Assessment Method of Urban Domestic Sewage Treatment Plant-Network Integration based on Current Drainage Management

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01

PART

Background

- 1.1 Concept
- 1.3 Significance
- 1.3 Domestic application

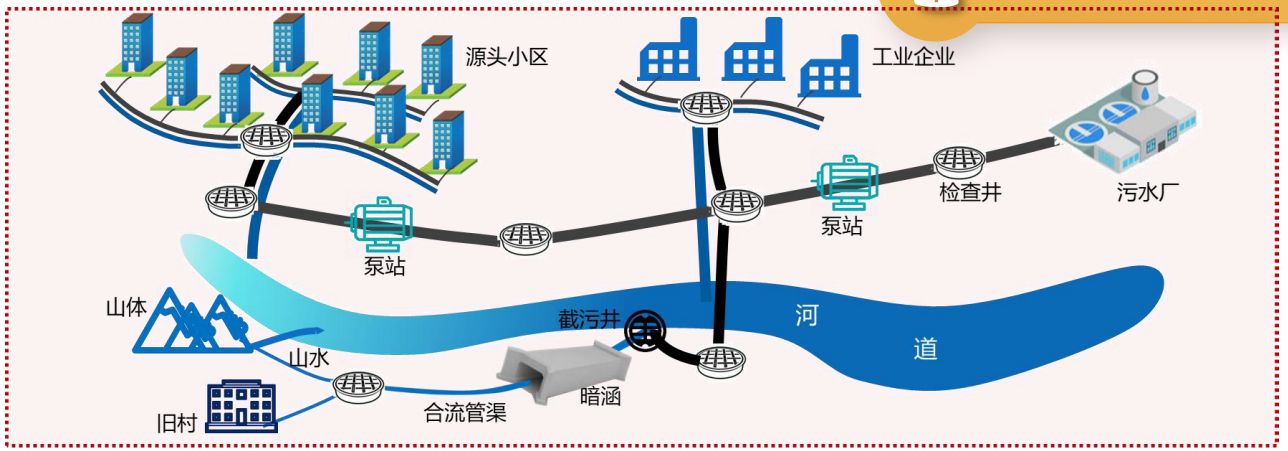
1.1 Concept

Sewage Treatment Plant-Network Integration

- sewage treatment plants
  - Sewage Treatment
  - Sludge disposal
  - Reclaimed water treatment

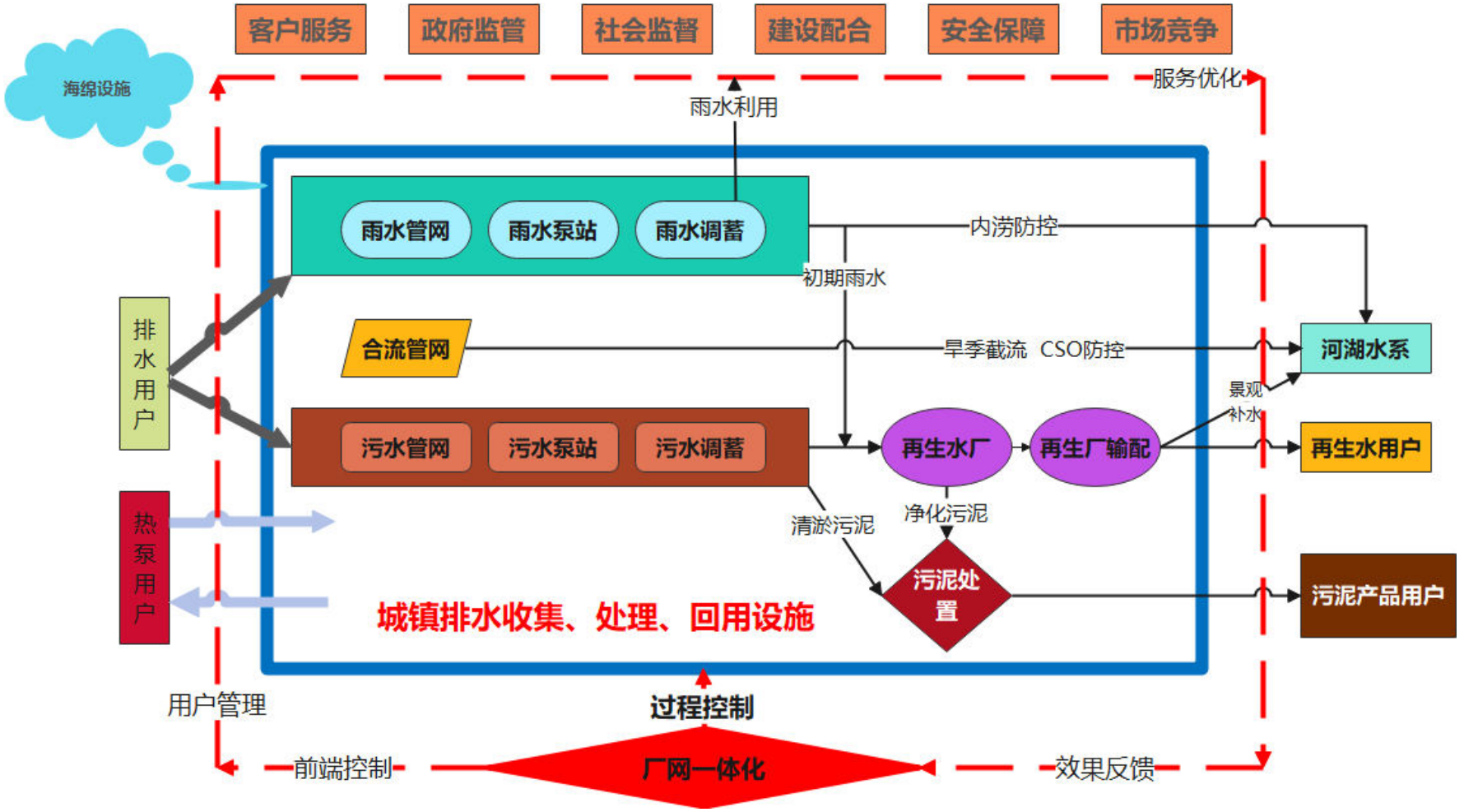
and

- drainage network
  - Storm water pipes
  - Sewage pipes
  - Drainage pumping station
  - Reclaimed water pipes



1.2 Significance

Sewage Treatment Plant-Network Integration can improve the efficiency of drainage system management



1.2 Significance

The Sewage Treatment's influent concentration is very low, then the sewage treatment is in the process of treating a large amount of clean water.

城市	污水处理量	进水BOD浓度(mg/L)	污水处理集中收集率
珠海	**23757.5**	**72.5**	**38.2%**
汕头	24848.8	67.4	39.7%
肇庆	**8883.9**	**38.3**	**26.5%**
韶关	6991.5	33.3	18.4%
潮州	8962.5	40.4	30.7%
揭阳	4888.3	35.3	12.4%
茂名	**5766.6**	**57.2**	**25.6%**
梅州	5189.9	32.7	24.1%

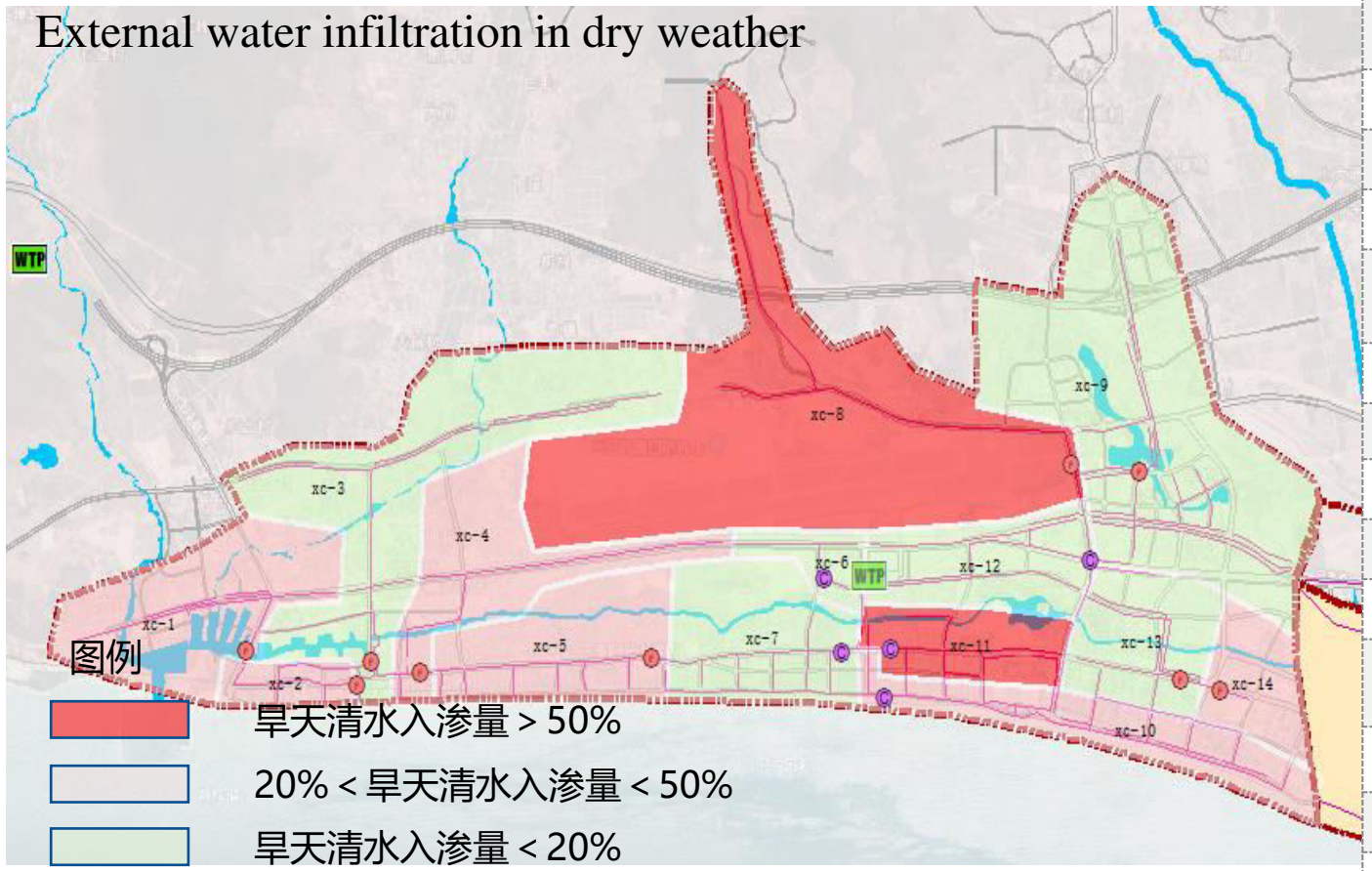
城市	污水处理量	进水BOD浓度(mg/L)	污水处理集中收集率
惠州	33519.8	63.5	55.2%
中山	10357.6	65.2	48.3%
阳江	4913.3	66.7	35.6%
东莞	111428	76.3	59.0%
河源	3051.8	48.2	28.3%
云浮	2396.0	36.4	19.9%
汕尾	2648.3	62.0	34.1%
清远	8123.6	60.7	58.2%

1.2 Significance

Separation of plant and network management may lead to low efficiency of wastewater treatment.

Jin Xu, Zuxin Xu（2022）.China sewage treatment engineering issues assessment

编号	监测点位	分区面积	监测水量（m³/d）	入渗水量（m³/d）	占比
XC1	御海路泵站	1.8	191	73	38.2%
XC2	鲁能三亚湾港湾一区	0.35	411	148	35.9%
XC3	启航路流量	3.14	0	0	0.0%
XC4	古榕泵站	1.58	2606	675	33.7%
XC5	阳光大酒店	1.44	5249	904	34.2%
XC6	新城污水厂西侧进水管	0.38	161	21	13.0%
XC7	新城泵站进水口	1.41	3066	0	0.0%
XC8	海虹路新开田村	5.34	5515	3045	55.2%
XC9	高峰路水姣路路口	4.34	6693	1012	15.1%
XC10	碧海金沙酒店	0.35	4900	984	20.1%
XC11	海坡四横巷新城路	3.14	306	204	66.7%
XC12	二月花海景花园南侧	1.16	5531	0	0.0%
XC13	新城东泵站（西侧）	1.07	1080	174	16.1%
XC14	新城东泵站（东侧）	0.69	8.6	3	40.0%
	求和	26.19	1.4w	7241	51.9%



1.2 Significance

External water infiltration of sewage pipe networks are common

- RDII=（Q雨-Q旱）/（区域建成区面积*降雨量）

External water infiltration in on rainy days

分区编号	面积 (km2)	RDII (m3/mm·km2)	占总入流入渗量比例
xc-1	1.90	43.33	9.2%
xc-2,xc-3, xc-4.xc-5	6.88	19.19	14.7%
xc-6	0.39	22.61	1.0%
xc-7	1.49	101.23	16.9%
xc-8	5.65	8.04	5.1%
xc-9	4.58	59.9	30.7%
xc-10	1.31	118.1	17.3%
xc-11	0.90	45.1	4.5%
xc-12	1.23	0	0%
xc-13	1.14	4.14	0.5%
xc-14	0.73	0	0%

1.3 Domestic application

Most cities in China fail to promote integrated plant-network management rapidly.

Integrated plant-network management in different cities of China: **Beijing, Shenzhen, Chongqing, Guangzhou, Sanya, and Suzhou have been developing at an accelerated rate.**

广州

排水体制改革、厂网一体化考核

2018年前中心城区排水设施“市区两级+雨污分割”管理
2018年成立城市排水公司（水投集团），建立从排水户—公共管网—泵站—污水的“厂网一体化”全覆盖管理，重点加强对旱天污水溢流和进厂水质浓度等考核

三亚

初步实现“厂网河”一体化管理

原来环投集团运营污水厂，排水设施由市政维护应急中心管养，河道保洁由属地政府维护管养；
通过特许经营将厂、网、河建设和运营统一交由环投集团，实施一体化运维考核，对污水处理、排水管网管养、河道保洁按效付费

北京

试点流域实现“厂网一体化”管理

厂网虽同由北排集团运营管养，但厂网由不同分公司运维，未实现真正的厂网一体化管理
2019年启动流域化“厂网一体”运营管理试点，北排集团建成了指挥调度中心、系统，实现排水系统建设及运行的统一调度

重庆
成都

突破上市公司限制，启动排水体制改革

机构重组改革：成立重庆市管网公司，将上市公司水务集团整合，把管网移交给重庆市管网公司统一运管。
探索按效付费机制：正在探索污水处理付费与污染物入厂削减总量挂钩，按效付费机制。

02

PART

Problem analysis

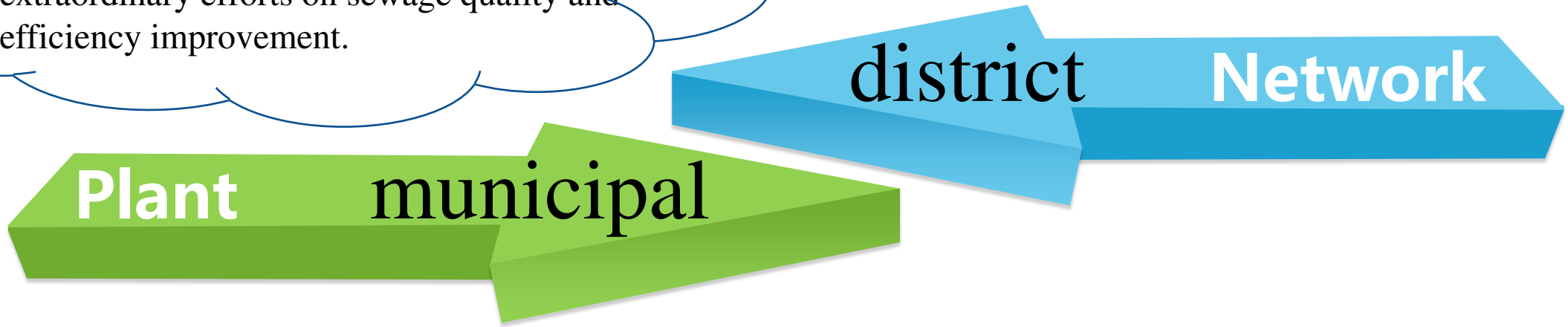
- 2.1 current drainage management
- 2.2 cause analysis

2.1 current drainage management

1. Mangement ——multi-level management

The district-level departments cannot contribute extraordinary efforts on sewage quality and efficiency improvement.

The sewer network is generally managed by the district authorities.



The sewage treatment is generally administered by municipal authorities.

For example,in 2020,
average daily sewage treatment : 650,900 m^3;
average inflow BOD concentration ： 72.5 mg/L.
external water might be around 30% ,
approximately 140 million yuan for external water.

2.1 current drainage management

2. Operations —— plant -network separate operation

No.	Name	Capacity (10^4 m^3/d)	Sewage Treatment Plant Operation and Maintenance Departments and Institutions		Network (within service area) Management and Maintenance Departments and Institutions	
1	Gongbei Water Purification Plant (Phase III)	8	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Urban Management Bureau of Xiangzhou District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
2	Beiqu Water Purification Plant (PhaseI)	5	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Construction Bureau of Gaoxin District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
3	Jida Water Purification Plant (Phase I)	1.8	Water Resources Bureau ofZhuhai City	Zhuhai Leaguer Environmental Protection Co., Ltd	Urban Management Bureau of Xiangzhou District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
4	Jida Water Purification Plant (Phase II)	3	Water Resources Bureau ofZhuhai City	Zhuhai Leaguer Environmental Protection Co., Ltd	Urban Management Bureau of Xiangzhou District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
5	Xiangzhou Water Purification Plant (P	3	Water Resources Bureau ofZhuhai City	Zhuhai HaiyuanEnvironmental Protection Co., Ltd	Urban Management Bureau of Xiangzhou District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
6	Xiangzhou Water Purification Plant (Phase II)	5	Water Resources Bureau ofZhuhai City	Zhuhai HaiyuanEnvironmental Protection Co., Ltd	Urban Management Bureau of Xiangzhou District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
7	Nanqu Water Purification Plant (Phase I)	5	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Urban Management Bureau of Xiangzhou District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
8	Sanzao Water Purification Plant	8	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Construction Bureau of Jinwan District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
9	Xinqing Water Purification Plant	3.5	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Water Resources Bureau of Doumen District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
10	Gongbei Water Purification Plant (Phase I & II)	5.5	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Urban Management Bureau of Xiangzhou District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
11	Jingan Water Purification Plant	3.5	Water Resources Bureau ofZhuhai City	Mingmen Water Quality	Water Resources Bureau ofDoumen District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
12	Baiteng Water Purification Plant	4	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Water Resources Bureau ofDoumen District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
13	Nanqu Water Purification Plant (Phase II)	4	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Construction Bureau of Hengqin New Area	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
14	Gongbei Water Purification Plant (PhaseIV)	7	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Urban Management Bureau of Xiangzhou District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company
15	Qianshan Water Purification Plant	10	Water Resources Bureau ofZhuhai City	Zhuhai Water Environment Holdings Group Ltd. Drainage Company	Urban Management Bureau of Xiangzhou District	Zhuhai Water Environment Holdings Group Ltd. Pipe Network Company

15 4 municipal 1 district

2.2 cause analysis

Existing problems

multi-level management

plant—municipal authorities
network—district authorities

separate operations

plant—sewage plant operating companies
network—drainage network operating companies

separate assessment payment

plant—municipal authorities
VS sewage plant operating companies
network—district authorities VS drainage network operating companies

2.2 cause analysis

□ analysis—separate assement and payment

The single assement payment will lead to city and district lack of interactivity, plant and network lack of integrated management.

系统考核	**管网管养考核指标**：以目测和第三方内窥检测考核，无定量指标 **污水厂考核指标**：水质达标，处理水量
付费模式	$F1 = P1 \times Q$ $F1 = P1 \times L$
付费程序	管网管养：区（功能区）水务主管部门按季度考核付费 污水处理：市水务主管部门或区按月考核付费
存在问题	**无奖优罚劣+劣管网无约束+汛期浓度低的情况污水处理费极贵**

03

PART

Solution

- 3.1 solution ideas
- 3.2 an integrated assessment payment
- 3.3 an application case

3.1 solution ideas

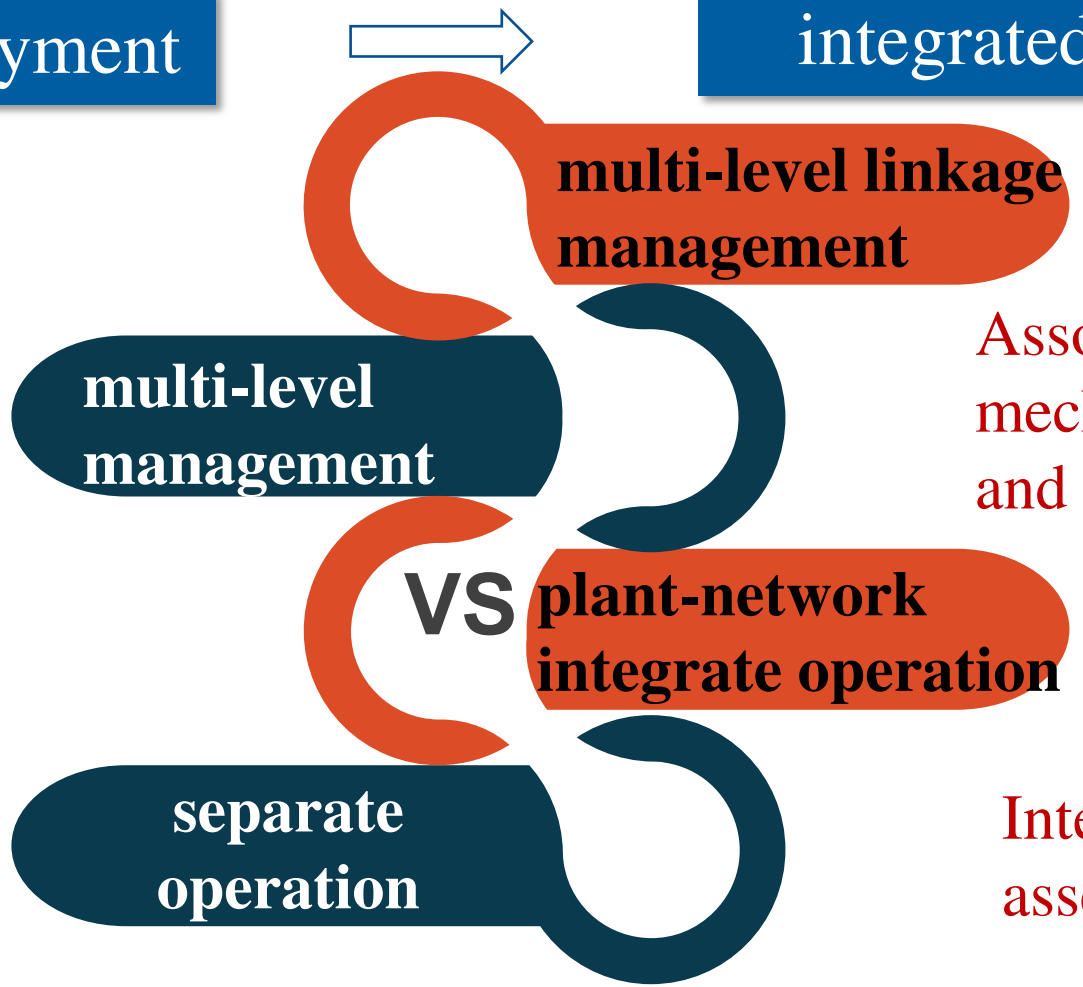
solution

separate assessment payment

integrated assessment payment

PLANT—municipal authorities
NETWORK—district authorities

PLANT—sewage plant operating companies
NETWORK—drainage network operating companies

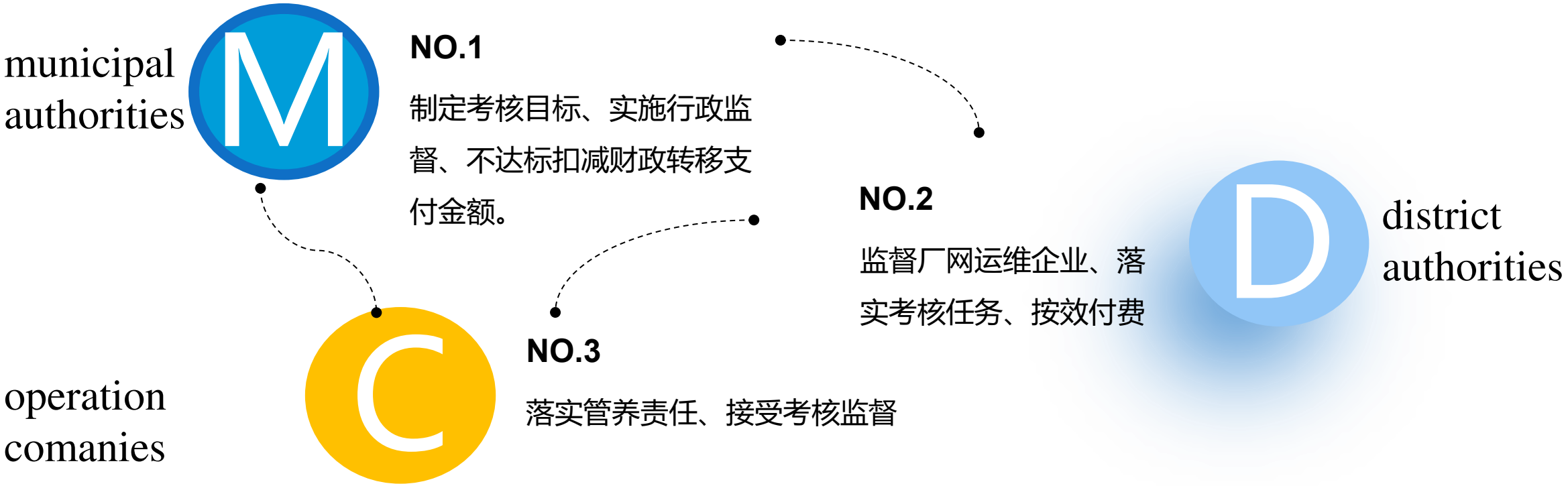


Associated assessment mechanism at the municipal and district levels

Integrated plant and network assessment mechanism

3.1 solution ideas

- **Implement plant-etwork integrated assessment in two aspects: urban two-level linkage assessment and government enterprise two-way linkage assessment.**



3.2 an integrated assessment payment

☐ Strengthen the assessment of municipal authorities on district level authorities.

Assessment method for the Integrated Linkage of City and District Plant-Networks

项目	序号	内容	分值
安全	1	安全管理	10
管理	2	内涝防治	10
市政管网系统运行维护情况	3	排水设施监管得分	12
提质增效	4	提质增效水质达标	15
	5	提质增效水量达标	10
	6	提质增效负荷达标	10
	7	提质增效工作落实	5
排水小区管理	8	排水单元检查	8
	9	排水户管理	5
污泥监管	10	污泥及淤泥监管	10
其他	11	交办事宜与舆情	5
合计			100

3.2 an integrated assessment payment

- **Determine the sewage treatment fees paid by the municipal finance department to the district finance department based on the assessment results**

Payment method for the Integrated Linkage of City and District Plant-Networks

考核得分	考核等级	财政转移支付金额支付比例
考核得分≥85	优秀	100%
70≤考核得分 < 85	良好	85%
60≤考核得分 < 70	合格	70%
考核得分 < 60	不合格	50%且暂不支付

3.2 an integrated assessment payment

☐ Constructing a authority performance evaluation and payment mechanism for enterprises.

Sewage Treatment Paid Assessment Index System

Index	Sewage Treatment Paid-Assessment indicator		Category
Basic index	Water Quantity	Operating Load Rate	Evaluation
	Water Quality	Inflow Water Quality Concentration	Reward&Punishment
		Outflow water quality standard-reaching rate (6 Conventional Indicators)	Penalty
		Outflow water quality standard-reaching rate (6Unconventional Indicators)	Evaluation
	Sewage overflow before entering the plant	Sewage Overflow due to inappropriate Operation	Penalty
		Sewage Overflow due to inappropriate Design	Penalty
	Pollutant reduction	Comprehensive Pollutant Reduction	Reward&Punishment
		Extra Pollutant Reduction Rate (when actual inflow water quality exceeds design value)	Reward&Punishment
	Sewage sludge	Moisture Content Standard-reaching rate	Evaluation
		Stable Treatment Rate	Evaluation
		Safe Disposal Rate	Evaluation
Qualitative index	Qualitative index	Fundamental management, Operation Management, Facility Management and etc.	Evaluation

3.2 an integrated assessment payment

☐ Constructing a authority performance evaluation and payment mechanism for enterprises.

Paid Assessment Index System for Network Management and Maintenance

index	Network management and maintenance assessment indicator		Category
Basic index	Inflow pollutant	Inflow pollutant concentration (e.g. BOD, COD)	Reward&Punishment
		Inflow pollutant, inflow volume × inflow pollutant concentration (BODor COD normally be used)	Reward&Punishment
	Sewage direct discharge and overflow	Spot-checked dry days sewage direct discharge and overflow due to improper maintenance or repair	Penalty
		Spot-checked rainy days sewage overflow due to overdue network dredging or repair	Evaluation
	Network management, maintenance and repair	Network dredging or detection frequency, length and effectiveness	Evaluation
		Network disease repairing, mixed connection or misconnection transformation	Evaluation
	Flooding emergency	Waterlogging point flooding management	Evaluation
		Severe waterlogging due to inappropriate management	Penalty
	Routine Maintenance	Network repair efficiency and effectiveness	Evaluation
Qualitative index	Qualitative index	Fundamental management, operation management, facility management and etc.	Evaluation

3.2 an integrated assessment payment

Pay fees based on effectiveness

sewage treatment fees

$$F'1 = P1 \times Q \times J1 \pm G1 - W1$$

network maintenance fees

$$F'2 = P2 \times L \times J2 \pm G2 - W2$$

- unit-price
- Total amount of qualified treatment
- Evaluation index coefficient
- Reward and punishment assessment cost
- Abnormal operation and maintenance deductions to deduct the abnormal operation and maintenance costs.

3.3 an application case

A case: Jida sewage-treatment plant,form Jan to jun, 2021

Sewage Treatment Fee of Jida Water Purification Plant from Jan. 2021 to Jun. 2021

Month	G1 (score/total*reward or punish fees) (10^4yuan)	J1	W1 (e. g. , sewage overflow penalty: sewage overflow volume*30*sewage treatment unit price; waterlogging would punish facility operation and maintenance fees) (10^4yuan)	=P*Q*J1+G1-W1 (10^4yuan)	Traditional Single Pricing F1(10^4yuan)
Jan	7	0.95	0	72.0	68.4
Feb	10	0.93	0	68.3	62.6
March	5.6	0.93	3.8	73.9	77.5
April	4	0.91	5.6	55.4	73.9
May	3.8	0.97	1.2	74.2	80.7
June	-18.9	0.92	6.9	86.0	121.5
Total				429.8	484.6

54.8 10^4yuan

3.3 an application case

A case: Jida sewage-treatment plant,form Jan to jun, 2021

Sewage Treatment Fee Shared by City-District Level of Jida Water Purification Plant From January to June 2021

Month	Target Concentration of Inflow BOD (mg/L)	Actual Concentration of Inflow BOD (mg/L)	compliance	Proportion of the municipal paid fees	Proportion of the district level fees	Fees of municipal authority (10^4yuan)	Fees of District Authority (10^4yuan)
January	102	149	Yes	100%	0	72.0	0.0
February	102	122	Yes	100%	0	68.3	0.0
March	102	104	Yes	100%	0	73.9	0.0
April	102	138	Yes	100%	0	55.4	0.0
May	102	137	Yes	100%	0	74.2	0.0
June	102	92.5	No	90.7%	9.3%	78.0	8.0
Total						421.8	8.0

3.3 an application case

The implementation effect of the assessment method form 2021

Operation Status of Domestic Sewage Treatment Plants in Zhuhai from 2018 to 2021

Year	Average daily sewage treatment volume (10^4m^3)	Average concentration of inflow BOD (mg/L)
2018	64.99	76.5
2019	68.14	79.8
2020	65.09	72.5
2021	64.59	86.6
2019 versus 2018	——	+4.3%
2020versus 2019	——	-9.1%
2021versus 2020	——	+19.4%

04

PART

Conclusion and Recommendation

conclusion and recommendation

- **The core reason for hindering the development of integrated plant-network management is the current sewerage management system.**

multi-level management

plant—municipal authorities
network—district authorities

separate operations

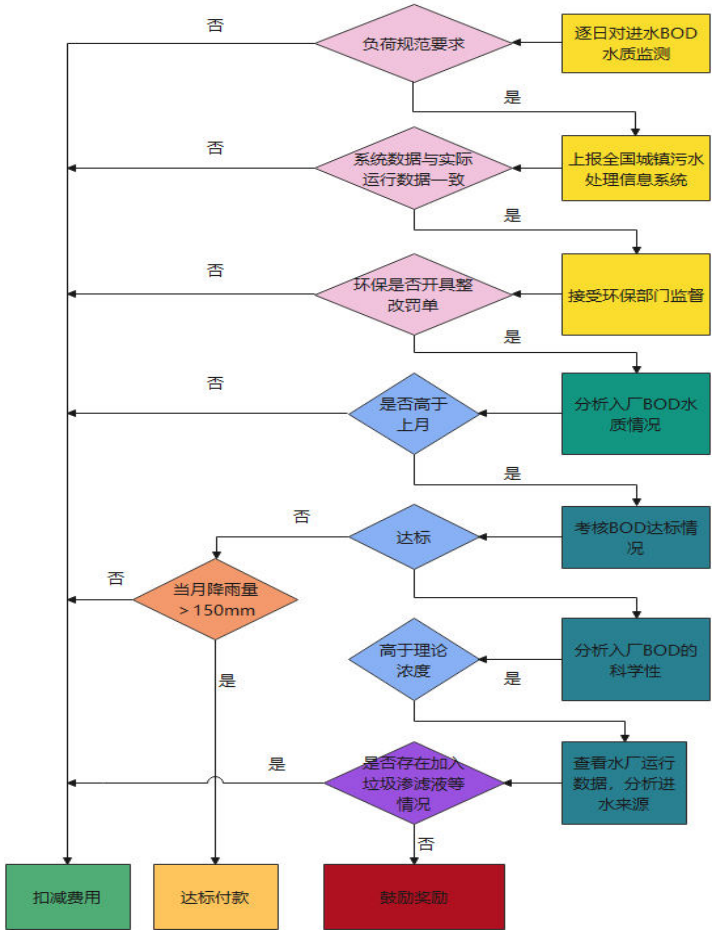
plant—sewage plant operating companies
network—drainage network operating companies

separate assessment payment

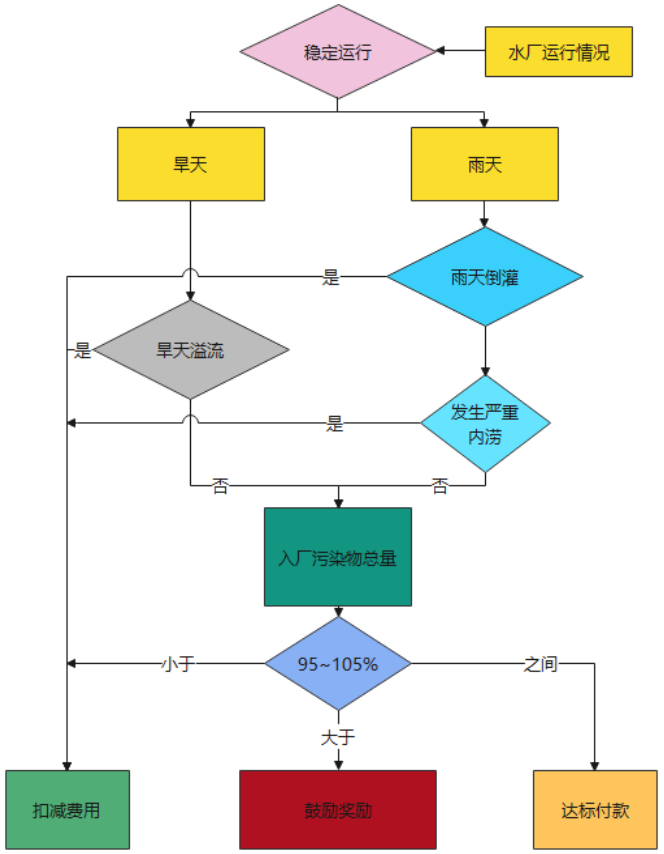
plant—municipal authorities
VS sewage plant operating companies
network—district authorities VS drainage network operating companies

conclusion and recommendation

an optimized integrated plant-network management assessment payment mechanism



step1—J



step2—W

类型	项目	内容	分值
日常管理指标	污水处理设施维护情况	污水处理设施监管	10
		污泥处理处置监管	8
	管网系统运行维护情况	通沟余泥处置监管	6
		管渠	6
		检查井	6
		泵站闸门	6
		管网功能性缺陷整改	6
		管网结构性缺陷整改	6
	水单元管理	排水单元内如管网检查	6
	防内涝应急布防	内涝布防和应急	10
	日常管理	日常巡查	5
		检修管理	5
	服务评价	半年度服务评分	10
	安全生产	安全生产	8
	其他	市交办事宜与舆情	2

step3—G

conclusion and recommendation

- It is demonstrated that this assessment plan is effective,based on the implementation effect of the case .

Year	Average daily sewage treatment volume (10^4m^3)	Average concentration of inflow BOD (mg/L)
2018	64.99	76.5
2019	68.14	79.8
2020	65.09	72.5
2021	64.59	86.6
2019 versus 2018	——	+4.3%
2020versus 2019	——	-9.1%
2021versus 2020	——	+19.4%


THANKS