase in Capacity (m^3/s)	Annual Fixed Cost (Dflm)
Tactic 6	min	15.0	4.92
	max	15.0	4.12
Pump Roer water to Panheel			
Increase throughput at Panheel			
Build pumping station at Noordervaart			
Tactic 7	min	15.0	5.76
	max	15.0	4.36
Install pumping on Wilhelminakanaal			
Tactics to Reduce Shipping Losses on the Julianakanaal			
Use portable pumps at Maasbracht		5.0	0.13(b)
Use portable pumps at Maasbracht		10.0	0.39(b)
Build pumping station at Maasbracht		5.0	0.81
Build pumping station at Maasbracht		10.0	1.07

(a) These tactics were screened out by dominance before the detailed cost/benefit analysis.

(b) In addition to this annualized fixed cost, both setup cost and operating cost were used in the screening analysis.

Table C.7

NATIONAL

Description	Capacity (m^3/s)	Annual Fixed Cost (Dflm)
IJmeer		
Raise Flevoland dike	(a)	5.32
Flevoland dike and discharges to IJsselmeer	35.0	8.34
Flevoland dike and pipeline to Noordzeekanaal	51.5	46.02
Short 2d Oostvaardersdijk	(a)	18.77
Drainage channel to Amsterdam; full separation	85.0	31.41
Drainage channel to Amsterdam; full separation; and syphon under channel	100.0	38.04
Drainage channel to Amsterdam; open connection	85.0	35.97
Long 2d Oostvaardersdijk; syphon and freshwater channel to Diemen	100.0	26.42
IJsselmeer and Markermeer		
Raise summer target level of lakes	-0.15(b)	0.47
	0.10(b)	3.41
Decrease minimum level of lakes	-0.45(b)	2.54(c)
	-0.50(b)	3.65(c)
Construct "wet Markerwaard"	33.0(d)	32.70
North-South Connection		
Alternative 1 (Tiel-Vreeswijk)	30.0	12.88
	100.0	23.93
Alternative 2 (Gorinchem-Vreeswijk)	30.0	11.81
	100.0	51.76
Alternative 3 (Tiel-Maas)	100.0	37.9
Bring Waal Water to Lek		
Dredging in Waal below Tiel	(a)	(e)
Modify groins in Waal around Tiel	(a)	1.16
Narrow Waal around Tiel	(a)	2.30
Merwedekanaal, Betuwe section	40.0(e)	0.92

Table C.7 (continued)

Description	Capacity (m^3/s)	Annual Fixed Cost (Dflm)
IJssel Canalization		
Canalize IJssel River	(a)	60.20

(a) Not applicable.

(b) Lake level, in meters relative to NAP.

(c) This cost excludes the cost of building pumping stations at the inlets to the Friesland boezem. Our analysis indicated that new pumping stations were not needed to supply the required water to Friesland for any of the demand scenarios.

(d) Capacity of pumping station between Markerwaard and IJsselmeer.

(e) There is only a variable cost associated with this tactic.

Appendix D

TABLE DEFINING IMPACT ASSESSMENT CASES

Table D.1

IMPACT ASSESSMENT CASES

Case Name			Mana-gerial	Water-board	MAX-	Surface Water	Groundwater				Pollutants	
Ext. Supply											Rijn Salt	
DEX	1943	1967	Strat.	Plans	TACS	Sprink.	Sprink.	Quota	Priority	Charge	Load	Other
A1	A2	A3	RWS	No	No	Low	Low	1.0	None	0	Ref	Ref
B1	B2	B3	MSDM	No	No	Low	Low	1.0	None	0	Ref	Ref
C1	C2	--	MSDM	Yes	No	Med	Low	1.0	None	0	Ref	Ref
D1	D2	--	MSDM	Yes	Yes	Med	Low	1.0	None	0	Ref	Ref
E1	E2	--	MSDM	Yes	Yes	Med	Med	1.0	I/D	0	Ref	Ref
F1	F2	F3	MSDM	Yes	Yes	High	High	1.0	I/D	0	Ref	Ref
G1	G2	G3	MSDM	Yes	Yes	High	Low	0.25	AGR	0	Ref	Ref
H1	H2	--	RWS	Yes	Yes	High	High	1.0	I/D	0	Ref	Ref
J1	J2	--	VEL	No	No	Low	Low	1.0	None	0	Ref	Ref
K1	K2	--	VEL	Yes	Yes	High	High	1.0	I/D	0	Ref	Ref
L1	--	--	MSDM	Yes	Yes	High	High	1.0	I/D	0.20	Ref	Ref
M1	--	--	MSDM	Yes	Yes	High	High	1.0	AGR	0.20	Ref	Ref
N1	--	--	MSDM	Yes	No	Low	Low	1.0	None	0	Ref	Ref
P1	P2	--	MSDM	Yes	Yes	High	High	1.0	AGR	0	Ref	Ref
Q1	--	--	MSDM	Yes	Yes	High	High	1.5	I/D	0	Ref	Ref
R1	R2	R3	MSDM	No	No	Low	Low	1.0	None	0	High	Ref
S1	S2	S3	MSDM	Yes	Yes	High	High	1.0	I/D	0	High	Ref
T1	--	T3	MSDM	Yes	Yes	High	High	1.0	I/D	0	Ref	Low

NOTES: Groundwater charge is in Dfl/m3. I/D indicates priority to industry and drinking-water companies. AGR indicates priority to agriculture.

Table D.2

IMPACT ASSESSMENT CASES USED FOR VARIOUS COMPARISONS

	Case																	
Type of Comparison	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T
Base Case	X																	
Primary cases	X		X	X	X	X	X											
Effect of different management strategies	X	X				X		X	X	X								
Effect of increasing surface water sprinkling		X	X	X			X						X					
Effect of increasing groundwater sprinkling		X			X	X					X			X	X			
Effect of groundwater quota, priority, and charges						X	X				X	X		X	X			
Effect of increasing Rijn salt load	X	X				X										X	X	
Effect of decreasing Rijn BOD load	X					X												X

Appendix E

THE TOTAL ECONOMIC IMPACTS OF MAJOR INFRASTRUCTURE INVESTMENTS

E.1. THE INVESTMENT EXPENDITURES

The direct investment costs for the major PAWN tactics were estimated by the PAWN team. Table E.1 summarizes those costs from Vol. XVI. It also shows the PAWN team's estimates of the number of years each project would require for completion.

Table E.1

INVESTMENT EXPENDITURES AND PERIOD OF CONSTRUCTION FOR MAJOR PAWN PROJECTS

Project	Total Investment (Dflm)	Construction Period (yr)
Van Starkenborghkanaal	5.73	3
Twenthekanaal	38.32	3
Maas-Delfland pipeline	347.16	5
Groin in Nieuwe Waterweg	7.00	1
Inlet in Grevelingendam	3.75	5
Pumping to Southeast Highlands	79.57	3
Minimum IJsselmeer level	34.21	3
Total cost	515.74	
Cost with value-added tax	608.57	

SOURCE: Appendix B of Vol. XVI.

NOTES: Twenthekanaal includes the Almelo lock, Stieltjeskanaal, Oranjekanaal West and East, and Verlengde Hoogeveensche Vaart. Pumping to the Southeast Highlands includes Zuid-Willemsvaart (Lozen-Nederweert), syphon to Noordervaart, upstream Noordervaart, upstream Wessem-Nederweert, and the upstream Wilhelminakanaal.

Three of the projects are relatively inexpensive; three others would cost between 30 and 80 Dflm; and one, the Maas-Delfland pipeline, which would insure an adequate supply of pure water to the glasshouse areas north of Rotterdam, is quite expensive. That one project alone would cost nearly 350 Dflm. An investment of this size, even spread over a five-year period, could easily stress the local labor market and perhaps cause problems for suppliers of certain specialized materials.

We consulted with experts from several branches of the RWS in estimating both the length of the construction period for each major project and the pattern of expenditures over that period. Usually they agreed that one particular year, typically near the middle of the period, would involve the highest level of expenditures. Their estimates of the peak-year expenditures are shown in Table E.2, disaggregated by construction subsector. (Expenditures that did not fit one of the new subsectors were considered to be "regular construction" and hence belong to the construction sector contained in the I-O model.)

Table E.2

ESTIMATED DISTRIBUTION OF PEAK-YEAR EXPENDITURES
(In Dflm)

	Construction Subsector			
Project	Regular Constr.	Wetwork	Locks	Pumping Station
Van Starkenborghkanaal		1.9		1.0
Twenthekanaal			6.4	12.8
Maas-Delfland pipeline	69.4			17.4
Groin in Nieuwe Waterweg		7.0		
Inlet in Grevelingendam		0.3	0.4	0.3
Pumping to Southeast Highlands				39.8
Minimum IJsselmeer level		17.1		
Total	69.4	26.3	6.8	71.3

SOURCES: Table E.1 and discussions with RWS personnel.

In this table we show the individual items and then we have summed the columns to obtain total peak-year expenditures for each of the four types of construction. Those totals need to be examined rather carefully. Note that the individual entries in the table refer to the peak expenditure for each particular project. Now, even if work on all of the projects were begun at the same time, the expenditure stream for each project would not necessarily peak in the same year. So when we sum the entries we create an upper-bound estimate for peak-year expenditures by construction subsector. We will use this upper-bound estimate until we determine the magnitude of the total investment impacts. If the result is estimates that are large enough to be at all significant, then we will test the sensitivity of those findings to a lower, more realistic, estimate.

E.2. IMPACTS ON THE PRIVATE ECONOMY

To estimate the total impacts of peak-year construction activity for the major PAWN investment options on the industrial sector of the Dutch economy, we must assume that the structure of that economy did not

Change between 1975 and 1976. We can then combine the 1976 cost estimates for each construction subsector with the 1975 industry multipliers from Sec. 18.2. The resulting output estimates are then also in 1976 guilders.

As Table E.3 shows, none of the projects evaluated here has impacts large enough to stress the Dutch economy at all, although, of course, some local shortages may occur. Even if all of the projects were implemented at the same time, and they all incurred peak expenditures in the same year, they would increase national production by less than 0.1 percent in that year. Imports and employment would be affected even less.

Table E.3

PEAK-YEAR ECONOMIC IMPACTS OF MAJOR PAWN INVESTMENTS

	Estimate of Change in			
Project	Total Production (Dflm)	Imports (Dflm)	Wages (Dflm)	Workers (1000)
Van Starkenborghkanaal	5.0	0.9	1.0	0.05
Twenthekanaal	36.4	6.1	7.7	0.33
Maas-Delfland pipeline	140.5	24.3	37.5	1.61
Groin in Nieuwe Waterweg	11.4	2.2	2.4	0.11
Inlet in Grevelingendam	1.8	0.3	0.4	0.02
Pumping to SE Highlands	76.8	12.7	15.9	0.68
Minimum IJsselmeer level	27.9	5.3	5.8	0.26
Total project-induced	299.8	51.8	70.7	3.04
Total Dutch for 1976	341,721	102,101	98,460	4,646
Project-caused change as percent increment to total	0.09	0.05	0.07	0.07

SOURCES: Computations on the estimates in Tables 18.1 and E.2. 1976 totals are from the Statistical Yearbook of the Netherlands 1978, Netherlands Central Bureau of Statistics, The Hague, Staatsuitgeverij, 1979.

The Maas-Delfland pipeline, of course, produces the most substantial impacts; it is responsible for nearly half of the total effects we have computed. We estimate that it would employ over 1600 workers in its peak (third) year of construction. This project could, therefore, introduce some stresses on the economies, especially the construction and construction-supply sectors, of the regions where it would be located. It would probably draw workers and supplies from throughout the Netherlands, however, and in relation to the national economy, its impacts are small enough to be handled with little distortion of the prevailing wages and prices.

Although these estimates are based on peak-year investment totals, which we know overestimate any realistic value for the expenditures, they indicate that the short-run impacts on the private economy would be small enough that sensitivity testing is not required. Using lower, more realistic, values for the peak-year expenditures would simply make the already-small estimates even smaller.

E.3. EFFECTS ON THE GOVERNMENT

The final short-term effect of investments in the major PAWN water management projects that we investigate is the change in the budget of the government of the Netherlands during the year of peak expenditures.

The government spends money to finance the construction of the projects. But it also receives some of that money back. A value-added tax is charged on all items produced in the Netherlands, including those purchased by the government. Wages and business profits are also taxed, and at rather high rates. We estimate the net financial impact on the government by subtracting the estimated receipts from these three types of taxes from the actual investment expenditures. (See Table E.4.)

Table E.4

CHANGES IN THE BUDGET OF THE GOVERNMENT
DURING THE PEAK YEAR OF CONSTRUCTION
(In Dflm)

Project	Investment	Value-Added Tax	Wage Tax	Income Tax	Net Impact
Van Starkenborgh	-3.39	0.52	0.19	0.10	-2.58
Twenthekanaal	-22.61	3.45	1.48	0.55	-17.13
Maas-Delfland	-102.41	15.62	7.20	2.88	-76.71
Nieuwe Waterweg	-8.26	1.26	0.46	0.27	-6.27
Grevelingendam	-1.11	0.17	0.08	0.03	-0.83
SE Highlands	-46.95	7.16	3.05	1.13	-35.61
IJsselmeer	-20.19	3.08	1.11	0.64	-15.36
Total	-204.92	31.26	13.57	5.60	-154.49

SOURCES: Computations on figures from Tables E.2 and E.3 and additional output from computer runs at DHL.

The value-added tax rate is 18 percent for most industrial goods. We estimate receipts from the value-added tax by applying that rate to the direct investment expenditures. Since this is a "value-added" tax, it does not apply to intermediate products. Its receipts can most easily be computed by applying the rate to the final value of the project.

Applying the tax to the total (direct plus induced) change in production would be double-counting and would overstate receipts by a factor equal to the (relevant combination of the) multipliers.

The national wage tax for the Netherlands averages just over 19 percent of total wage and salary payments. And estimates of the marginal changes in those payments are output by the I-O model. So it is easy to estimate the governmental receipts from the wage tax that are induced by the new (peak-year) investments. The I-O model estimates that wage and salary payments will amount to about 40 percent of the value of the total investment expenditures (before the value-added tax). Therefore, we estimate that receipts from the wage and salary tax will amount to about 7 percent of the investment expenditures.

Our I-O model also shows the increases in "other income" induced by the projects. We take this category to include business profits as well as several other small items. The national average tax rate on this income has been averaging just over 29 percent, and our I-O model indicates that changes in other income would be about 11 percent of the total investment expenditures. So we estimate that governmental receipts from this tax would be about 3 percent of the total amount invested.

Therefore, the peak-year cost of all of the projects taken together would be 173.66 Dflm plus 31.26 Dflm for value-added tax. The government would receive back, from the three tax sources discussed here, a total of 50.43 Dflm, or about 25 percent of its total expenditure. The net cost to the government would thus be about 155 Dflm.

Finally, we must remember that these estimates represent the true marginal impacts of the selected investments only if the only alternative available to the government is truly to do nothing. If the government, however, is considering these investments as options to other projects, whether those options are in the water management field or in defense or foreign aid, the marginal impacts of our projects must be computed as the difference between the estimates shown above and the impacts that would have been displaced. Correspondingly, if the option is to reduce taxes, and the resulting increased income for households and firms would lead to increased spending by those units, the marginal impact of the PAWN projects should be estimated as the difference in the two sets of estimates. Thus, the true marginal effects of our projects, judged against the actual alternatives, could well be zero, or even of opposite sign.

E.4. SUMMARY

In summary, we find that construction of all of the major PAWN projects concurrently would produce slight dislocations in a few industries or in small regions of the Netherlands, but the overall net impact would be small enough that it could safely be ignored in economic decision-making.

Appendix F

THE ULTIMATE MONETARY EFFECT ON HOUSEHOLDS

Water management policies have immediate positive and negative impacts on many sectors of the economy. The PAWN project estimates benefits and costs arising to agriculture, drinking-water (DW) companies, industry, shipping, and electricity-generating plants. Details on those estimates are described in other sections of this report. Here we describe the ultimate effects on the budgets of individual Dutch households.

Only monetary benefits and costs can be analyzed in this manner. Short-run, transitory impacts are identified only if they contribute to our understanding of the magnitude and location of the ultimate, long-run effects. We look only at average results (the impacts in the 1943 external supply scenario), because these are the most meaningful index of ultimate effects. However, the methodology presented is, of course, applicable to other situations.

F.1. THE NUMERICAL ESTIMATES

In estimating the household budget effects we consider income, expenditure, and tax impacts--all relative to the base case (case A). The procedures we used in deriving those effects were discussed in Chap. 19. Table F.1 presents our results when we average farm and nonfarm households together. Estimates are shown for the typical Dutch household with an average level of after-tax income (27,483 Dfl in 1976) and for a typical lower-income household (20,255 Dfl).

We estimate that the combination of all effects would be equivalent to a net increase of about 25 to 40 Dfl/yr in the income of the typical average-income household for cases C, D, E, and G; and an increase of about 70 Dfl/yr in the income of the average household in case F, the intensive sprinkling case. None of these effects would represent changes of more than one-quarter of one percent of the household's budget. For a low-income household the monetary benefits would be only slightly lower. That is, all cases would provide small benefits over the base case for both the typical average-income household and the typical low-income household.

These findings almost certainly overestimate the household effects. We compare cost increases for a future situation that assumes major increases in agricultural and industrial production with 1976 household incomes and expenditures; and, in certain cases, we assume a completely inflexible response on the part of the households and business firms. The resulting impacts, which we estimate to be only small fractions of the household budgets, should in fact be interpreted as upper bounds for the likely range of the true impacts.

Table F.1

TOTAL EFFECTS OF PAWN POLICIES ON THE BUDGETS OF AVERAGE- AND LOW-INCOME DUTCH HOUSEHOLDS
(In Dflm/yr)

Item	Effects by Case, Relative to Case A				
	C	D	E	F	G
Average-Income Household					
Source of effect					
Price					
DW	0	0	0	0	-42
Other	0	1	1	2	-2
Income	19	23	28	44	39
Tax	19	6	10	26	48
Net household effect	38	30	39	72	43
Net household effect as percent of:					
Net income	0.14	0.11	0.14	0.26	0.16
Budget expenditure	0.14	0.11	0.14	0.26	0.16
Low-Income Household					
Source of effect					
Price					
DW	0	0	0	0	-41
Other	0	1	1	2	-1
Income	14	17	20	33	30
Tax	13	4	7	17	32
Net household effect	27	22	28	52	20
Net household effect as percent of:					
Net income	0.13	0.11	0.14	0.26	0.10
Budget expenditure	0.12	0.10	0.13	0.24	0.09

NOTES: A positive entry in the table is equivalent to an increase in the income of the household; a negative entry is equivalent to an increase in expenditures with the quantity of goods consumed being held constant. Estimates are for the average household, and include farm as well as nonfarm families. Net annual after-tax income was estimated to be 27,483 Dfl in 1976 for average-income households and 20,255 for a representative lower-income household.

Table F.2 contains our full range of impact estimates. In it we further differentiate between farm and nonfarm households, and between households in different pseudo-provinces. The upper portion of the table shows our estimates of the effects on a representative average-income household and on a representative low-income household of implementing PAWN cases C, D, E, F, and G, as compared to the base case A. In the lower portion of the table the estimates for the average-income household are disaggregated by province, further distinguishing between farm and nonfarm households.

In Table F.2 a positive entry indicates the number of extra guilders that the household would retain if it continued to consume the same market basket of goods as before the policies were implemented. A

Table F.2

SUMMARY OF TOTAL BUDGET EFFECTS OF PAWN WATER MANAGEMENT POLICIES ON DUTCH HOUSEHOLDS: NET BENEFITS BY INCOME LEVEL, REGION, AND URBANITY
(In Dflm/yr)

Pseudo-Province and Income Level	Effects by Case, Relative to Case A									
	C		D		E		F		G	
	Farm	Nonfarm	Farm	Nonfarm	Farm	Nonfarm	Farm	Nonfarm	Farm	Nonfarm
National Estimates for Farm and Nonfarm Households Combined										
Average income	38		30		39		72		43	
Low income	27		22		28		52		20	
Estimates by Pseudo-Province for Average-Income Households										
Groningen	143	19	131	7	151	11	292	28	238	-88
Friesland	377	19	365	7	432	11	806	28	666	-70
Drenthe	93	19	156	7	294	11	548	28	192	-105
Overijssel	166	19	147	7	164	11	236	28	148	-61
Gelderland	42	19	30	7	71	11	125	28	41	-2
Utrecht	76	19	64	7	68	11	123	28	88	-7
Noord-Holland	124	19	112	7	116	11	195	28	226	42
Zuid-Holland	34	19	201	7	205	11	247	28	283	38
Zeeland	19	19	22	7	26	11	43	28	46	31
Noord-Brabant	225	19	220	7	235	11	405	28	324	-35
Limburg	79	19	75	7	88	11	156	28	125	-3
Netherlands	127	19	142	7	171	11	284	28	237	2

SOURCE: Vol. X.

NOTES: Estimates are for the average effects (1943 external supply scenario). Detail may not add to totals due to rounding.

negative entry indicates the increase in expenditure necessary if the household desires to continue consuming that same bundle of goods.

Our analysis indicates that the PAWN cases, which represent, in a sense, the extremes of currently conceived water management policies, would have only small effects on most Dutch households: Net gains and losses are on the order of several hundred guilders a year, and often less. Monetary effects would be slightly larger for average-income households than for low-income households, but total effects would never be more than 0.3 percent of the households' annual expenditures for goods and services.

Our analysis also indicates that farm households would gain at the expense of nonfarm households. We estimate that the majority of the benefits would accrue to farmers, appearing initially as increases in their income. Farmers in Friesland, Drenthe, and Noord-Brabant can usually expect to receive at least several hundred guilders more in benefits than nonfarm families in the same pseudo-provinces.

Increases in farm income are by far the most important form of benefits in most of the cases studied. Only when groundwater (GW) extractions are restricted do other considerations significantly affect the final magnitude and distribution of benefits.

In case G, GW extractions are restricted to one-quarter of their reference level to help restore and preserve the natural environment; waterboard plans, MAXTACS, and other PAWN policies are implemented. Under these circumstances, aggregate monetary benefits are at their lowest levels. Nonfarm households in many regions of the country, even with average incomes, would be hurt by the restriction in GW withdrawals. The disaggregate analysis demonstrates that there would be very large differences in benefits among pseudo-provinces and between farm and nonfarm families. Some farm households, especially those in Friesland, Noord- and Zuid-Holland, and Noord-Brabant, would receive substantial benefits, mainly at the expense of the nonfarm households.

Note that in the first four cases benefits are always positive, although they differ greatly in magnitude, for all of the groups we have identified. If we could have isolated smaller groups, or perhaps if we could have been more accurate in describing the groups we do have, it is quite possible that we would have shown some groups to be worse off because of the policies. Since these policies appear to provide a wide range of positive benefits, however, it is quite probable that any losers who were identified could be adequately compensated.

Case G is quite different. We estimate that many groups would suffer significant losses in case G and that redistribution, even if it were costless, would be a major task.

F.2. THE SENSITIVITY OF THE FINDINGS

We tested the sensitivity of our estimates to a number of the more obvious uncertainties contained in the analyses and the input data. The major findings were that

- Using a grass multiplier of 1 reduced benefits for most households by over 60 percent, and some formerly small benefits for nonfarm families became negative.
- Using price (which may include charges) rather than quotas for (optimally) distributing GW among industrial firms causes many income transfers with the final outcome depending on the type of taxes the government chooses to adjust.
- Relaxing the assumption of marginal-cost-based pricing of DW reduces our estimated benefits for all the households we have identified, although it may increase benefits for some upper-income families.
- Taxing policies of the government have as important a role as its water management policies in determining the distribution of net benefits.

These findings clearly indicate that our quantitative estimates of household effects are quite sensitive. This means, of course, that our estimates are suspect, but, more important, it identifies the areas that are apparently crucial in determining the extent and the distribution of the benefits of water management policies.

F.3. THE CONCLUSIONS OF THE DISTRIBUTIONAL RESEARCH

The numerical estimates and sensitivity analyses reported above, and the findings of many tasks and separate investigations documented only in Vol. X or in informal PAWN reports, all contribute to the major conclusions of this portion of the study. Those conclusions are presented below.

First, total benefits exceeding total costs is not sufficient justification for implementing a water management policy. The recipients of the benefits (including foreign nations) and those paying the costs must be identified before the political/economic decisions can be intelligently addressed. Simply identifying sectors of the economy that are directly affected by the projects is seldom sufficient, because benefits are commonly passed from producers to consumers and, especially, to the government.

- Total benefits being greater than total costs does not insure that some groups are made worse off while others benefit more than average. When benefits are large enough, it is always potentially possible for the winners to compensate the losers. However, in many cases that is not practical, and difficult political choices are involved.

Second, a small country like the Netherlands that produces, consumes, and trades a large number of different products with neighboring nations has little control over the prices of those products and will retain most of the benefits (and costs) of water management policies implemented within its borders.

- Shipping benefits are an obvious exception. Projects that lower shipping costs cause a considerable portion of benefits to accrue to foreign as well as Dutch shippers, carriers, and consumers of shipped products.

Third, domestic price effects are also trivial for most internationally traded products and for products whose prices are controlled or supported by governmental agencies. Policies affecting the supply of those products will have little impact on household budgets.

Fourth, policies affecting the costs of monopolistically operated enterprises, such as publicly owned electricity plants and DW companies, can have major impacts on prices and thus on the expenditures of households. Their products are necessities consumed by nearly all families, and cost-plus pricing policies ensure that all benefits and costs are transferred to the consumers.

Fifth, benefits will exceed costs for most of the seriously considered policies, but they will normally be of the same order of magnitude. Hence, to discern real differences among policies and make wise selections, tracing the distribution of costs is as important as tracing the benefits. Governmental financing arrangements are usually flexible enough, and obscure enough, that the costs of particular policies can be transferred to any of a large number of social and economic groups.

Sixth, the primary PAWN water management policies would benefit mainly farm households, and those mainly in Friesland, Drenthe, and Noord-Brabant. The average-income farm household in those pseudo-provinces would benefit by about 200 Dfl/yr in most cases; benefits accruing to most other farm households would be perhaps half that size. Benefits, if any, to most nonfarm households would be trivial, perhaps negative.

- Low-income households would probably be affected slightly less in absolute terms than average-income households; but expressed as a percentage of household income, the impacts would be nearly identical.

- Limitations on GW extractions may benefit the environment or future generations, but they lower current monetary benefits. Severe restrictions can cause net benefits for most groups except farmers to become negative.

- We are confident that the patterns of benefits described above are correct. The actual size of the estimates, however, depends critically on the size of the grass multiplier used and on the taxes selected to finance or to be subsidized by the projects.

Finally, efficiency pricing--in the form of marginal-cost-based prices for DW, and GW charges based on its marginal value--will initially affect the production sectors where it is applied. Its ultimate effect on household budgets depends, again, crucially on the tax assumptions. If the surpluses earned by DW companies charging marginal-cost-based prices are used to offset personal taxes, the imposition of efficiency pricing will benefit average- and low-income households. If the surpluses are used to offset business taxes, most of the benefits would be diverted to higher-income households.

Appendix G

EFFECT OF GROUNDWATER QUOTA, PRIORITY, AND CHARGES

G.1. IMPACTS IN AGRICULTURE

Changes in policy variables relating to the cost of and access to groundwater (GW) have a large impact on the net benefits of agriculture in an extremely dry year (DEX). The average (1943) impact is smaller but still impressive.

We explored the effect on agricultural net benefits of three policy variables relating to GW: extraction quota, access priority, and use charge. To do so, we used the six impact assessment cases defined in Table G.1. In all cases but G, the GW sprinkler intensity is high. In case G it is at its current level (low). Also in case G, the extraction quota is only 0.25. It is 1.5 in case Q and 1.0 in the other cases. In cases G, P, and M, agriculture has access priority to GW. Industry and drinking-water (DW) companies have priority in F, L, and Q. There is no charge for GW use except in cases M and L, where a charge of 0.20 Dfl/cm^3 is levied. In other respects the cases are the same.

Table G.1

DEFINITION OF CASES FOR EFFECT OF GW QUOTA, PRIORITY, AND CHARGES

Item	Case					
	G	P	F	M	L	Q
Managerial strategy	MSDM	MSDM	MSDM	MSDM	MSDM	MSDM
Waterboard plans	Yes	Yes	Yes	Yes	Yes	Yes
MAXTACS	Yes	Yes	Yes	Yes	Yes	Yes
SW sprinklers	Hi	Hi	Hi	Hi	Hi	Hi
GW sprinklers	Low	Hi	Hi	Hi	Hi	Hi
GW extraction quota	.25	1.0	1.0	1.0	1.0	1.5
GW priority above current sprinklers	AGR	AGR	I/D	AGR	I/D	I/D
GW charge on IND and AGR (Dfl)	0	0	0	.20	.20	0
Rijn salt dump	Ref	Ref	Ref	Ref	Ref	Ref
External pollution	Ref	Ref	Ref	Ref	Ref	Ref

NOTE: I/D = industry/DW companies; IND = industry; AGR = agriculture. MSDM indicates the SIMPLE MSDM strategy.

Table G.2 shows the net agricultural benefits for these cases in the DEX external supply scenario. As one would expect, case G, with the low intensity of GW sprinklers, yields the smallest Dutch benefits, 1879 Dflm/yr. It is somewhat surprising, though, that benefits

Table G.2

IMPACTS OF GW QUOTA, PRIORITY, AND CHARGES ON AGRICULTURAL BENEFITS: DEX EXTERNAL SUPPLY
(In Dflm/yr)

Item	Effects, by Case				
	G	P	F	L	Q
Gross benefits					
Grass	1357	2194	1626	1609	1922
Non-grass	889	1162	993	900	1086
Sprinkling cost					
Variable costs	-199	-370	-266	-248	-324
Fixed costs	-103	-192	-140	-125	-169
Waterboard plan costs	-22	-22	-22	-22	-22
Net benefits	1922	2772	2191	2114	2493
Division of net benefits					
Dutch					
Producer	1083	1581	1243	1134	1418
Consumer	52	67	55	57	62
Government	744	1076	850	878	967
Total	1879	2724	2148	2069	2447
Foreign					
Producer	-275	-316	-275	-284	-303
Consumer	521	596	521	538	571
Government	-203	-232	-203	-209	-222
Total	43	48	43	45	46

NOTE: These estimates were not shown at the final briefing.

increase by only 269 Dflm/yr in case F, which has a high level of sprinkling. This unexpectedly small increase has two causes. In case F, the GW extraction quota is 1.0, and industry and DW companies have priority to GW; consequently, many fewer GW sprinklers are permitted than implied by the specified intensity. In case G, the low GW quota leads to agricultural benefits by the process described in Chap. 30.

The imposition of GW charges in case L (in contrast to case F) lowers Dutch benefits by 79 Dflm/yr because it reduces the number of GW sprinklers. However, revenue collected by the Dutch government from the GW charge causes its benefits to rise, not only as a fraction of net benefits, but in absolute terms. The pseudo-provinces of Drenthe and Noord-Brabant lose substantial benefits as a result of the imposition of charges. Limburg is the largest gainer.

Giving GW access priority to agriculture (case P) rather than to industry and DW companies (case F) results in substantially higher agricultural benefits (624 Dflm/yr higher in case P than in case F). However, in Drenthe and Zuid-Holland, benefits decline by 12 Dflm/yr and 16 Dflm/yr. The increased damage in Zuid-Holland is to glasshouse crops (from increased salinity). The considerably increased GW extractions in case P are apparently producing this extra damage by the opposite working of the mechanism described for "agricultural benefit from reduced GW extractions."

Increasing the GW quota to 1.5 in case Q from 1.0 in case F raises Dutch benefits 299 Dflm/yr. This is at the expense primarily of Zuid-Holland, which suffers substantially lower benefits. Drenthe, Utrecht, and Noord-Holland suffer smaller declines, probably for the reason just cited.

The net benefits to agriculture for cases G, P, and F in the 1943 external supply scenario are shown in Table G.3. Although the average benefits are only a fraction of those observed in DEX, they are still significant. Giving agriculture GW extraction priority (case P) increases Dutch benefits by 104 Dflm/yr above what they are when industry has priority (case F). Two-thirds of this increase represents additional grass benefits. No crop suffers a decline in benefits. The pseudo-provinces of Groningen, Friesland, Overijssel, Gelderland, and Limburg are the main beneficiaries. Zuid-Holland suffers a decline in benefits of 3 Dflm/yr.

G.2. IMPACTS ON INDUSTRIAL FIRMS AND DW COMPANIES AND THEIR CUSTOMERS

Changes in GW costs, quality, and availability may induce substantial adjustments in the water use of firms. Firms may switch to alternative water sources or they may reduce their total water requirements by adopting water-conserving processes. In this section, we compare the impacts on the firms of the GW sensitivity cases and then show the resulting distribution of monetary benefits and losses among the firms, their customers, and the government.

The GW sensitivity cases were defined in Table G.1. We include case G, one of the primary cases, as a GW sensitivity case because it contains the large (75 percent) reduction (from the basic RID estimates) in the amount of GW that can be extracted. This restriction turns out to be the most significant of all our GW policies.

Case F can be thought of as the base case for these studies; it is identical with case A so far as this discussion is concerned.

G.2.1. Impacts on Industrial Firms

Table G.4 shows how the industrial firms will adjust their water use in response to the GW sensitivity cases and how this will affect their costs. Recall that we always express the cost to industrial firms as net of the GW shadow prices. Only GW taxes that are levied in addition to the RESDM-generated shadow prices are counted, the assumption being that the basic allocation of GW among industrial firms is accomplished by fiat rather than by pricing.

Table G.3

EFFECTS OF GW QUOTA, PRIORITY, AND CHARGES ON AGRICULTURAL BENEFITS: 1943 EXTERNAL SUPPLY
(In Dflm/yr)

Item	Effects, by Case		
Item	G	P	F
Gross benefits			
Grass	372	609	446
Non-grass	204	296	239
Sprinkling cost			
Variable costs	-109	-217	-154
Fixed costs	-103	-192	-140
Waterboard plan costs	-22	-22	-22
Net benefits	342	474	369
Division of net benefits			
Dutch			
Producer	193	271	210
Consumer	11	15	12
Government	129	178	138
Total	333	464	360
Foreign			
Producer	-50	-65	-52
Consumer	96	122	99
Government	-37	-47	-38
Total	9	10	9

NOTE: These estimates were not shown at the final briefing.

The impacts of all cases shown in Table G.4 are shown relative to the base case, case A. Case P differs from case A only in that priority for GW extractions (in addition to reference-level sprinkling requirements) is given to farmers. This makes industry costs increase by 25 Dflm/yr as firms must intake additional (higher-cost) DW and SW to replace the GW now given to farmers. Cases L and M differ from case A by including a GW tax of 0.20 Dfl/m^3. This tax causes (1) about 50 Dflm/yr in taxes to be transferred from industrial firms to the government and (2) about 25 Dflm/yr in other water-related costs to be incurred by industry. These other costs are primarily for the purchase of DW to replace a portion of the now higher-priced GW.

Case G restricts the GW quota to one-fourth of the basic RID estimates. This severe GW restriction causes large increases in industry costs as firms do some switching to DW and SW but mainly rely on reducing their water intake. Total water intake falls by about 175 mcm/yr and costs increase by 230 Dflm/yr compared to case A.

Table G.4

IMPACTS OF GW SENSITIVITY CASES ON INDUSTRIAL FIRMS

Item	Impacts by Case, Relative to Case A				
	G	L	M	P	Q
Change in industry water use (mcm/yr)					
GW	-283	-170	-189	-79	33
DW	77	20	29	16	-14
SW	30	9	16	14	-3
Total	-177	-141	-144	-49	16
Change in industry costs (Dflm/yr)					
Direct	36	8	0	2	-1
For DW	204	11	24	24	-18
GW charges	0	54	50	0	0
Total	240	73	74	26	-19

NOTES: Numerous entries have changed since the final briefing. The industry use of surface water (SW) reflects new data from the DHL. In cases G, P, M, and L, SW usage went up by 29 mcm/yr over the final briefing estimates. In case Q, it dropped from 32 to -3. And finally, the cost for DW was changed to adjust for the imposition of a 4 percent value-added tax.

Case Q represents the other extreme. It is similar to case A in all respects except that the GW quota is increased to 150 percent of the basic RID estimate. This induces firms to use more GW rather than less and decreases their water-related costs by about 20 Dflm/yr. This is a very rough estimate, since our models were not really designed to examine possibilities where GW could be substituted for DW or SW. The substitution effects and cost savings are both probably underestimated.

G.2.2. Distribution of Costs in the Industrial Sector

Table G.5 shows our estimates of the distribution of the cost changes associated with the principal PAWN industry cases. All the comments concerning the analogous table (Table 30.11), discussed in connection with the impacts of the PAWN primary cases in year DEX, apply to this table also. Here we simply wish to contrast the distributions associated with the GW sensitivity cases with that of the base case.

The same distributional pattern holds for all the cases: Dutch industrial firms must retain nearly 60 percent of the cost increases, whereas the government accepts nearly 40 percent of the burden in the form of reduced profits-tax revenues; Dutch consumers feel only small effects. Foreign entities are affected in the reverse manner, with producers (and the government) benefiting from the small price increases negotiated by

Table G.5

DISTRIBUTION OF COSTS/BENEFITS IN THE INDUSTRIAL SECTOR
FOR THE GW SENSITIVITY CASES
(In Dflm/yr)

Item	Case G	Case L	Case M	Case P	Case Q
Industry cost increases					
GW costs	0	54	50	0	0
DW costs	204	11	24	24	-18
Other costs	36	8	0	2	-1
Total cost	240	73	74	26	-19
Distribution of benefits					
Domestic					
Producer	-137	-42	-42	-15	11
Consumer	-14	-4	-4	-2	1
Government	-89	-27	-27	-10	7
Total Dutch	-240	-73	-73	-27	19
Foreign					
Producer	122	37	38	13	-10
Consumer	-245	-74	-75	-27	19
Government	118	36	36	13	-9
Total foreign	-5	-1	-1	-1	0
Net benefit	-245	-74	-74	-28	19

SOURCE: Computations of PAWN personnel.

the Dutch firms, whereas the foreign consumers are slightly worse off from being forced to pay those increases.

The close relationship continues between the magnitude of the net Dutch effect and the total industrial cost (see discussion in Sec. 30.5.2). Thus, the benefits for these sensitivity cases are related to the benefits for the base case in the same manner as are the cost increases discussed in connection with Table G.4.

G.2.3. Impacts in the DW Sector

In the DW sector, PAWN sensitivity cases induce three effects: They affect the costs of producing and purchasing DW; they require the construction of new DW production facilities (SW projects); and they affect the quality and taste of DW. We discuss each of these effects in turn.

Financial Impacts on DW Companies and Their Customers. The sensitivity cases affect the composition, the costs, and the pricing of DW. Table G.6 presents, for each case, the DW companies' costs (relative to the base case) for supplying DW and their revenues from

Table G.6

FINANCIAL IMPACTS OF GW SENSITIVITY CASES
ON DW COMPANIES AND THEIR CUSTOMERS

	Impacts, by Case, Relative to Case A					
Item	G	P	F	M	L	Q
Revenue (Dflm/yr)						
Household	306	32	0	19	-1	-45
Commercial	218	23	0	12	-1	-31
Industrial	204	24	0	24	11	-19
Total	728	79	0	55	9	-95
Production cost (Dflm/yr)	479	18	0	14	8	-44
Surplus (Dflm/yr)	249	61	0	41	1	-51
Change in average DW price (Dfl/m^3)	0.43	0.04	0.00	0.02	-0.01	-0.07

SOURCE: Calculations using RESDM output.

NOTES: Costs do not include local distribution and overhead but do include 4 percent value-added tax in revenues. Nearly all entries have changed since the final briefing. Case F is unaffected, as are the average DW prices (reflected in the last row). In cases G, P, and M, the surplus has increased by from 6 to 19 Dflm/yr over final briefing estimates. In case Q, the surplus has decreased by 13 Dflm/yr. There are two reasons for the changes. First, the numbers have been revised to correct some minor errors in manual computations discovered during documentation. Second, a value-added tax of 4 percent has been imposed on DW company revenues.

selling it. The DW surplus is the revenue earned from selling DW minus the costs of production.

As we noted before, revenues at marginal-cost prices exceed costs of supplying DW in every case, because sales are made at marginal-cost rates and marginal costs are higher than average costs in every case. Here we see that the scarcer the GW, the greater the surplus. The DW surplus is highest for case G and lowest for case Q (which have GW extraction quotas of 0.25 and 1.5, respectively). It is higher for cases M and P than for case L because in M and P agriculture has been given priority in extracting GW, effectively diminishing the GW quota for industrial firms and DW companies, and thus increasing the marginal cost of DW and the industrial demands for it as a substitute for GW.

In case Q, DW production costs, revenues, and surplus all fall. When DW companies are allowed more GW, they use less of the lower-quality SW; consequently, both their average costs of production and their marginal costs of production fall. Marginal costs, in fact, fall faster than average costs, so that the surplus also declines.

DW Production Impacts on the Environment. As noted above, DW companies strive to use GW in producing DW because GW is generally of higher quality and thus less costly to convert into DW than is SW. Table G.7 shows how the GW sensitivity cases would affect the need for, and utilization of, the candidate SW projects for converting SW into DW.

The base case (case A), and cases C through F of our primary cases, would require a total of six SW projects: the Biesbosch and Braakman

Table G.7

SW PROJECTS AND SW EXTRACTIONS REQUIRED
IN THE GW SENSITIVITY CASES

	Extractions in mcm/yr, by Case					
SW Project	A-F	G	L	M	P	Q
Spaarbekken Lettelbert	--	50*	--	--	--	--
Spaarbekken Twente	--	57*	--	--	--	--
Spaarbekken Maas/Waal	--	100*	--	--	--	--
Spaarbekken Ysselmeer	--	44	--	--	--	--
Spaarbekken Zuid-Flevoland	--	69	--	--	--	--
Spaarbekken Biesbosch	160**	200	160**	160**	160**	160**
Spaarbekken Markiezaat	--	31	--	--	--	--
Spaarbekken Braakman	16*	16*	16*	16*	16*	16*
Spaarbekken Itteren/Borgharen	--	51	--	--	--	--
Grindgat Heel/Panheel	--	50*	--	0	12	--
Duininfiltratie Noord-Holland	21	90	20	25	28	--
Duininfiltratie Zuid-Holland	23	110*	23	23	23	--
Oevergrondwater Lek	50*	50*	50*	50*	50*	12
Oeverinfiltratie Maas	--	50*	--	--	--	--
Oevergrondwater Roosteren	--	25*	--	25*	25*	--
Plassenwaterleiding Amsterdam	60*	60*	60*	60*	60*	--
Infiltratie Veluwe	--	205	--	--	--	--
Infiltratie Groot Heide	--	20*	--	--	--	--
Total SW extracted	330	1278	330	360	373	188
Total number of SW projects required	6	18	6	8	8	3

NOTES: Only two SW projects are not required in response to primary and GW sensitivity case policies--Spaarbekken Philipsland and Oppervlaktewater Andijk--and so they are omitted from the table. (The latter has relatively high transportation costs in the model, which accounts for its not being used, even though it is currently used in the real world.)

--SW project not required for this case.

*Extraction equals maximum capacity of SW project.

**160 mcm/yr represents forced extraction from the Biesbosch.

reservoirs, dune infiltration in both Noord- and Zuid-Holland, water that has infiltrated through the banks of the Lek, and the special water collection system for Amsterdam. Case L would require virtually the same projects and capacities. Case M would require those plus water from the Roosteren; and case P would also require water from the Heel/Panheel project. None of these cases, however, would require a large increase in SW use--case P requiring the most, a 13 percent increase over case A.

Case G, where GW extractions are reduced sharply, is entirely different. It would require all 18 projects in the table and a total of 1,278 mcm/yr of SW.

Case Q, on the other hand, has almost an excess of GW. Only three SW projects are required, and the major one, the Biesbosch reservoir, is needed only because RESDM requires it, as explained in Sec. 25.4.3. The Braakman reservoir and the Lek project are the others chosen for case Q.

The Percentage of GW in DW. Table G.8 shows our estimates of the percentage of GW in DW. We again use this percentage as a proxy for DW quality and the susceptibility of DW supply to interruptions.

Case G, as we have seen before, is the difficult case. When the GW extraction quota is cut to 25 percent of its value in cases A-F, SW extractions by DW companies nearly quadruple to make up the large deficit. The percentage of GW in DW drops substantially in all pseudo-provinces. And four pseudo-provinces, Noord- and Zuid-Holland, Zeeland, and Limburg, would have almost no GW available for DW purposes.

Table G.8

DW COMPOSITION IN THE GW SENSITIVITY CASES
BY PSEUDO-PROVINCE

	Percentage of GW in DW, by Case					
Pseudo-Province	A-F	G	L	M	P	Q
Groningen	100	20	100	100	100	100
Friesland	100	40	100	100	100	100
Drenthe	100	75	100	100	100	100
Overijssel	100	31	100	100	100	100
Gelderland	100	21	100	100	100	100
Utrecht	100	20	100	100	100	100
Z.-IJpolders	100	46	100	100	100	100
N.-Holland	50	7	51	48	47	100
Z.-Holland	33	7	34	34	33	51
Zeeland	67	3	67	60	100	100
N.-Brabant	100	15	100	100	100	100
Limburg	100	0	100	100	100	100
Netherlands (av.)	77	16	77	75	74	87

NOTE: Costs do not include local distribution and overhead charges.

In the other cases the situation is less severe, but significant decreases in DW quality still occur. Only the low-lying western pseudo-provinces of Noord- and Zuid-Holland and Zeeland need to use SW in their DW production. But, as noted earlier, these three pseudo-provinces contain over 40 percent of the total population and they consume a correspondingly large portion of total DW.

G.3. SUMMARY OF EFFECTS OF GW QUOTAS, PRIORITIES, AND CHARGES

Table G.9

IMPACTS ON GW EXTRACTION AND DW PRODUCTION
OF GW SENSITIVITY CASES: DEX EXTERNAL SUPPLY

Item	Impacts, by Case					
	G	P	F	M	L	Q
GW extractions (mcm/yr)						
Agricultural	275	1136	625	760	508	915
DW companies	250	1081	1102	1106	1128	1240
Industrial	154	359	438	249	268	471
Total	679	2576	2165	2115	1904	2626
DW production (mcm/yr)						
From GW	250	1081	1102	1106	1128	1240
From SW	1278	373	330	360	330	188
Total	1528	1454	1432	1466	1458	1428
Percent GW in DW	16	74	77	75	77	87
Change in SW projects for DW	18	8	6	8	6	3

NOTES: The largest change from the final briefing was the result of correcting a typographical error--the total DW production in case L was corrected from 1488 to 1458. The only other changes from the final briefing result from changes in industrial GW extractions, calculated here from IRSM. The IRSM impact assessment runs all show slightly smaller extraction amounts than the RESDM estimates reported in the briefing.

Table G.10

SUMMARY SCORECARD: EFFECT OF GROUND WATER QUOTA, PRIORITY, AND CHARGES, DEX EXTERNAL SUPPLY SCENARIO

Item	Cases					
	G	P	F	M	L	Q
Dutch net benefits (Dflm)	1296.2	2609.4	2074.0	2243.4	1910.4	2407.5
Minimum summer lake level (cm)	-49	-49	-49	-49	-49	-49
Percent GW in DW	16	74	77	75	77	87
Pollution (% violation frequency)						
BOD						
Provincial nodes	45	45	44	46	45	45
Nonprovincial nodes	40	40	40	40	40	40
Total phosphate						
Provincial nodes	92	89	91	90	90	89
Nonprovincial nodes	52	50	51	51	51	50
Chloride						
Provincial nodes	46	52	47	50	47	49
Nonprovincial nodes	69	69	69	60	69	70
GW extraction (mcm/yr)	679	2576	2165	2115	1904	2626
DW projects (number)	18	8	6	8	6	3
MAXTACS (env. impacts)	YES	YES	YES	YES	YES	YES

Rankings: Best (white box), Intermediate (shaded box), Worst (black box)

NOTES: Dutch net benefits have changed in all cases from the estimates presented at the final briefing. In case G, benefits have increased by some 223 Dflm/yr because we have included DW company benefits (at 249 Dflm/yr); increased costs to industry, households, and commercial business account for about 20 Dflm/yr, whereas the increased cost of MAXTACS accounts for about 6 Dflm/yr. In case P, benefits have increased by about 47 Dflm/yr, again due to including DW companies' benefits (at 61 Dflm/yr), tempered by increased costs to industry, households, and commercial business (8 Dflm/yr) and the increased cost of MAXTACS (6 Dflm/yr).

Benefits in case F decreased by about 7 Dflm/yr, due almost entirely to the increased cost of MAXTACS.

In case M, benefits are about 3 Dflm/yr higher than the 2240.7 Dflm/yr on the final briefing scorecard. Our records show that two errors were detected and corrected by 13 December 1979. Shipping costs were too high by 13 Dflm/yr, and cost to households too high by 8 Dflm/yr. The subsequent decision to include benefits to DW companies, which in this case are 41 Dflm/yr, results in a total of 62 Dflm/yr increase in benefits. However, costs have also increased. The largest change s in industry cost, which was increased by 50 Dflm/yr to correct an unintentional omission. MAXTACS cost has gone up by 6 Dflm/yr, and household cost by 3 Dflm/yr, for a total cost increase of 59 Dflm/yr. Thus, although there have been fairly large changes in the components, the net result is that the total net benefits change very little.

The benefits in case L have dropped by about 60 Dflm/yr, as a result of increasing industry cost by 53 Dflm/yr to correct an omission and increased MAXTACS cost (up 6 Dflm/yr). Household and commercial benefits have each decreased by 1 Dflm/yr, whereas DW companies' benefits (at 1 Dflm/yr) have been added.

In case Q, we have added a net loss to DW companies of 51 Dflm/yr, which when combined with the 6 Dflm/yr increase in MAXTACS cost accounts for most of the drop of 60 Dflm/yr in benefits. Household benefits dropped by 1 Dflm/yr, and commercial by 2 Dflm/yr, making up the rest of the 60 Dflm/yr difference from the final briefing estimates.

GW extractions have been modified slightly to agree with Table G.9. DW projects in case G have been corrected from 15 to 18.

Table G.11

SUMMARY SCORECARD: EFFECTS OF GROUND WATER QUOTA, PRIORITIES, AND CHARGES, 1943 EXTERNAL SUPPLY SCENARIO

Item	Case G	Case P	Case F
Dutch net benefits (Dflm)	-238.4	382.0	302.9
Minimum summer lake level (cm)	-25	-25	-25
Percent GW in DW	16	74	77
Pollution (% violation frequency)			
BOD			
Provincial nodes	46	47	45
Nonprovincial nodes	49	49	49
Total phosphate			
Provincial nodes	90	91	90
Nonprovincial nodes	54	54	54
Chloride			
Provincial nodes	28	29	28
Nonprovincial nodes	54	54	54
GW extraction (mcm/yr)	568	2111	1919
DW projects (number)	18	8	6
MAXTACS (env. impacts)	YES	YES	YES

Rankings: Best (white box) Intermediate (shaded box) Worst (black box)

NOTES: Dutch net benefits in all cases and DW projects in case G2 have been changed. In F2, the benefits have dropped by about 6 Dflm as a result of MAXTACS (see Vol. XVI, App. B). The change in G2 is primarily because DW company benefits have been included. Dutch net benefits, percentage of GW in DW, and DW projects now agree with Tables 31.8 and G.9. Benefits in P2 increased by some 43 Dflm; the inclusion of DW companies' benefits, at 61 Dflm, was tempered somewhat by increased costs to industry, households, and commercial, as well as MAXTACS.

GW extractions now based on IRSM rather than RESDM estimates of industrial GW use.

Appendix H

EFFECT OF INCREASING GROUNDWATER SPRINKLING

Increasing groundwater (GW) sprinkling results in very large agricultural net benefits under the DEX external supply scenario. Large net benefits are also observed in the 1943 scenario.

Six sensitivity cases, B, E, F, L, P, and Q, can be used to study the effect on agricultural net benefits of increased GW sprinkling (see Table H.1). Case B represents the current infrastructure and sprinkling but with the MSDM managerial strategy. In each of the other cases, waterboard plans and MAXTACS have been implemented and new sprinklers installed: the medium level in case E and the high level otherwise. Furthermore, the number of GW sprinklers implied by the intensity was reduced in cases L and P by imposing, respectively, a 0.20 Dfl/cm^3 charge on GW extractions and giving agriculture GW extraction priority over industry and DW companies. The number of GW sprinklers implied by the intensity was increased in case Q by increasing the GW extraction quota to 1.5.

Table H.1

DEFINITION OF CASES FOR EFFECT OF INCREASING GW SPRINKLING

	Case					
Item	B	E	F	L	P	Q
Managerial strategy	MSDM	MSDM	MSDM	MSDM	MSDM	MSDM
Waterboard plans	No	Yes	Yes	Yes	Yes	Yes
MAXTACS	No	Yes	Yes	Yes	Yes	Yes
SW sprinklers	Low	Med	Hi	Hi	Hi	Hi
GW sprinklers	Low	Med	Hi	Hi	Hi	Hi
GW extraction quota	1.0	1.0	1.0	1.0	1.0	1.5
GW priority above current sprinklers	-	I/D	I/D	I/D	AGR	I/D
GW charge on IND and AGR (Dfl)	0	0	0	.20	0	0
Rhine salt dump	Ref	Ref	Ref	Ref	Ref	Ref
External pollution	Ref	Ref	Ref	Ref	Ref	Ref

NOTE: I/D = industry/DW companies; IND = industry; AGR = agriculture.

The resulting amounts of GW sprinkling are shown in Table H.2. The variation in GW sprinkling among cases F, L, P, and Q (all of which have high sprinkler intensities) illustrates the importance of the policy variables in determining the actual area in which GW sprinklers are installed. Imposing a GW extraction charge in case L sufficiently discourages farmers from installing sprinklers that the case's total

Table H.2

PERCENTAGES OF CROP AREAS SPRINKLED WITH GW
FOR SELECTED IMPACT ASSESSMENT CASES

Item	B	E	F	L	P	Q
Crop area sprinkled with GW	3.5	6.2	9.0	6.8	16.5	13.2
GW-sprinkled area containing grass	74	70	69	83	74	72
GW-sprinkled area not containing grass	26	30	31	17	26	28

amount of sprinkling is very similar to the sprinkling in case E (where there is no GW charge but medium sprinkler intensity). However, case L has a markedly higher proportion of grass vs. non-grass crops that are sprinkled. The percentage of crop area sprinkled with GW is highest in cases P and Q; Q has the more lenient 1.5 GW quota, and in P extraction priority is given to agriculture.

The cases outlined above do not provide a way to directly measure the impact of GW sprinkling on agricultural net benefits. We can, however, make an estimate. Table H.3 contains the approximate agricultural net benefits attributable to GW sprinkling for the DEX external supply scenario. The values were computed by subtracting the approximate contribution of surface water (SW) sprinkling from the net benefits in each case. It is clear from the table that increasing GW sprinkling can result in significant net agricultural benefits. However for equivalent increases in GW and SW sprinkling, the net benefits produced by GW sprinkling are <u>lower</u> than those from SW sprinkling, unless a dry year causes large cutbacks in the SW available for sprinkling.

A comparison of cases E and L provides an interesting insight into the distribution of GW sprinkling benefits. Despite the fact that both cases have nearly the same amount of GW sprinkling and benefits, because of the imposition of a GW extraction charge in case L, the Dutch government's share of GW benefits is substantially higher than in case E (73 vs. 40 percent). In addition, the distribution of GW benefits between grass and non-grass crops is radically different. In case E, non-grass crops contribute 63 Dflm/yr to Dutch net GW benefits. In case L this figure is only 6 Dflm/yr.

Table H.3

IMPACTS OF GW SPRINKLING ON AGRICULTURE BENEFITS:
DEX EXTERNAL SUPPLY
(In Dflm/yr)

Item	Impacts, by Case					
	B	E	F	L	P	Q
Gross GW benefits						
Grass	--	162	269	252	837	565
Non-grass	--	78	104	11	273	197
GW sprinkling cost						
Variable costs	--	-29	-67	-49	-171	-125
Fixed costs	--	-19	-37	-22	-89	-66
Net GW benefits	--	192	269	192	850	571
Division of net GW benefits						
Dutch						
Producer	--	113	160	51	498	335
Consumer	--	2	3	5	15	10
Government	--	76	106	134	332	223
Total	--	191	269	190	845	568
Foreign	-	1	0	2	5	3

NOTE: These estimates were not discussed at the final briefing.

Table H.4

SUMMARY SCORECARD: EFFECT OF INCREASING GROUNDWATER SPRINKLING, DEX EXTERNAL SUPPLY SCENARIO

Item	Case B	Case E	Case F	Case L	Case P	Case Q
Dutch net benefits (Dflm)	4.5	1270.1	2074.0	1910.4	2609.4	2407.5
Minimum summer lake level (cm)	-35	-47	-49	-49	-49	-49
Percent GW in DW	77	77	77	77	74	87
Pollution (% violation frequency)						
BOD						
Provincial nodes	46	44	44	45	45	45
Nonprovincial nodes	39	39	40	40	40	40
Total phosphate						
Provincial nodes	92	92	91	90	89	89
Nonprovincial nodes	52	52	51	51	50	50
Chloride						
Provincial nodes	35	43	47	47	52	49
Nonprovincial nodes	69	69	69	69	69	70
GW extraction (mcm/yr)	1815	1985	2165	1904	2576	2626
DW projects (number)	6	6	6	6	8	3
MAXTACS (env. impacts)	NO	YES	YES	YES	YES	YES

Rankings: Best (white) Intermediate (shaded) Worst (black)

NOTES: Dutch net benefits have changed in all cases from the final briefing scorecard estimates. Benefits in case B have dropped by 0.2 Dflm/yr due to minor corrections to shipping and thermal costs. Benefits in cases E and F have decreased by some 7 Dflm/yr due primarily to the increased cost of MAXTACS. In case L, industry benefits dropped by over 50 Dflm/yr when an omission was corrected, accounting for most of the drop in benefits. Benefits in case P increased by almost 50 Dflm/yr, because DW companies' benefits have now been included. In case Q, DW companies' benefits were negative (-51 Dflm/yr), and their inclusion, together with the increased cost of MAXTACS and small reductions in household and commercial benefits, accounts for the 60 Dflm/yr drop in total benefits.

GW extractions have been changed in cases L, P, and Q to agree with Table G.9. Percentage of GW in DW and number of DW projects also now agree with Table G.9.

Appendix I

EFFECT OF INCREASING SURFACE WATER SPRINKLING

Dramatic increases in net agricultural benefits result from each increase in surface water (SW) sprinkling in the DEX external supply scenario. The benefits are significantly smaller under the 1943 external supply scenario but remain large.

Impact assessment cases B, N, C, D, and G provide a way to study the effect on agriculture when SW sprinkling is increased (see Table I.1). Case B represents the current base infrastructure and sprinkling but with the MSDM managerial strategy; in each succeeding case, we vary one variable. Waterboard plans were added in case N; the medium intensity of SW sprinkling in case C; MAXTACS in case D; and finally the high intensity of SW sprinkling in case G. (In case G we also reduced the GW extraction quota by 75 percent and gave agriculture GW extraction priority.) From Table I.2 we see that the percentage of the country's cropland sprinkled with SW ranges from a low of 10 percent in case B up to 31 percent in case G. In all cases, approximately 70 percent of the area sprinkled with SW contains grass.

Table I.1

DEFINITION OF CASES FOR EFFECT OF INCREASING SW SPRINKLING

	Case				
Item	B	N	C	D	G
Managerial strategy	MSDM	MSDM	MSDM	MSDM	MSDM
Waterboard plans	No	Yes	Yes	Yes	Yes
MAXTACS	No	No	No	Yes	Yes
SW sprinklers	Low	Low	Med	Med	Hi
GW sprinklers	Low	Low	Low	Low	Low
GW extraction quota	1.0	1.0	1.0	1.0	.25
GW priority above current sprinklers	-	-	-	-	AGR
GW charge on IND and AGR (Dfl)	0	0	0	0	0
Rhine salt dump	Ref	Ref	Ref	Ref	Ref
External pollution	Ref	Ref	Ref	Ref	Ref

NOTE: AGR = agriculture; IND = industry. MSDM indicates the SIMPLE MSDM strategy.

Table I.2

PERCENTAGES OF CROP AREAS SPRINKLED WITH SW
FOR SELECTED IMPACT ASSESSMENT CASES

Item	Case B	Case N	Case C	Case D	Case G
Crop area sprinkled with SW	9.7	12.1	21.5	21.5	30.9
SW-sprinkled area containing grass	68	68	71	71	72
SW-sprinkled area not containing grass	32	32	29	29	28

Table I.3

IMPACTS OF INCREASING SW SPRINKLING ON AGRICULTURAL BENEFITS:
DEX EXTERNAL SUPPLY
(In Dflm/yr)

Item	Impacts, by Case B	N	C	D	G
Gross benefits					
Grass	0.0	171	663	763	1357
Non-grass	7.7	199	420	598	889
Sprinkling cost					
Variable costs	---	-23	-93	-112	-199
Fixed costs	---	-12	-58	-58	-103
Waterboard plan costs	---	-22	-22	-22	-22
Net benefits	7.7	313	910	1169	1922
Division of net benefits					
Dutch					
Producer	3.9	173	513	654	1083
Consumer	0.4	10	26	34	52
Government	2.9	122	352	451	744
Total	7.2	305	891	1139	1879
Foreign					
Producer	-3.2	-65	-131	-196	-275
Consumer	6.1	120	246	370	521
Government	-2.3	-47	-96	-144	-203
Total	0.6	8	19	30	43

NOTE: These estimates were not shown at the final briefing.

Table I.4

IMPACTS OF INCREASING SW SPRINKLING ON AGRICULTURAL BENEFITS:
1943 EXTERNAL SUPPLY
(In Dflm/yr)

Item	Case			
	B	C	D	G
Gross benefits				
Grass	0.0	195	203	372
Non-grass	0.3	98	137	204
Sprinkling cost				
Variable costs	--	-56	-60	-109
Fixed costs	--	-58	-58	-103
Waterboard plan cost	--	-22	-22	-22
Net benefits	0.3	157	200	342
Division of net benefits				
Dutch				
Producer	0.2	89	111	193
Consumer	--	5	7	11
Government	0.1	60	75	129
Total	0.3	154	193	333
Foreign				
Producer	-0.1	-22	-38	-50
Consumer	0.3	42	73	96
Government	-0.1	-17	-28	-37
Total	0.1	3	7	9

NOTE: These estimates were not shown at the final briefing.

As one would expect, increasing the area containing SW sprinklers, and providing the means to get water to them, increases agricultural net benefits. As can be seen in Table I.5, which depicts the cases under the DEX external supply scenario, the increases are very large. Merely installing waterboard plans in case N yields net benefits 291 Dflm/yr greater than in case B. Case N is particularly interesting because the amount of new area with SW sprinklers is relatively small, about 50,000 ha, and is the area made suppliable by the new waterboard plans. Case G, with waterboard plans, MAXTACS, and high sprinkling intensity, returns enormous net benefits, 1291 Dflm/yr higher than those in case B. Each of the incremental expansions in infrastructure and sprinkling results in an incremental increase in net agricultural benefits. And in all of the cases, grass accounts for a large percentage of the increase in benefits: Supporting data show an increase from 46 percent in case N to as much as 61 percent in case C. Yet agricultural net benefits would remain high even if these grass benefits were eliminated completely.

Table I.5

SUMMARY SCORECARD: EFFECT OF INCREASING SURFACE WATER SPRINKLING, DEX EXTERNAL SUPPLY SCENARIO

	Case				
Item	B	N	C	D	G
Dutch net benefits (Dflm)	4.5	295.8	865.0	1080.4	1296.2
Minimum summer lake level (cm)	-35	-37	-37	-45	-49
Percent GW in DW	77	77	77	77	16
Pollution (% violation frequency)					
BOD					
Provincial nodes	46	47	46	45	45
Nonprovincial nodes	39	40	40	39	40
Total phosphate					
Provincial nodes	92	92	91	92	92
Nonprovincial nodes	52	52	51	52	52
Chloride					
Provincial nodes	35	37	39	42	46
Nonprovincial nodes	69	69	69	69	69
GW extraction (mcm/yr)	1815	1815	1815	1818	679
DW projects (number)	6	6	6	6	18
MAXTACS (env. impacts)	NO	NO	NO	YES	YES

Rankings: Best (white) Intermediate (shaded) Worst (black)

NOTES: Dutch net benefits have all changed from the final briefing scorecard estimates. Cases C, D, and G were described in the notes to Table 30.22. In cases B and N the changes are very minor, resulting from small corrections in agriculture, shipping, and thermal net benefits. Two other changes resulted from comparison checks with other tables--GW extractions and DW projects have been changed for case G (see Table 30.22), and GW extractions have been changed to agree with Table 30.16.

Appendix J

COMBINED EFFECTS OF MANAGERIAL STRATEGY, SPRINKLING SCENARIO, QUOTA, AND PRIORITY ON SHIPPING

We considered the sensitivity of shipping benefits (costs) to variations in surface water (SW) and groundwater (GW) sprinkling, management strategy, and GW quotas, priorities, and charges. These results are shown in Tables J.1 and J.2. The tables show total losses for the reference case (A) and net benefits (relative to case A) for all other cases.

From the tables it is clear that:

- Highland lock losses are important only in an extremely dry year and are affected only by GW sprinkling policy.
- The waterboard plans considerably increase shipping losses, particularly if SW sprinkling is not limited.
- MAXTACS benefits shipping, reducing shipping losses by almost 10 percent in an extremely dry year, and more than offsetting the losses caused by introducing the waterboard plans and increasing SW sprinkling.
- Managerial strategies are relatively unimportant to shipping costs, but either the MSDM or Velsen (VEL) strategy would benefit shipping in dry years, under nominal conditions. When the system is stressed, however, these policies hurt shipping in comparison to the RWS management strategy.
- Increased SW sprinkling damages shipping in extremely dry years but affects it only negligibly when water conditions improve.
- Large increases in GW extraction can significantly increase shipping costs, especially if agriculture has priority.
- Restricting GW extraction through quotas benefits shipping, no matter who has priority for GW use.
- If industry and DW companies have GW extraction priority, imposing a GW charge damages shipping; if agriculture has priority, a charge benefits shipping.

Considering these observations we can conclude that none of the alternative policies has a very strong impact on shipping costs. We can suggest four reasons for this result:

Table J.1

SUMMARY OF NET BENEFITS FOR SHIPPING (Dflm)
(DEX EXTERNAL SUPPLY)

Item	Case A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q
Shipping costs	-1814.9	2.86	-29.97	4.09	2.46	-20.38	-14.80	-16.39	8.92	-20.04	-44.46	-34.12	-3.54	-54.96	-36.01
Total variable shipping losses															
Low water losses	-347.44	2.65	-29.59	3.85	2.24	-18.10	-14.76	-14.13	8.74	-17.67	-42.10	-31.65	-3.59	-52.39	-33.36
Highland lock delay losses	-9.72	0.00	-0.11	0.03	0.01	-2.19	0.02	-2.20	0.00	-2.19	-2.20	-2.35	-0.04	-2.39	-2.53
Dredging costs	-0.36	0.21	-0.27	0.21	0.21	-0.09	-0.06	-0.06	0.17	-0.18	-0.16	-0.12	0.09	-0.18	-0.12
Total	-357.52	2.86	-29.97	4.09	2.46	-20.38	-14.80	-16.39	8.92	-20.04	-44.46	-34.12	-3.54	-54.96	-36.01
Dutch variable shipping losses															
Low water losses	-215.41	1.64	-18.35	2.38	1.39	-11.22	-9.15	-8.77	5.42	-10.96	-26.10	-19.62	-2.20	-32.48	-20.68
Highland lock delay losses	-5.93	0.00	-0.08	0.02	0.01	-1.36	0.01	-1.36	0.00	-1.36	-1.36	-1.46	-0.03	-1.48	-1.57
Dredging costs	-0.36	0.21	-0.27	0.21	0.21	-0.09	-0.06	-0.06	0.18	-0.18	-0.16	-0.12	0.09	-0.18	-0.12
Total	-221.70	1.85	-18.70	2.61	1.61	-12.67	-9.20	-10.19	5.60	-12.50	-27.62	-21.20	-2.14	-34.14	-22.37
Long run fleet proxy Annualized fixed cost															
Total fleet	-2862.1	0.2	0.2	0.2	0.2	0.0	0.0	-0.3	0.2	0.0	0.0	0.2	0.2	0.0	0.0
Dutch fleet	-1758.1	0.1	0.1	0.1	0.1	0.0	0.0	-0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0

Table J.2

SUMMARY OF NET BENEFITS FOR SHIPPING (Dflm)
(1943/1967 EXTERNAL SUPPLY)

Item	Case 1943 A	B	C	D	E	F	G	H	J	K	P	1967 A	B	F	G
Shipping costs	-1570.6	0.12	-0.05	0.77	0.73	0.52	0.41	0.30	0.57	0.51	0.15	13.39	0.00	0.04	0.03
Total variable shipping losses															
Low water losses	-113.02	0.03	-0.04	0.62	0.58	0.42	0.25	0.32	0.54	0.53	-0.02	13.34	0.00	0.00	-0.01
Highland lock delay losses	-0.12	0.00	-0.10	0.03	0.03	0.04	0.04	0.04	0.00	0.04	0.04	0.05	0.00	0.04	0.04
Dredging costs	-0.12	0.09	0.09	0.12	0.12	0.06	0.12	-0.06	0.03	-0.06	0.13	0.00	0.00	0.00	0.00
Total	-113.26	0.12	-0.05	0.77	0.73	0.52	0.41	0.30	0.57	0.51	0.15	13.39	0.00	0.04	0.03
Dutch variable shipping losses															
Low water losses	-70.07	0.02	-0.02	0.38	0.36	0.26	0.16	0.20	0.34	0.34	-0.01	8.27	0.00	0.00	0.00
Highland lock delay losses	-0.08	0.00	-0.07	0.02	0.02	0.02	0.02	0.02	0.00	0.02	0.04	0.03	0.00	0.02	0.02
Dredging costs	-0.12	0.09	0.12	0.12	0.12	0.06	0.12	-0.06	0.04	-0.05	0.13	0.00	0.00	0.00	0.00
Total	-70.27	0.11	0.06	0.52	0.50	0.34	0.30	0.16	0.38	0.31	0.16	8.30	0.00	0.02	0.02
Long run fleet proxy Annualized fixed cost															
Total fleet	-2862.1	0.2	0.2	0.2	0.2	0.0	0.0	-0.3	0.2	0.0	0.0	2862.1	0.2	0.0	0.0
Dutch fleet	-1758.1	0.1	0.1	0.1	0.1	0.0	0.0	-0.2	0.1	0.0	0.0	1758.1	0.1	0.0	0.0

1. Tactics that might impose high costs on shipping were eliminated in the screening analysis.

2. Shipping and other users do not always compete for water, because shipping is a nonconsumptive user.

3. Low-water losses do not increase significantly until depths at critical points become quite low.

4. Shipping losses are determined predominantly by Rijn and Maas flows, and water management tactics can vary these flows and losses by only relatively small amounts.

In other than the driest years, shipping is not seriously affected by any of the proposed tactics. Similarly, the cost for the required fleet does not change in the long run. As a result, the RWS should not be apprehensive about the effects of future water management policies if they are careful in making their decisions. Certain actions, however, appear to benefit shipping. These are:

- Dredging the Waal below withdrawal points to remove sandbars before they interfere with shipping operations.

- Improving the Merwedekanaal for transporting water north from the Waal to reduce withdrawals at Tiel.

- Incorporating MAXTACS, if GW and SW sprinkling increase dramatically.

- Changing the current managerial strategy to use IJsselmeer rather than Waal water for augmenting Noordzeekanaal flows.

By choosing reasonable policies, the Dutch should be able to protect domestic and international shipping from severe consequences when they make future water management decisions.

Appendix K

ADDITIONAL RESULTS OF SENSITIVITY ANALYSES

Table K.1

EFFECT OF CHANGING RIJN SALT LOAD ON DUTCH BENEFITS:
DEX EXTERNAL SUPPLY
(In Dflm/yr)

Item	Effects, by Case			
	B	R	F	S
Dutch share				
MAXTACS	--	--	-56.4	-56.4
Agriculture	7.1	-21.6	2148.0	2121.3
Shipping	1.9	1.9	-12.7	-13.2
Thermal penalty	-4.5	-6.2	-5.0	-5.4
Industry	--	--	--	--
Households	--	--	--	--
Commercial	--	--	--	--
DW companies	--	--	--	--
Total	4.5	-25.9	2074.0	2046.3
Dutch government				
MAXTACS	--	--	-56.4	-56.4
Agriculture	2.9	-8.6	849.7	839.0
Shipping	0.9	0.9	-5.1	-5.4
Thermal penalty	--	--	--	--
Industry	--	--	--	--
Households	--	--	--	--
Commercial	--	--	--	--
DW companies	--	--	--	--
Total	3.7	-7.7	788.2	777.3

NOTES: Components may not add to total due to rounding. The major changes from the final briefing occur in cases F and S and are primarily due to the increased cost of MAXTACS (see Vol. XVI, App. B).

Table K.2

EFFECT OF CHANGING RIJN SALT LOAD ON DUTCH BENEFITS:
1943 EXTERNAL SUPPLY
(In Dflm/yr)

Item	Effects, by Case			
	B	R	F	S
Dutch share				
MAXTACS	--	--	-56.4	-56.4
Agriculture	0.3	-12.7	360.5	354.2
Shipping	0.1	0.1	0.3	0.5
Thermal penalty	-2.0	-3.5	-1.6	-3.0
Industry	--	--	--	--
Households	--	--	--	--
Commercial	--	--	--	--
DW companies	--	--	--	--
Total	-1.6	-16.0	302.8	295.4
Dutch government				
MAXTACS	--	--	-56.4	-56.4
Agriculture	0.1	-5.1	138.2	135.7
Shipping	0.1	0.1	0.2	0.3
Thermal penalty	--	--	--	--
Industry	--	--	--	--
Households	--	--	--	--
Commercial	--	--	--	--
DW companies	--	--	--	--
Total	0.2	-5.0	82.0	79.6

NOTES: Components may not add to total due to rounding. The major changes from the final briefing occur in cases F and S, and are primarily due to the increased cost of MAXTACS (see Vol. XVI, App. B).

Appendix L

SUPPLEMENTARY NOTES FOR CHAPTERS 30 AND 31

Notes for Table 30.2

Five numbers have been changed by either 1 or 2 Dflm from the final briefing to correct previous transcription errors.

Notes for Table 30.4

Distributions by pseudo-province have all changed slightly. The largest change is for Friesland, where benefits have gone up from 9 to 28 Dflm/yr. The change in damage and in variable cost agrees with the BENCOMP output, so it appears that there were transcription errors for fixed costs.

Notes for Table 30.5

The low-water losses (and hence the total) under total variable shipping cost for case A dropped by 5.7 Dflm when a transcription error was corrected.

Notes for Table 30.7

Nearly all entries have changed since the final briefing. Case F is unaffected, as are the average DW prices (last row). In cases G, P, and M, the surplus has increased by 6 to 19 Dflm/yr. In case Q, the surplus has decreased by 13 Dflm/yr. There are two reasons for the changes. First, the numbers in the source documents have been revised to correct some minor errors in manual computations discovered during documentation. Second, a value-added tax charge of 4 percent has been imposed on DW company revenues.

The change in average DW price is obtained by differencing the average marginal costs for the Netherlands in Table 4.11, Vol. VII.

DW company revenues and costs for the base case and for the cases above were obtained from Vol. VII, Table 4.13, and then the revenues from households and the commercial sector separated out. A value-added tax charge of 4 percent was then applied to the revenues.

Notes for Table 30.10

Numerous entries have changed since the final briefing. The industry use of SW reflects new data from DHL. In cases G, P, M, and L, the usage went up by 29 mcm/yr. In case Q, it dropped from 32 to -3. The other changes are in the cost for DW and are due to the imposition of a 4 percent value-added tax charge.

Notes for Table 30.12

Numerous changes have been made since the final briefing. The largest changes occur in case G and are due primarily to industry and DW companies. There, the total Dutch share of net benefits went from 1074 to 1296 Dflm/yr, mainly as a result of including the net benefits to DW companies here. The total Dutch government share in case G dropped from 862 to 764 Dflm/yr, mainly as a result of recalculations of the loss of government income from the corporate-income and value-added taxes when business profits and sales decline because of the large increase in GW costs. Governmental tax receipts from the industrial sector dropped from 27.2 to -89.0 Dflm/yr. Industry, households, commercial business, and DW companies' net benefits affect only case G, but there they have all changed from the final briefing. The other notable change is in the cost of MAXTACS, which went from 50 to 56.4 Dflm/yr. The reasons for this change are documented in App. B of Vol. XVI.

For the net benefits to agriculture, minor changes were made to correct transcription errors and to show these benefits to one decimal place (they were rounded to the nearest integer before).

Notes for Table 30.13

Numerous changes have been made since the final briefing. The largest changes occur in case G and are due primarily to industry and DW companies. There, the total Dutch share of net benefits went from 1074 to 1296 Dflm/yr, mainly as a result of including the net benefits to DW companies here. The total Dutch government share in case G dropped from 862 to 764 Dflm/yr, mainly as a result of recalculations of the loss of government income from the corporate-income and value-added taxes when business profits and sales decline because of the large increase in GW costs. Governmental tax receipts from the industrial sector dropped from 27.2 to -89.0 Dflm/yr. Industry, households, commercial business, and DW companies' net benefits affect only case G, but there they have all changed from the final briefing. The other notable change is in the cost of MAXTACS, which went from 50 to 56.4 Dflm/yr. The reasons for this change are documented in App. B of Vol. XVI.

For the net benefits to agriculture, minor changes were made to correct transcription errors and to show these benefits to one decimal place (they were rounded to the nearest integer before). The Dutch government share is obtained by taking the Dutch share, subtracting the dredging cost, taking 40 percent of the result, and adding the dredging cost back in.

Notes for Table 30.22

Dutch net benefits have changed from those in the final briefing. In case C, minor corrections to shipping and thermal penalty resulted in a decrease of 0.1 Dflm/yr. In cases D through F, the benefits decreased by about 6.5 Dflm/yr, mainly due to the increased cost of MAXTACS (see Vol. XVI, App. B). In case G, the net benefits increased from 1073.7 to 1296.2 Dflm/yr, most of which was due to the decision to include DW company benefits in the Dutch share. Only two other entries were changed. GW extractions and DW projects in case G were changed to agree with Tables 30.8 and 30.18.

Dutch net benefits were obtained by preparing a financial summary of benefits from previous tables. Where previous tables changed, so have these numbers.

Notes for Table 31.1

Four numbers have been changed by either 1 or 2 Dflm to correct previous transcription errors.

Notes for Table 31.4

The low-water losses (and hence the total), under total variable shipping cost, for case A, have dropped by 1.8 Dflm/yr. We found a minor error in the dredging cost for case C. It has been corrected here and in Vol. IX.

Notes for Table 31.6

Numerous changes have been made since the final briefing. The largest changes occur in case G and are due primarily to industry and DW companies. There the total Dutch share of net benefits went from -461.1 to -238.4 Dflm/yr, mainly as a result of including the net benefits to DW companies here. The total Dutch government share in case G dropped from 250.4 to 152.4 Dflm/yr, mainly as a result of industry contributions, which dropped from 27.2 to -89.0 Dflm. Industry, households, commercial business, and DW companies' net benefits affect only case G, but there they have all changed from the final briefing. The other notable change is in the cost of MAXTACS, which went from 50 to 56.4 Dflm/yr. The reasons for this change are documented in App. B of Vol. XVI.

The net benefits to agriculture were checked against BENCOMP runs. Minor changes were made to correct transcription errors and to show these benefits to one decimal place (they were rounded to the nearest integer before).

Notes for Table 31.8

Dutch net benefits have changed from the final briefing estimates. These are taken from Table 31.6, and the notes there describe the reasons for the changes. The only other change is in the DW projects in case G, which was 15 in the final briefing and has been corrected to 18. GW extractions reflect the IRSM estimates for industrial GW use in impact assessment and average about 12 mcm/yr less than the estimates presented in the final briefing that were based on RESDM estimates of industrial GW use.

GLOSSARY

AC	average cost
ACB	Administratie Centrum voor het Beroepsvervoer (Netherlands Administrative Center for Commercial Transport)
AGR	agriculture
algae bloom	a heavy growth of algae
annualized fixed cost	annualized investment cost plus annual fixed operating and maintenance cost
annualized investment cost	obtained by applying a capital recovery factor to the total investment; an interpretation is that the total investment is financed with borrowed funds, and the loan is paid off with equal annual payments, including principal and interest, over the useful life of the facility; similar to annual mortgage payment
aquifer	a stratum of earth or porous rock that contains water
average cost	total cost divided by total quantity
basic demand	demand for drinking water or groundwater before application of tactics
basic drainage	the flow of groundwater to streams and rivers; occurs in the Highlands
BENCOMP	benefits comparison program
biomass	the dry weight of a biological substance; indicates the amount of material to be digested by bacteria
BLOOM II	the algae bloom model used in PAWN's analysis of eutrophication
BOD	biochemical oxygen demand; this indicates the amount of oxygen-consuming substances (dead organic matter and certain inorganic chemicals), expressed in terms of the amount of oxygen they will consume in a polluted water sample in a standard amount of time at a standard temperature (usually 5 days and 20 deg C)

boezem — a system of canals surrounding one or more polders, which allows for flushing and independent water level control in those polders

BTW — Belasting over toegevoegde waarde (value-added tax)

Buis — Dutch word for pipe; refers to a sprinkler system consisting of one or more movable lateral pipes equipped with multiple sprinkler heads

capital recovery factor — a device for converting a lump-sum payment made now into an equivalent stream of equal annual payments; used to determine annualized investment cost

CBS — Centraal Bureau voor de Statistiek (Netherlands Central Bureau of Statistics)

CEMT — Conference of European Ministers of Transport

CER — cost-estimating relationship

CHARON — the nutrient model used in the analysis of eutrophication

Cl^- — chloride ion

cm — centimeter

cm^3 — cubic centimeter

CPB — Centraal Plan Bureau (Central Planning Bureau of the Netherlands)

CRF — capital recovery factor

crop price — the amount of Dutch florins (guilders) each hectare planted in the crop will produce if no damage occurs to the crop during the year and it reaches the maximum potential yield possible under the corresponding external supply scenario

crop price scenario — a list of crop prices, one for each of 13 crops

decade — used by the Dutch to refer to one-third of a month. The first two decades in any month have 10 days, and the third decade has the number of days necessary to complete the month; ten-day period (three decades per month)

decade sprinkling algorithm — a procedure that estimates the demand for sprinkling water during a decade under a specified sprinkling policy in response to that decade's rain and evapotranspiration

deg C	degrees Celsius (Centigrade)
demand	the amount of water desired for a given use; usually varies with price, increasing when price decreases
DEMGEN	the demand generator, a stand-alone computer program that handles the housekeeping necessary to run DISTAG and writes its results for subsequent analysis; for some special analyses, DEMGEN replaces DM but cannot make "distribution-like" computations, such as constraining delivery of water for sprinkling
DEX	the "extremely dry" external supply scenario; rainfall and river flows as low as those in DEX are likely to occur an average of no more than once every 50 years
Dfl	Dutch florin (guilder)
Dflm	millions of Dutch florins (millions of guilders)
Dflt	thousands of Dutch florins (thousands of guilders)
DHL	Delft Hydraulics Laboratory
DISTAG	district hydrologic and agriculture model
district	the basic hydrologic entity in PAWN; the Netherlands has been partitioned into 77 districts, each of which is small enough that internal details of surface water movement can be regarded as unimportant from a national water management standpoint
dm	decimeter
DM	water distribution model
DSM	daily sprinkler operations simulation model
DVK	Dienst Verkeerskunde-Hoofdafdeling Sheepvaart, the shipping service of the RWS
DW	drinking water
DW companies	firms that produce and distribute high-quality water
DW projects	synonymous with SW projects, defined below
EBW	Economisch Bureau voor het Weg- en Watervervoer (Netherlands Economic Bureau for Road and Water Transport)
EEC	European Economic Community, the common market

EGR	economic geographical region
elasticity	the demand (supply) elasticity shows the sensitivity of sales (production) to an increase in price; economists define the demand (supply) elasticity as the ratio of the percentage change in sales (production) to the percentage increase in price
eligible area	the eligible area for surface water sprinkling, i.e., cultivated land that can be supplied with surface water for sprinkling crops; the remainder of the cultivated land is assumed eligible for groundwater sprinkling
EPA	the U.S. Environmental Protection Agency
EPRAC	electric power reallocation and cost model
eutrophication	the condition in which a body of water has become rich in dissolved nutrients; in PAWN, used as a synonym for (objectionably) heavy growth of algae
evapotranspiration	the combined loss of water from an area by direct evaporation and transpiration by plants
excess temperature	a measure of thermal pollution; the rise in temperature of a water body above its natural temperature
external supply scenario	indicates the amount of water entering the Netherlands from various sources in each decade of a given year; for each decade of the year, the scenario contains data on rainfall and evaporation at 14 weather stations covering the nation, discharges of the Rijn, the Maas, and various other rivers, and salt concentrations of the Rijn
extractable amount	established by RID, this shows the amount of groundwater that can be extracted in a particular district or province during an average year without risking serious consequences from the corresponding drop in groundwater level
flushing	the process of exchanging polluted or saline water in polders for better quality water by letting water in at one end of the polder and then pumping it out the other end
g	gram
GIFT	the amount of sprinkling water applied per irrigation; measured in millimeters
groin	a low dam built out from the shore of a waterway, used to direct a current

groundwater	water in the ground near the surface that fills wells and in high ground drains to lower ground, streams, and rivers
GW	groundwater
GW charge	a tax on groundwater extractions intended to help conserve groundwater; a pricing tactic
GW shadow price	in a particular district, the (common) value of one additional cubic meter of groundwater to each user; also, the price each user should be willing to pay for that unit of groundwater; if all users are charged this price for each unit of groundwater, they should demand in total exactly the amount of groundwater available under the quotas specified for the district
ha	hectare, a measure of area; one hectare = 10,000 square meters (about 2.5 acres)
Haspel	Dutch word for hose; refers to a sprinkler system consisting of a large reel and hose; the hose, with sprinkler on one end, is wound onto the reel to move the sprinkler across the field
Highlands	that part of the Netherlands where the ground elevation is more than 2 meters above mean sea level
hp	horsepower
hr	hour
ICW	Instituut voor Cultuurtechniek en Waterhuishouding (Institute for Cultivation and Water Management)
ICWA	Interdepartementale Coordinatie Commissie Waterhuis-houding (Interdepartmental Coordinating Committee for Water Management)
I/D	industry/drinking-water companies
IJssel lakes	the system of huge storage basins that supply fresh water to the northern part of the Netherlands
IMP	Indicatief Meerjarenprogramma (Prospective Multi-Year Program); five-year plans required by the Anti-Water-Pollution Act)
impact assessment	the final analysis stage in the PAWN study, where the many consequences (impacts) of promising water management policies were determined
IND	industry

infrastructure	water management facilities, e.g., canals, pumping stations, and sluices
Int	international
I-O model	the input-output model of the Netherlands economy
IRSM	industrial response simulation model
IWW	ICWA-Werkgroep Waterhuishouding; ICWA working group established to provide guidance for PAWN and the Nota Waterhuishouding
KEMA	NV Tot Keuring Van Elektrotechnische Materialen; the research institute for the Electric Power Industry; it is closely related to NV SEP
kg	kilogram
kg/s	kilograms per second
Kjeldahl-nitrogen	the sum of the most chemically active forms of nitrogen
km	kilometer
km^2	square kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
l	liter
LEI	Landbouw Economisch Instituut (Agricultural Economics Institute)
level control	the maintenance of the level of a body of water at a desired value
long run	any period longer than the short run, often a year or years; a long-run tactic is applied continuously for such a period
Lowlands	that part of the Netherlands where the ground elevation is less than 2 meters above mean sea level
m	meter
m^2	square meter

m^3	cubic meter (usually of water)
m/s	meters per second
m^3/s	cubic meters per second
Maas	Meuse River
managerial rule	a prescribed action or set of actions that control the operation of the water management infrastructure so as to determine water distribution, at least locally
managerial tactic	a tactic that involves changing the way the water management infrastructure is managed (i.e., changing managerial rules)
marginal cost	the extra cost incurred to produce one more unit; economists contend that prices based on marginal costs allocate resources most efficiently
MAXTACS	the set of nine dominant promising technical and managerial tactics presented at the final PAWN briefing held in the Netherlands, December 1979
MC	marginal cost
Mcal	megacalorie; the heat required to raise the temperature of one cubic meter of water one degree Celsius
Mcal/s	megacalories per second
mcm	millions of cubic meters (usually of water)
mg	milligram
mg/l	milligrams per liter
min	minute
ml	milliliter
MLC	mean load capacity
mln	million
mm	millimeter
MSDM	managerial strategy design model
MSDM strategy	the optimal managerial strategy, designed with MSDM
MW	megawatt

NAP	Normaal Amsterdams Peil; this is the normal mean sea level used as the reference level for measuring elevations in the Netherlands
national system	the major rivers, canals, and lakes in the Netherlands
national water distribution system	the major rivers, canals, and lakes in the Netherlands
natural temperature	the temperature of a water body in the absence of heat discharges
network	a schematization of the waterways other than local ditches that comprise the surface water distribution system; links in the network represent sections of waterways, and nodes represent locations where waterways join or places where water is stored
No.	number
node-decade	an aggregate measure of compliance with a water quality standard that includes both the frequency and the geographic extent of the standard's violation. At each node, we compare the calculated concentration of the pollutant with the standard in each decade and determine the number of decades with violations; we accumulate the number of decades with violations over the nodes. The total score is number of node decades not meeting the standard. Our measure of compliance is the number of node decades in violation, expressed as a percentage of the worst possible score (every node in violation every decade)
nodes	locations in the surface water distribution system where waterways join or places where water is stored
Nota	the shortened form of Nota Waterhuishouding (defined below)
Nota Waterhuishouding	the new national policy document on water management for the Netherlands, scheduled for publication in mid-1983
NSG	Netherlands support group
NV	a company with limited liability; a corporation
NVI	Nederlands Vervoerswetenschappelijk Instituut (Netherlands Institute of Transport)

optimal sprinkling policy	a sprinkling policy tells when to start sprinkling and how much water to put on a field when sprinkling starts; optimal sprinkling policies, developed for each relevant combination of crop type, soil group, and root zone depth, minimize the expected value of operating cost and crop damage
OXYMOD	the dissolved oxygen model used in the analysis of eutrophication
PAWN	Policy Analysis for the Water Management of the Netherlands; a joint research project of The Rand Corporation, the Rijkswaterstaat, and the Delft Hydraulics Laboratory
pct	percent
pi	the ratio of the circumference to the diameter of a circle
plot	one of the more than 1200 small areas into which PAWN divided the Netherlands on the basis of soil and crop types, the type of sprinkling (if any), and other hydrologic properties; the smallest area considered in the PAWN analysis
plot damage model	a subroutine of DISTAG that computes agricultural damage
plot salt model	a subroutine of DISTAG that computes salt concentrations in the soil
plot water model	a subroutine of DISTAG that computes water demands by agriculture
polder	a land area surrounded by dikes, in which the water level in the ditches is controlled independently from neighboring areas
policy	a particular combination of all four kinds of strategies; a policy should be thought of as the <u>overall</u> water management for the Netherlands in much the same way as we would think of the Netherlands foreign policy or economic policy
policy design	the second analysis stage in PAWN
ppm	parts per million
P/R	price and regulation (tactics)
PREPDM	preprocessor for the distribution model

pseudo-province	an integral aggregate of PAWN districts that approximates an actual Dutch province
quota	the permissible annual amount of groundwater extractions in a district or province; a regulation tactic
RALL	eligible area: a future situation reflected in the sprinkler scenarios in which the implementation of all promising waterboard plans have led to an eligible area for surface water sprinkling larger than the current one
Rec	recreational ship traffic
region	the basic unit used in the screening analysis. The Netherlands is divided into eight regions, each of which is a combination of contiguous districts
regional system	the rivers, canals, and lakes that transport water within a region and from the national system to the region
requirement	the minimum amount of water for a given use; unlike a demand, a requirement does not vary with price
RESDM	response design model, used to develop long-run pricing and regulation strategies
response	one or more actions taken by an industrial firm, a drinking-water company, etc., in response to price or regulation tactics
RID	Rijksinstituut voor Drinkwatervoorziening (the State[1] Institute for Drinking Water Supply)
RIDDWM	RID's drinking-water model
Rijkswaterstaat	the Netherlands governmental agency for water control and public works
RIN	Rijksinstituut voor Natuurbeheer (the State Institute for Nature Management)
RIZA	Rijksinstituut voor Zuivering von Afvalwater (the Netherlands Pollution Control Institute); the State Institute for Wastewater Treatment--actually a part of the RWS
RNONE	eligible area: the situation in sprinkler scenarios in which no promising waterboard plans have been implemented; reflects the current area eligible for surface water sprinkling
RWS	Rijkswaterstaat, the Netherlands governmental agency for water control and public works

RWS managerial strategy	the managerial rules that the RWS used at the time of the study, but with one modification: a highly cost-effective new policy for flushing the Markermeer, the second largest of the IJssel lakes, which the RWS has since adopted
screening	the first stage of analysis in PAWN; in this stage a large number of potential tactics were reduced to a small number of promising tactics that were subsequently examined more extensively
sector	the different parts of the PAWN problem/methodology; e.g., agriculture, industry, shipping, environment, locks, etc.
seepage	the movement of groundwater to places with lower groundwater levels; in the lower parts of the country, seepage flows may enter the surface water; in some areas, this seepage, driven by relatively high sea level, may be saline
SEP	NV Samenwerkende Elektriciteits-Produktiebedrijven (Cooperative of Electric Power Producers), a company concerned with the production of power; it maintains the power grid, manages production, and develops a national optimal production scheme
short run	a day or ten days, corresponding to the time it might take to implement some day-to-day action (e.g., a managerial tactic) and see its effect on the water management system; it also corresponds to the one-third of a month that is the time-step for most of our models
SIMPLE MSDM strategy	the simplified version of the MSDM strategy that was implemented in the water distribution model; it does not incorporate the MSDM strategy features for dealing with several lower-priority water uses
SPRHI	sprinkler intensity: a future situation in which farmers in eligible areas optimize the amount of installed sprinklers
sprinkler intensity	the proportion of an eligible area on which sprinklers are installed
sprinkler scenario	specifies how much land has each type of sprinkling (surface water or groundwater) and identifies its location and crop type; a sprinkler scenario is defined by specifying the surface water and groundwater sprinkler intensities as well as the area eligible for surface water sprinkling

SPRLOW	sprinkler intensity: a situation in which the installed sprinkler equipment in the eligible area approximately corresponds to the current situation in the Netherlands
SPRMED	sprinkler intensity: a situation in which the installed sprinkler equipment in the eligible area is the average between the current and the optimal amount
SSACM	sprinkler system allocation and cost model
standard	maximum tolerable concentration for salt or some other pollutant in the water
strategy	a mix of tactics of a particular kind; e.g., a technical strategy or a managerial strategy
SW	surface water: found in rivers, lakes, and canals
SW projects	a menu of reservoirs and treatment plants that drinking-water companies might use, build, or expand to meet drinking-water demands
tactic	a single action intended to alter the current water management policy, e.g., build a particular facility or tax a particular water use
technical tactic	a tactic that involves changing the water management infrastructure; e.g., building a pumping station
TLC	total load capacity
ton	metric ton (1000 kilograms)
VEL	an abbreviation for the Velsen managerial strategy, a modification of the RWS managerial strategy to provide more cooling water from the IJssel lakes to the Velsen power plant
Velsen	a large power plant located at the mouth of the Noordzee-kanaal
VEWIN	Vereniging van Exploitanten van Waterleidingbedrijven in Nederland (Union of Drinking-Water Companies in the Netherlands), a trade association of Dutch drinking-water companies
violation frequency	our measure of compliance with a water quality standard; see node decades above
VNO	Vereniging van Nederlandse Ondernemingen (Union of Dutch Business Concerns), the Netherlands Employers Association

WABASIM	a combined project of the RWS and DHL, with Rand advisors; its purpose was to develop water basin models
waterboard	a governmental body that is responsible for water management within its boundaries; there are about six hundred waterboards in the Netherlands
waterboard plan	a plan developed by a waterboard for expanding or improving the water supply possibilities within its jurisdiction
water management policy	a combination of tactics--technical, managerial, pricing, and regulation--designed as a package to be an overall policy for the management of Dutch water resources
waterway	a river, canal, or lake that is used to transport water
waterwork	a pumping station, sluice, syphon, or lock that is used to transport water between adjacent bodies of water
weir	a (movable) dam placed across a river to raise the level of the river behind the weir
weir pond	the water behind a weir
wk	week
WW	Directie Waterhuishouding en Waterbeweging (Directorate of Water Management and Water Movement); the directorate within the RWS for which the PAWN study was carried out
yr	year
µg	microgram
µg/l	micrograms per liter

NOTE

1. The most literal translation of "Rijks" is "state," meaning the national government. When referring to organizations at this level of government, we use the terms "state," "Netherlands," and "government" interchangeably.

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